DEVELOPING AN IMAGE CAPTURE SPECIFICATION FOR FUTURE BUILDING MODIFICATIONS

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Developing an Image Capture Specification for Future Building Modifications

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ABSTRACT

In the construction industry, images taken by cameras have been used to extract information for a number of purposes. However, a review of the literature suggests that there is an absence of specifications regarding the equipment, the method by which the images are to be taken, as well as the method to retrieve and store these images. The purpose of this research is to formulate specifications for capturing images at construction sites to be used later, using an 'appropriate' camera. The research has concluded that any camera available in the market can be used to take these images using the specifications for capturing such images developed as a result of this study.

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CHAPTER 1. INTRODUCTION

An enormous amount of information and data can be found in a single image, hence capturing images is one of the most effectual ways of monitoring construction work on site, communicating site conditions, assessing progress and highlighting problems. The purpose of this study is to introduce image capturing specifications for future construction projects and building modifications.

The amount of information provided by images can be used for other applications as well. Their utility can be extended to extract 2D information for as-built records and for the future renovation and/or maintenance.

Digital images can be used to extract data for a variety of purposes. However, using the unordered and uncalibrated images suggest a simple and primitive use of digital image data. A number of studies deal with capturing images on construction site (Tangelder et al. 2003, Lemaire et al. 2005, Bakis et al. 2007) reveals that:

1. Specifications are more focused on-site conditions.
2. Non-specific to camera other than image density.
3. No details provided on archiving project photographs.
4. No details provided on minimum distance required between building element and camera.

This study aims to explore whether the specifications proposed will improve the collection of images, as well of the storage of these images by creating a database, in order to utilize these images efficiently in construction projects. Currently, digital images are captured in an unordered fashion without guidance in the specifications for quality or equipment. This research proposes to consider both the equipment specification and image requirements for a

more comprehensive specification directed at a functional as-built image data set to be achieved for future building modifications.

Images can be rich source of data and information on a project and ultimately in the lifetime of the building, if they are properly registered with respect to their location on the project and their image quality is adequate. Background literature indicates that the identification and coordination issues can be reasonably solved with current methods. A noticeable gap in the literature and practice is a specification on the collection and sequencing of images. Linking photographic images to a building information model requires a baseline specification to direct image capture on the site which would include equipment required as well as recommended/required periodic images to be captured. Current cell phone camera technology may be an adequate recording device, but it is not known if they will produce the quality of image capture needed for construction images.

Capturing the photographs on job site is often a mandatory activity for progress reports. It is important to understand how the contractors use digital cameras during the period of construction and the directions that are given in the contract. The purpose of capturing images should be known and how often the images are taken during construction needs clarity. Moreover, the means and methods that are used to attain the images, organizing, sorting and storing is a significant aspect if there is to be value in using the images at a later time. Additionally, it is also important to know what specifications and standards companies use on job site for the digital cameras.

The ultimate goal of the research is to identify a process to capture the project site data efficiently without the aid of special purpose cameras or other technologies. Furthermore, the research can help to identify minimum technology (camera) required. Hence, the quality of the

captured images will not be compromised and overall purpose of capturing the images will be served.

Some assumptions were made while selecting equipment for experiments that the cell phone Samsung Galaxy S6, Olympus digital camera, and Nikon DSLR are capable of producing good quality image as compare to cell phone cameras and other digital cameras available in market. Outdoor images were captured utilizing daylight only. In order to enhance image quality camera features were not fully utilized to keep experiment simple.

CHAPTER 2. BACKGROUND

The use of digital still and/or video cameras on the site during and after construction for various purposes is very common today. A brief synopsis of work previously done is presented in three broad categories. 3D- modeling using photogrammetry, assessment and evaluation using photogrammetry, and construction progress monitoring using photogrammetry.

2.1. 3D-Modeling and Photogrammetry

Various techniques have been used in past years to create 3D models of buildings/objects using digital images. Aerial imagery is also one of the techniques that has been used for building detection and reconstruction. This study was applied to different resolutions image (between 1 meter and 10 centimeters per pixel) for the analysis of urban and suburban areas. For the purpose of image matching, several algorithms including new correlation and hierarchical processing were investigated for their ability to identify various components of building. These algorithms have useful properties for building feature grouping and building recognition. Information from 2D (monocular) and 3D (stereoscopic) was combined to detect and represent the buildings present in the images. But limitations of this research are that mid-resolution methods cannot be applied to high-resolution images. Since the content of these images was very different as compared to mid-resolution (Paparoditis et al. 1998). Whereas, some other researchers suggested that field images can be interpreted, and the appropriate CAD components selected from a standardized CAD component library can be used. The library contains description of simple components. By aligning the edges of the component's wire frame over the visible edges of objects in the images, the shape, position, and orientation of the real component was determined implicitly for fast reconstruction of the objects. This process involved two steps, the first step was to approximately align the component from library onto the image and second step was to

apply fitting algorithm for an automatic and precise alignment. Efficiency was improved by the imposition of geometric constraints on the CAD components (Tangelder et al. 2003).

The problems faced and solutions evaluated for using terrestrial images to create 3D models was discussed in one of the paper. This work was published in 2006 at time when 3D scanning was a standard source for providing input data in many areas. Image-based modelling was not common at that time. Researchers reviewed various papers in which problems were discussed in image-based modeling (Remondino and El-Hakim 2006). To create a 3D model of any object, an accurate geometric dimension of that object is required. One of the studies suggested that CAD modeling can be replaced by using the surveying technique of photogrammetry for the purpose of obtaining geometric information of objects present in digital images. Photogrammetry was considered to be less expensive and less time-consuming. The researchers took number of pictures from various view-points of a precast façade. These pictures were used as an input for the well-established commercial software system named as PhotoModeler (Eos Systems Inc. 2007) to create a 3D model of the precast façade (Dai and Lu 2008). Geometric information of erected buildings or under construction can be acquired for two-dimensional plans or three-dimensional CAD models. Nowadays, three-dimensional CAD data is preferred which can illustrate the shape and size of the building elements. Data for CAD modeling can be acquired by numerous methods such as using geodetic survey instruments, tachometers, theodolites or by photogrammetry digital image. To demonstrate the technology, the researchers examined various methods to determine the real dimensions of windows of the building under construction. They applied photogrammetric methods, using the PhotoMod software. A large number of marks (target points) were placed over the building to obtain the scale factor to create tie points (a common point in two images taken from two or more different

viewpoints) for further processing. A *Leica* total station was used to determine the precise coordinates of each mark and subsequently the data obtained from construction site were transformed to the photogrammetric PhotoMod Project. A *Canon EOS 350D* digital camera was used to capture images. TCC software (developed by the photogrammetric Institute of University of Bonn) was used to correct images according to the camera calibration result. Later those images were treated using the PhotoMod photogrammetric software (JSC Racurs, 1993) to achieve the required measures. Since only the actual dimensions were required, only the measurement of the area of interest was performed. Images taken from distance of 39 meter reduced the accuracy of measures in the images (Sužiedelyte-Visockiene and Bručas 2009). Site engineers take multiple photographs of "interesting" construction processes and activities on a everyday basis which results in a large amount of photographs accumulating in project records over time. These researchers developed a shape recognition model using date, time, material and manual schemes to classify and afterward retrieve related photographs from a database of random project photographs images from the database (Brilakis and Soibelman 2008).

An alternate technology was investigated in which researchers used handheld cameras to create as-built 3D point clouds and compared the as-built data with the original as-built 3D models to check for accuracy for modeling process. Off the shelf software packages were used to create 3D point clouds from the images of 20000 ft. construction of a bridge. Images were captured at a resolution of 16 megapixels by an off the shelf DSLR camera. The results indicated that creation of point clouds by using 16 megapixel DSLR camera is not suitable for modeling purposes (Bhatla et al. 2012).

2.2. Assessment and Evaluation using Photogrammetry

Photogrammetry has also been used previously for assessment and evaluation purposes. In one of the researches an advanced digital image processing technique was applied to study the microstructure of asphalt concrete (AC). In particular, the role of coarse aggregate in the bearing capacity and stability of AC mixtures was of interest. The coarse aggregate particles' shape, their distribution, and orientation in the mixture was determined in this quantitative study through image analysis. MOCHA (an image analysis software) was used to scale the image and to calculate the morphological (relating to the form or structure of things) parameters of aggregates from the image which were related to bearing capacity and stability (Yue et al. 1995). Non-coated surface quality of concrete was assessed with respect to grey levels of the surface and the surface bubble parameters through digital images. Comparing images of non-coated concrete surface under different illumination conditions is difficult. The researchers presented a method for attaining images of lightness L* (whereas the saturation and hue remains constant) simulated for one Standard Illuminant D65 (D65 corresponds roughly to the average midday light in Western Europe/Northern Europe). By the analysis of the images, precise defect information regarding surface bubble size and distribution can be obtained (Lemaire et al. 2005).

Various image processing techniques were used to assess the damages in the acoustic borehole imagery of concrete dam. For extracting damage information from the acoustic imagery of two boreholes with diameters of 77 and 96mm were drilled in a fifty-year-old dam located in Eastern Canada. Optical images were captured by OBI-40 camera from Mount Sopris Instruments and acoustic images were captured by ABI-40 Televiewer. Out of various techniques applied on imagery, only the texture analysis approach was found to be efficient (Kabir et al. 2009).

The application of digital photogrammetry to generate as-build maps of underground utilities to avoid potential strike hazards to buried utilities, foundations, structures, sidewalks, pavements causes by the ground movement during horizontal directional drilling. For monitoring surface movements, the researchers took 2D pictures of the construction area before, during and after construction, scaled those images to create reality three-dimensional model to measure changes and locations of targets within the generated model. A Canon EOS Rebel XSi Digital SLR camera of 12.2 megapixel and PhotoModeler used as a tool to perform the experiment (Lueke et al. 2011).

The architecture photogrammetry is the technique in which simple hand-held cameras are used for the record keeping of heritage buildings. The researchers commented that photogrammetry and laser scanning are expensive processes, but the results of photogrammetry are more accurate than the results obtained from laser scanning. A stereo model was created by taking various pictures of the building. Later plotting (a systematic process through which the complete subject's features transformed into scaled line-drawings) was done on the stereo model using AutoCAD (Salleh 2012). Unmanned aerial vehicle (UAV) and smartphone were used for photogrammetric purposes in one of the researches. High-resolution images were produced by using camera mounted in smartphone. The main goal of this study was to assess the payload possibility using a smartphone for photogrammetric UAV system. The smartphone application was also developed to obtain real-time image, altitude and location data using smartphone under both dynamic and static conditions. Images captured by the smartphone were converted to ortho-images (a corrected uniform-scale image) through a process called image triangulation. In static conditions the results from triangulation process were improved by 35% when interior orientation (determined by camera calibration) were not taken into consideration. Whereas,

triangulation accuracy was not significantly improved after considering interior orientation in dynamic conditions. This study concluded that a smartphone is feasible as a payload for UAV system (Yun et al. 2012). The researchers investigated sources of error cause by camera internal parameters, (principal distance, principal point, camera lens distortion coefficients, and type) image settings, and processing software programs in photogrammetry and its impact on modeling and surveying for construction site safety monitoring, quality control, and quantity takeoff applications. Experiments were conducted by the researchers for correcting full-scale photogrammetric models in construction applications. This research was performed to avoid the use of expensive technology on the construction site. Two cameras (a Canon EOS Rebel T3i and a Canon EOS 60D) with two different lenses were used to create model for the experiment. Red-reflective marks were placed on the retaining wall so that iWitness (software) can identify the spatial characteristics and establish relative orientation of the object. The researchers concluded that these 3D models can facilitate construction management functions such as assessment of quality, quantities, and production rates (Dai et al. 2014).

Unmanned aerial vehicle (UAV) photogrammetry was also used to obtain accuracy of ortho-images (a corrected uniform-scale image) and to explore the influence of terrain morphology, flight altitude, and ground control points (GCPs) on digital surface model (DSM). 60 different photogrammetric projects were carried out for this study considering four flight altitudes (50, 80, 100, and 120m), five terrain morphologies and three numbers of GCPs (3, 5, and 10). The obtained results validated that neither flight altitude nor the studied terrain morphologies has a significant bearing on the accuracy, whereas the number of GCPs and flight altitude governed the horizontal and the vertical accuracies, as they were improved when the number GCPs were increased and flight altitude decreased. The researchers generated a scaled

map according to the American Society for Photogrammetry and Remote Sensing map standard of 1990 for civil engineering projects (Agüera-Vega et al. 2016).

2.3. Construction Progress Monitoring using Photogrammetry

Photogrammetry has been used in construction industry for many years to monitor construction progress. In one of the state of the art in photogrammetry and computer vision in construction industry the researchers specifically aimed at incorporating capabilities of computer vision into the nD (n=2,3,4) modelling framework to automatically capture the construction progress on site and to assist the cost and schedule control tasks via integrated cost, schedule, and design information. Their views indicated that work schedule development and the estimation of the project cost cannot be completely automated. The use of photogrammetry and computer vision in the processes of construction such as updating the schedule based on construction progress, calculating valuations, and calculating cost needs to be examined in more detailed manner (Bakis et al. 2007). To monitor construction activities on site, cameras were fixed at various location in one of the researches to capture time-lapse images. The researchers used those images to compare the images of actual job site condition with the planned virtual reality (VR) images of construction from VR Simulated space. The researchers used two images with the matching 3D coordinates of viewpoints and direction vector which enabled to examine the difference between 3-dimensional CAD plans and job site actual situation. 3D coordinates of objects can easily be obtained from VR space which makes it possible to view the VR objects from numerous viewpoints as if the user was performing walk-through (Kim and Kano 2008).

In one of the researches, photogrammetry and laser scanning were integrated to enhance the accuracy and speed of data collection from the construction jobsite. Drawbacks of only using laser scanner for estimating quantity of work done were also presented in the research. The

experiment proved that laser scanning can only be performed outside the building from various location which is very time consuming and, in some cases, might not be feasible. The researcher's proposed method of integrating photogrammetry and laser scanning saved around 75% of the time required to scan the construction site by scanning only one side of the project and increasing resolution angle (El-Omari and Moselhi 2008).

To facilitate progress monitoring, document project development and to identify discrepancies between as-planned and as-built progress, researchers developed a system in which progress is visualized through integrating the as-built photographs with the as-planned 4D (3D+time) model.

Researchers first gathered the data from two different sources, the as-planned and the as-built. The information from these sources was merged to produce a 4D model and time-lapsed photographs. For any given time, the as-planned model is superimposed on the photographs taken from the construction site. In order to accurately superimpose the as-planned model onto the site photographs, registration of the three-dimensional virtual world and photograph coordinates was needed. To obtain images of known coordinates, the camera was geometrically calibrated at a fixed location on the construction site. After successful superimposition of the 4D model onto the construction site photographs, the progress discrepancies between the as-planned model and the photograph (as-built) were analyzed. Later, those images that showed discrepancies were documented for decision making and saved as a progress monitoring log (Golparvar-Fard et al. 2009).

The researchers proposed a new method for monitoring settlement of buildings. According to one of the researches, off-the-shelf cameras are capable enough to produce the high level of accuracy in millimeters. Therefore, an ordinary digital camera could replace traditional

surveying equipment such as total station with automatic leveling. After performing an experiment, the researchers concluded that there was a 10 to 31 mm difference between results obtained by total station and results obtained by photogrammetry. The results hold great potential but calls for further improvements (Dai and Lu 2010). For the purpose of construction progress monitoring a comparison was made by the researchers between photogrammetric point clouds and building information model (BIM) elements. The researchers proposed two methods for automatic construction site monitoring, one was to generate as-built data, and the other was for the as-built - as-planned comparison. A laser scanner was replaced by photogrammetric technology to create the point cloud model. Reduced geometric accuracy was the only disadvantage of using photogrammetric technology. The researchers noted that the required images cannot be taken from everywhere on a construction site. Therefore, to counter this problem they used structure from motion (SfM) process (a photogrammetric range imaging technique used for estimating 3D structures from 2D image sequences) along with control points to create a scaled point cloud (Tuttas et al. 2014).

Current methods for site data gathering, processing and representation are time-consuming and labor-demanding. The everyday progress reports hinge on data collected by field personnel and understanding of what needs to be measured and the way it needs to be presented. Therefore, reports may not reveal the actual impact of site conditions on the construction project. Thus, to make the site data collection and monitoring process easier, researchers introduced a new approach to recognizing the physical progress of a construction project by using unordered daily construction photograph collections and building information models (BIMs). Researchers proposed that low-quality images from a construction site can be used to generate dense as-built point cloud models (a model that is generated by the help of a set of data points in some three-

dimensional coordinate system to represent the external surface of an object). Subsequently, the underlying model was registered with other point cloud models which was generated by structure from model, multiview stereo, and voxel coloring techniques as well as the as-planned model, generated an integrated 4D as-built and as-planned model for progress visualization. High accuracy was demonstrated by the as-built and as-planned voxel coloring and labeling algorithm (Golparvar-Fard et al. 2012).

2.4. Summary

The literature shows that photogrammetry has been part of construction industry for a long time and digital images can be used to extract data for a variety of purposes and various types of equipment has been used to collect information in the researches cited. However, these studies have failed to include any information regarding the specifications related to collection of these images by using the unordered and uncalibrated images suggest a simple, perhaps more elegant use of digital image data. Literature review reveals that, digital images are captured in an unordered fashion without guidance in the specifications nor for quality or equipment. This research proposes to consider both the equipment specification and image requirements for a more comprehensive specification directed at a functional as-built image data set to be achieved for future building modifications.

CHAPTER 3. METHODOLOGY

Selection of equipment for capturing images was one of the important concerns in this research. There are numerous types of digital cameras of different brands and models available in the market, but for this research, three potential types of cameras were used which are easily available in the marketplace. These include smartphone's camera (Samsung Galaxy S6), low-cost digital camera (Olympus Digital Camera), and a DSLR camera (Nikon). The procedure for selecting acceptable equipment was based on performance characteristics and able to produce accurate images that do not need corrections with or without special software assistance. A primary consideration was the availability of cellular telephones with cameras and to look at their capabilities compared to traditional digital cameras.

A systematic method for collecting data was determined from set target points and physical objects in the image field of view. Varying distances to the points to be measured were selected to represent potential image conditions on project sites in the field. At each distance the camera's resolution was adjusted from a low resolution (around 2 megapixels (MP), middle resolution (8MP) and high resolution (16MP). The experiment set-up was varied from the first experiment to the second and third to increase measured point availability. The experiments are described in the next section.

3.1. Experiment Setup

Three experiments were conducted in which several images of a wall having windows and marks posted on different locations were taken by all three cameras. In order to have a common baseline all images of the wall were captured at location of University Village apartments, North Dakota State University. Normal camera holding height (5'-0") and constant lighting conditions were kept in all three experiments. (fig. 3.1.)

Figure 3.1. Image of subject wall with marks posted on it, taken from Samsung Galaxy S6

The dimensions of the windows and the distance from mark to mark was noted down (fig. 3.2. & 3.3.) to compare with the dimensions obtained from scaled images.

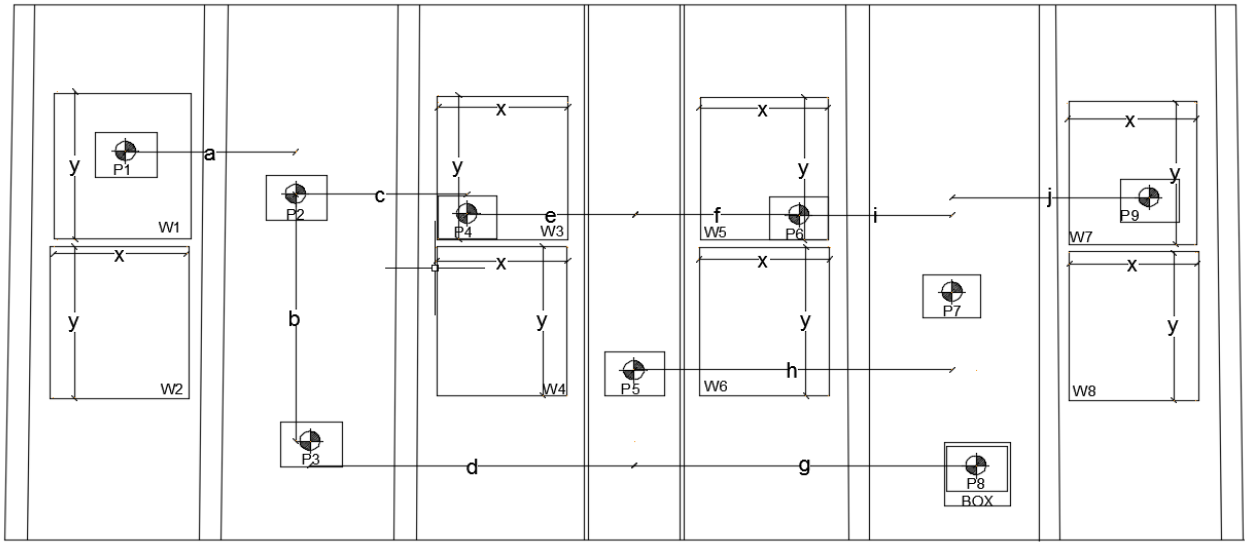


Figure 3.2. Location of marks placed on subject wall and dimension between mark to mark and windows for experiment 1.

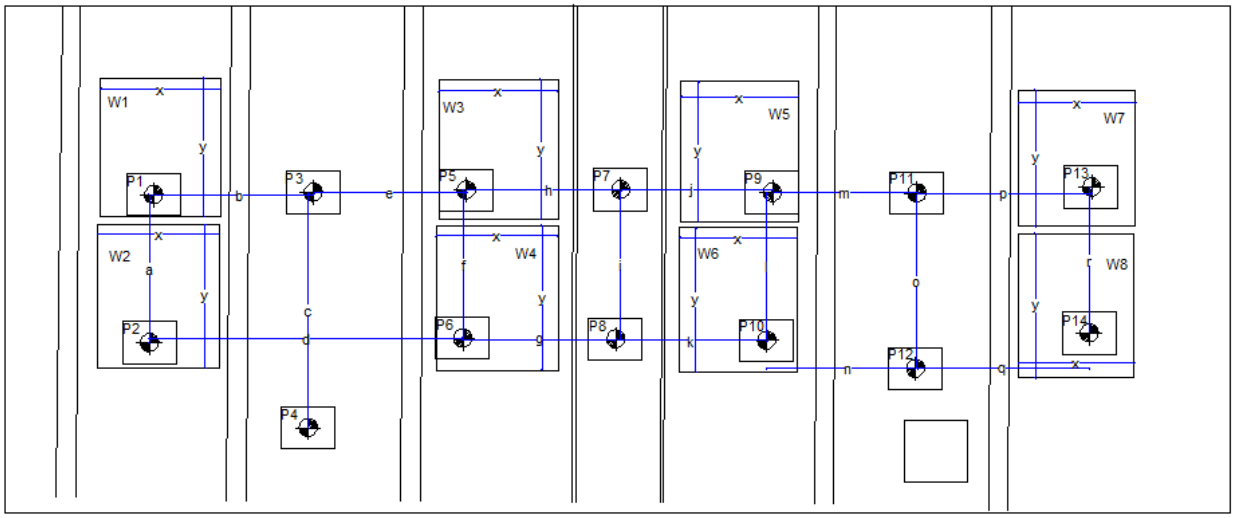


Figure 3.3. Location of marks placed on subject wall and dimension between mark to mark and windows for experiment 2 & 3.

As the functional image quality is one of the aspects in selecting the camera, all cameras were tested on three different resolutions settings of 2.4-megapixel, 8.0-megapixel and 16.0-megapixel. Distance between the object and camera also plays vital role in improving the quality of data captured in an image. To obtain the most area of the subject wall in the frame of the camera, minimum distance between the wall and the camera was kept 10 feet. Distance between the camera and the wall was increased to 20 feet, 30 feet and 40 feet to observe the variation in image quality and to cover the maximum area of the subject wall simultaneously. In order to avoid complications, it is best to keep the camera in its default or 'auto' setting. Doing so will ensure that the best picture is captured based on the ambient conditions on site. At every given resolution 4 images were captured at the distances described above (fig. 3.4.).

(a)

(c)

(b)

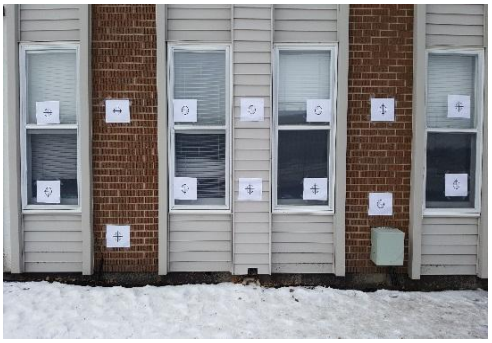
(d)

Figure 3.4. Images captured by Samsung Galaxy S6 at the distance of 10', 20', 30', and 40' respectively

While taking photographs, the camera was positioned perpendicular to the wall and the grid option in the camera was used to mitigate the rotation of the image. A total of 12 images were captured with each camera in one experiment. Since it is highly unlikely that images inside the building would be to that distances, therefore in the second and the third experiments the distances between the subject wall and camera was reduced from 20 feet to 15 feet, 30 feet to 25 feet and no pictures were taken at 40 feet distance (fig. 3.5.). In order to obtain more sample points, the number of marks were increased on the subject wall.

(a)

(c)



(b)

(d)

Figure 3.5. Images captured by Samsung Galaxy S6 at the distances of 10', 15', 20', and 25' respectively

At the end of each experiment images from all three cameras were transferred to a separate folder created for each camera into the computer. Since all images were identical, it was necessary to give a unique identifier to each image for example "1_S6_2.4mp_10". In this example, the first digit represents the number of experiments, the second alphabet and number represent equipment name, the third one represents the resolution of camera, and the last one represents the distance between the camera and the wall.

3.1.1. Scaling

AutoCAD 2016 software was selected for extracting 2-dimensional measurements from the images due to its ease of availability as it is the most commonly used drafting software. Additionally, it is of great utility due to its simple command structure therefore, no special skills are required to perform this task.

After importing images in the AutoCAD software, the first step was to scale up/down the size of image to extract 2-dimensional information. Therefore, images obtained as an output from all experiments were scaled by using “scale” command available in AutoCAD software. At least one dimension is known in the images to use scale command.

There are various options of importing images to the AutoCAD 2016 but the most efficient way of importing images is to drag the images into an opened AutoCAD file. This is the only option in which images and/or DWG files can be moved. Otherwise using “Attach” option in AutoCAD 2016 restricts the movement of both images and DWG file. After importing, all images were scaled down/up with the help of a reference (manually measured ‘b’ and ‘d’ dimension in fig. 3.2. and fig. 3.3. respectively) dimension in the image. “Dimension” command in AutoCAD software was applied on the x-axis and y-axis of all windows visible in the image and in between marks posted on the wall. (fig. 3.6.)

Figure 3.6. Image scaled and dimensions applied with the help of AutoCAD

After scaling all the images obtained in the result of experiment 1, an excel file with separate spreadsheet for each camera for each resolution was created. Other than results and summary spreadsheets, total of 9 spreadsheets were created for each experiment. All the dimensions which were measured in the field were noted down under the column of "Actual Distance" and the dimensions obtained from the images were listed down under the columns of 10 feet, 20 feet, 30 feet, and 40 feet obtained at respective distances. The difference between the actual dimension and the dimension acquired from images were presented under the column of "Difference between Measured Distance and Image Distance (Error)" (see appendix).

3.1.2. Storing and Sorting

The purpose of the measurements would be for the application in a future 'as built' database of photographs. For this research, images were stored in the designated folders created for each camera type. A project schedule can also be used to create databases for any images captured on the construction site. The project schedule is the only document where activities have unique identifiers and follows logical and sequential relationships which leads to milestones followed by work breakdown structure (WBS). Names and codes of activities, milestones, and work breakdown structure can be used to create folders and within those folders, subfolders of dates can be created, and the images captured on those dates can be saved in their respective folders. This system of creating database will help in storing images in organized manner and will also assist in tracking images. Images should be transferred from camera to computer on daily basis. The ID of each image should be unique and denote its actual location on site.

CHAPTER 4. ANALYSIS AND RESULTS

The objective of all three experiments was to determine the difference (error) between the actual distances measured on-site and the distances measured in the image for windows and set targets. In order to observe the error, data extracted from several unadulterated images taken from the cameras (Samsung Galaxy S6, Olympus Digital Camera, and Nikon Dslr) were transferred to numerous excel sheets.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	20'-0"	30'-0"	40'-0"	10'-0"	20'-0"	30'-0"	40'-0"
2	Samsung Galaxy S6 (8.0MP)	W1	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W2	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W3	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W5	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W6	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W7	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W8	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									0.00	0.00	0.00	0.00
	ZERO ERROR (%)									100.00	100.00	100.00	100.00
	Samsung Galaxy S6 (8.0MP)	W1	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W4	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W6	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W7	y	y-axis	2'-5"	NIF	2'-5"	2'-4"	2'-5"	NIF	0"	1"	0"
		W8	y	y-axis	2'-5"	NIF	2'-6"	2'-5"	2'-5"	NIF	1"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									0.00	12.50	12.50	0.00
	ZERO ERROR (%)									100.00	87.50	87.50	100.00
	Samsung Galaxy S6 (8.0MP)	P1-P2	a	P1 to P2	2'-7"	NIF	2'-7"	2'-8"	2'-7"	NIF	0"	1"	0"
		P2-P3	b	P2 to P3	4'-0"	NIF	4'-0"	4'-0"	4'-0"	NIF	0"	0"	0"
		P2-P4	c	P2 to P4	2'-8"	NIF	2'-8"	2'-8"	2'-8"	NIF	0"	0"	0"
		P3-P5	d	P3 to P5	4'-11"	4'-10"	4'-11"	5'-0"	5'-0"	NIF	0"	1"	1"
		P4-P5	e	P4 to P5	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P5-P6	f	P5 to P6	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P5-P8	g	P5 to P8	5'-4"	NIF	5'-5"	5'-3"	5'-4"	1"	1"	1"	0"
		P5-P7	h	P5 to P7	4'-11"	5'-0"	5'-1"	4'-11"	5'-0"	1"	1"	0"	1"
		P6-P7	i	P6 to P7	2'-5"	NIF	2'-5"	2'-4"	2'-5"	NIF	0"	1"	0"
		P7-P9	j	P7 to P9	3'-1"	NIF	3'-4"	3'-2"	3'-2"	NIF	3"	1"	1"
3	ERROR > 1" (%)									0.00	10.00	0.00	0.00
4	ERROR = 1" (%)									50.00	20.00	50.00	30.00
5	ZERO ERROR (%)									50.00	70.00	50.00	70.00

*NIF = Not in Frame

ERROR > 1"

ERROR = 1"

ZERO ERROR

Figure 4.1. A sample spreadsheet

A sample spreadsheet (fig. 4.1.). Column ‘A’ states type of equipment used and under what resolutions images were captured. Columns ‘B’, ‘C’, and ‘D’ represent the coordinates of the benchmark spacing. Whereas, the column ‘E’ states the measurements taken on site with the help of measuring tape of respective points stated in prior columns. The measurements extracted from the images were noted down in column ‘F’ through column ‘I’. The discrepancies between the actual distances and the distances in the image were noted down in column ‘J’ through ‘M’. The data collected was categorized as measured objects, W-windows and target points, in order to observe the errors propagated in each setting (2MP, 2.4MP, 8MP, 16MP, Basic, Normal, and Fine). Each set of measurements were broken down to x-axis and y-axis.

The results from all three experiments show that there are differences in the images captured. The Nikon DSLR did not produce results with the least amount of errors as compare to Samsung Galaxy S6 and Olympus digital camera. The Samsung Galaxy S6 or the Olympus digital camera can be used on construction site for capturing images. In general, few things should be taken care of while capturing images as described in specifications. Results from all three experiments are shown in the following excel spreadsheets. Whereas, summaries from observations can be found in appendix.

In table 4.1., 4.2., and 4.3. the percentage of measurement error is calculated from the number of measurements determined to be greater than 1” inch different from the known dimension divided by the total number of measurements.

For example, in table 4.1 the 2.4MP settings for the Samsung Galaxy S6, one measurement of target points out of 37 total measurement of target points measured were greater1”. Thus, 2.70% of the measurements were greater than 1”.

Errors were classified from the measurements reported from the AutoCAD file. “Zero” Error indicates the reported measurement was equal to the baseline measurement. “Error ≤ 1” reflects all measurements that the error was not exactly equal to the baseline measurement but up to 1 inch or less in variation. The last category “Error > 1” captures all measurement results that exceeded a 1 inch upper limit compared to the baseline measurement. The basis for the classification in this manner was that the cameras or resolution settings that yielded the largest “ZERO” errors would be a preferred camera or resolution setting.

4.1. Summary

Table 4.1. Result for Error Greater than an Inch in Experiment 1, 2, & 3

EXPERIMENT 1								
Samsung Galaxy S6			**Olympus Digital Camera**			**Nikon DSLR**		
Resolution (MP)	Locations	Error > 1" (%)	Resolution (MP)	Locations	Error > 1" (%)	Resolution (MP)	Locations	Error > 1" (%)
2.4	W (x)	0.00	2.0	W (x)	7.14	Fine	W (x)	0.00
	W (y)	0.00		W (y)	3.57		W (y)	0.00
	Target Points	2.70		Target Points	7.89		Target Points	10.53
8.0	W (x)	0.00	8.0	W (x)	0.00			
	W (y)	0.00		W (y)	0.00			
	Target Points	2.94		Target Points	5.26			
16.0	W (x)	0.00	16.0	W (x)	0.00			
	W (y)	0.00		W (y)	0.00			
	Target Points	2.63		Target Points	0.81			
Average Error	W (x)	0.00	**Average Error**	W (x)	2.38	**Average Error**	W (x)	0.00
	W (y)	0.00		W (y)	1.19		W (y)	0.00
	Target Points	2.76		Target Points	4.65		Target Points	10.53

EXPERIMENT 2								
Samsung Galaxy S6			**Olympus Digital Camera**			**Nikon DSLR**		
Resolution (MP)	Locations	Error > 1" (%)	Resolution (MP)	Locations	Error > 1" (%)	Resolution (MP)	Locations	Error > 1" (%)
2.4	W (x)	0.00	2.0	W (x)	0.00	Basic	W (x)	3.57
	W (y)	0.00		W (y)	0.00		W (y)	7.14
	Target Points (x)	2.50		Target Points (x)	5.00		Target Points (x)	15.00
	Target Points (y)	0.00		Target Points (y)	0.00		Target Points (y)	3.85
8.0	W (x)	0.00	8.0	W (x)	7.14	Normal	W (x)	0.00
	W (y)	0.00		W (y)	7.14		W (y)	3.57
	Target Points (x)	0.00		Target Points (x)	12.50		Target Points (x)	7.50
	Target Points (y)	0.00		Target Points (y)	7.69		Target Points (y)	4.00
16.0	W (x)	0.00	16.0	W (x)	0.00	Fine	W (x)	0.00
	W (y)	3.57		W (y)	0.00		W (y)	0.00
	Target Points (x)	7.50		Target Points (x)	12.50		Target Points (x)	10.00
	Target Points (y)	0.00		Target Points (y)	3.85		Target Points (y)	0.00
Average Error	W (x)	0.00	**Average Error**	W (x)	2.38	**Average Error**	W (x)	1.19
	W (y)	1.19		W (y)	2.38		W (y)	3.57
	Target Points (x)	3.33		Target Points (x)	10.00		Target Points (x)	10.83
	Target Points (y)	0.00		Target Points (y)	3.85		Target Points (y)	2.62

Table 4.1. Result for Error Greater than an Inch in Experiment 1, 2, & 3 (continued)

EXPERIMENT 3								
Samsung Galaxy S6			**Olympus Digital Camera**			**Nikon DSLR**		
Resolution (MP)	Locations	Error > 1" (%)	Resolution (MP)	Locations	Error > 1" (%)	Resolution (MP)	Locations	Error > 1" (%)
2.4	W (x)	0.00	2.0	W (x)	0.00	Basic	W (x)	0.00
	W (y)	0.00		W (y)	0.00		W (y)	0.00
	Target Points (x)	7.32		Target Points (x)	5.00		Target Points (x)	7.50
	Target Points (y)	0.00		Target Points (y)	0.00		Target Points (y)	0.00
8.0	W (x)	0.00	8.0	W (x)	0.00	Normal	W (x)	7.14
	W (y)	8.33		W (y)	0.00		W (y)	10.71
	Target Points (x)	6.06		Target Points (x)	5.00		Target Points (x)	12.50
	Target Points (y)	0.00		Target Points (y)	0.00		Target Points (y)	0.00
16.0	W (x)	0.00	16.0	W (x)	0.00	Fine	W (x)	0.00
	W (y)	0.00		W (y)	0.00		W (y)	3.57
	Target Points (x)	2.50		Target Points (x)	7.50		Target Points (x)	5.00
	Target Points (y)	0.00		Target Points (y)	0.00		Target Points (y)	0.00
Average Error	W (x)	0.00	**Average Error**	W (x)	0.00	**Average Error**	W (x)	2.38
	W (y)	2.78		W (y)	0.00		W (y)	4.76
	Target Points (x)	5.29		Target Points (x)	5.83		Target Points (x)	8.33
	Target Points (y)	0.00		Target Points (y)	0.00		Target Points (y)	0.00

Table 4.2. Result for Error Between Less than or Equals to an Inch in Experiment 1, 2, & 3

EXPERIMENT 1								
Samsung Galaxy S6			**Olympus Digital Camera**			**Nikon DSLR**		
Resolution (MP)	Locations	Error = 1" (%)	Resolution (MP)	Locations	Error = 1" (%)	Resolution (MP)	Locations	Error = 1" (%)
2.4	W (x)	28.57	2.0	W (x)	7.14	Fine	W (x)	28.57
	W (y)	10.71		W (y)	28.57		W (y)	53.57
	Target Points	45.95		Target Points	36.84		Target Points	52.63
8.0	W (x)	0.00	8.0	W (x)	3.57			
	W (y)	7.14		W (y)	14.29			
	Target Points	35.29		Target Points	23.68			
16.0	W (x)	0.00	16.0	W (x)	10.71			
	W (y)	14.29		W (y)	17.86			
	Target Points	39.47		Target Points	18.42			
Average Error	W (x)	9.52	**Average Error**	W (x)	7.14	**Average Error**	W (x)	28.57
	W (y)	10.71		W (y)	20.24		W (y)	53.57
	Target Points	40.24		Target Points	26.32		Target Points	52.63

EXPERIMENT 2								
Samsung Galaxy S6			**Olympus Digital Camera**			**Nikon DSLR**		
Resolution (MP)	Locations	Error = 1" (%)	Resolution (MP)	Locations	Error = 1" (%)	Resolution (MP)	Locations	Error = 1" (%)
2.4	W (x)	14.29	2.0	W (x)	17.86	Basic	W (x)	28.57
	W (y)	21.43		W (y)	50.00		W (y)	46.43
	Target Points (x)	50.00		Target Points (x)	32.50		Target Points (x)	32.50
	Target Points (y)	11.54		Target Points (y)	26.92		Target Points (y)	34.62
8.0	W (x)	10.71	8.0	W (x)	17.86	Normal	W (x)	21.43
	W (y)	39.29		W (y)	32.14		W (y)	53.57
	Target Points (x)	29.73		Target Points (x)	25.00		Target Points (x)	32.50
	Target Points (y)	16.67		Target Points (y)	23.08		Target Points (y)	28.00
16.0	W (x)	35.71	16.0	W (x)	10.71	Fine	W (x)	17.86
	W (y)	25.00		W (y)	50.00		W (y)	46.43
	Target Points (x)	55.00		Target Points (x)	27.50		Target Points (x)	30.00
	Target Points (y)	23.08		Target Points (y)	19.23		Target Points (y)	30.77
Average Error	W (x)	20.24	**Average Error**	W (x)	15.48	**Average Error**	W (x)	22.62
	W (y)	28.57		W (y)	44.05		W (y)	48.81
	Target Points (x)	44.91		Target Points (x)	28.33		Target Points (x)	31.67
	Target Points (y)	17.09		Target Points (y)	23.08		Target Points (y)	31.13

Table 4.2. Result for Error Between Less than or Equals to an Inch in Experiment 1, 2, & 3 (continued)

EXPERIMENT 3								
Samsung Galaxy S6			**Olympus Digital Camera**			**Nikon DSLR**		
Resolution (MP)	Locations	Error = 1" (%)	Resolution (MP)	Locations	Error = 1" (%)	Resolution (MP)	Locations	Error = 1" (%)
2.4	W (x)	19.23	2.0	W (x)	21.43	Basic	W (x)	32.14
	W (y)	38.46		W (y)	50.00		W (y)	53.57
	Target Points (x)	41.46		Target Points (x)	37.50		Target Points (x)	35.00
	Target Points (y)	38.46		Target Points (y)	15.38		Target Points (y)	26.92
8.0	W (x)	16.67	8.0	W (x)	0.00	Normal	W (x)	17.86
	W (y)	41.67		W (y)	32.14		W (y)	46.43
	Target Points (x)	48.48		Target Points (x)	27.50		Target Points (x)	37.50
	Target Points (y)	31.82		Target Points (y)	3.85		Target Points (y)	42.31
16.0	W (x)	28.57	16.0	W (x)	17.86	Fine	W (x)	17.86
	W (y)	17.86		W (y)	42.86		W (y)	46.43
	Target Points (x)	47.50		Target Points (x)	30.00		Target Points (x)	22.50
	Target Points (y)	15.38		Target Points (y)	23.08		Target Points (y)	19.23
Average Error	W (x)	21.49	**Average Error**	W (x)	13.10	**Average Error**	W (x)	22.62
	W (y)	32.66		W (y)	41.67		W (y)	48.81
	Target Points (x)	45.82		Target Points (x)	31.67		Target Points (x)	31.67
	Target Points (y)	28.55		Target Points (y)	14.10		Target Points (y)	29.49

Table 4.3. Result for Zero Measurement Error in Experiment 1, 2, & 3

EXPERIMENT 1								
Samsung Galaxy S6			**Olympus Digital Camera**			**Nikon DSLR**		
Resolution (MP)	Locations	Zero Error (%)	Resolution (MP)	Locations	Zero Error (%)	Resolution (MP)	Locations	Zero Error (%)
2.4	W (x)	71.43	2.0	W (x)	85.71	Fine	W (x)	71.43
	W (y)	89.29		W (y)	67.86		W (y)	46.43
	Target Points	51.35		Target Points	55.26		Target Points	36.84
8.0	W (x)	100.00	8.0	W (x)	96.43			
	W (y)	92.86		W (y)	85.71			
	Target Points	61.76		Target Points	71.05			
16.0	W (x)	100.00	16.0	W (x)	89.29			
	W (y)	85.71		W (y)	82.14			
	Target Points	57.89		Target Points	68.42			
Average Error	W (x)	90.48	**Average Error**	W (x)	90.48	**Average Error**	W (x)	71.43
	W (y)	89.29		W (y)	78.57		W (y)	46.43
	Target Points	57.00		Target Points	64.91		Target Points	36.84

EXPERIMENT 2								
Samsung Galaxy S6			**Olympus Digital Camera**			**Nikon DSLR**		
Resolution (MP)	Locations	Zero Error (%)	Resolution (MP)	Locations	Zero Error (%)	Resolution (MP)	Locations	Zero Error (%)
2.4	W (x)	85.71	2.0	W (x)	82.14	Basic	W (x)	67.86
	W (y)	78.57		W (y)	50.00		W (y)	46.43
	Target Points (x)	47.50		Target Points (x)	62.50		Target Points (x)	52.50
	Target Points (y)	88.46		Target Points (y)	73.08		Target Points (y)	61.54
8.0	W (x)	89.29	8.0	W (x)	75.00	Normal	W (x)	78.57
	W (y)	60.71		W (y)	60.71		W (y)	42.86
	Target Points (x)	70.27		Target Points (x)	62.50		Target Points (x)	60.00
	Target Points (y)	83.33		Target Points (y)	69.23		Target Points (y)	68.00
16.0	W (x)	64.29	16.0	W (x)	89.29	Fine	W (x)	82.14
	W (y)	71.43		W (y)	50.00		W (y)	53.57
	Target Points (x)	37.50		Target Points (x)	60.00		Target Points (x)	60.00
	Target Points (y)	76.92		Target Points (y)	76.92		Target Points (y)	69.23
Average Error	W (x)	79.76	**Average Error**	W (x)	82.14	**Average Error**	W (x)	76.19
	W (y)	70.24		W (y)	53.57		W (y)	47.62
	Target Points (x)	51.76		Target Points (x)	61.67		Target Points (x)	57.50
	Target Points (y)	82.91		Target Points (y)	73.08		Target Points (y)	66.26

Table 4.3. Result for Zero Measurement Error in Experiment 1, 2, & 3 (continued)

EXPERIMENT 3								
Samsung Galaxy S6			**Olympus Digital Camera**			**Nikon DSLR**		
Resolution (MP)	Locations	Zero Error (%)	Resolution (MP)	Locations	Zero Error (%)	Resolution (MP)	Locations	Zero Error (%)
2.4	W (x)	80.77	2.0	W (x)	78.57	Basic	W (x)	67.86
	W (y)	61.54		W (y)	50.00		W (y)	46.43
	Target Points (x)	51.22		Target Points (x)	57.50		Target Points (x)	57.50
	Target Points (y)	61.54		Target Points (y)	84.62		Target Points (y)	73.08
8.0	W (x)	83.33	8.0	W (x)	100.00	Normal	W (x)	75.00
	W (y)	50.00		W (y)	67.86		W (y)	42.86
	Target Points (x)	45.45		Target Points (x)	67.50		Target Points (x)	50.00
	Target Points (y)	68.18		Target Points (y)	96.15		Target Points (y)	57.69
16.0	W (x)	71.43	16.0	W (x)	82.14	Fine	W (x)	82.14
	W (y)	82.14		W (y)	57.14		W (y)	50.00
	Target Points (x)	50.00		Target Points (x)	62.50		Target Points (x)	72.50
	Target Points (y)	84.62		Target Points (y)	76.92		Target Points (y)	80.77
Average Error	W (x)	78.51	**Average Error**	W (x)	86.90	**Average Error**	W (x)	75.00
	W (y)	64.56		W (y)	58.33		W (y)	46.43
	Target Points (x)	48.89		Target Points (x)	62.50		Target Points (x)	60.00
	Target Points (y)	71.45		Target Points (y)	85.90		Target Points (y)	70.51

4.2. Errors

The errors were categorized as zero, no discrepancies between the actual and measured distances; 1 inch for discrepancy, less than or equal to 1”, and errors greater than 1”.

4.2.1. Evaluation of Data in Experiments

When data is classified by distance to targets or objects the outcome indicates that the error measurements up to 1” should be expected. Provided tolerance for location of elements in the image were satisfactory, some source of errors are as follows:

i. Scaling; this error would likely result in most all measurements being off from baseline values. This is not observed in the data.

ii. Target Positioning; target positioning could result from inaccurate field layout procedures. Result would be one target set be considered off from baseline value. Possible for points P12 to P14, P11 to P13, P5 to P7, and P6 to P8.

iii. Edge Identification; these errors are possible when measuring window dimensions. Resulting in more random distribution or error.

iv. Cameras; cameras could introduce errors at lower resolution. While data shows this as true in overall 2MP results, the difference is not enough to statistically claim a difference.

Table 4.4. and 4.5. examine the overall error of the experiment. While a slight increase in error is noted for lower resolution it is not clear that any advantage is gained at higher resolution or by different types of cameras.

Table 4.4. The Performance of the Equipment in all 3 Experiments

Equipment	Total Points	Measurements with Errors	Error (%)
Samsung Galaxy S6	981	296	30.17
Olympus Digital Camera	1017	289	28.42
Nikon DSLR	824	327	39.68

Of the three cameras tested, the digital camera provided the best results overall with the cell-phone (Samsung Galaxy S6) camera performing nearly as well. The Nikon DSLR did not perform as well as the other two in this comparison and was the lowest performing camera in all three experiments. Further examination of this will be recommended for future research.

Distance to the points being imaged was also examined as shown in Table 4.5. While no great difference is noted from 15 feet through 25 feet, the measurements at 10 feet resulted with the largest number of errors. While the number of points are lower, the data below shows that the number of errors nearly equaled all the other distances. One explanation could be due to the level of detail in the 10 ft. images as compared to the more distant images. Higher detail could result in more points being classified with errors. This result could also be compounded with the

AutoCAD conversion of the images where their point identification can be more precise than in other images.

Table 4.5. The Errors Observed at Various Distances in all 3 Experiments

Distance (ft.)	Total Points	Total Errors	Error (%)
10	452	204	45.13
15	780	239	30.64
20	796	251	31.53
25	794	218	27.46

Another consideration was discrepancies in target layout and their baseline measurement. Table 4.6. isolates point P11 to P13, measurements from experiment 2 and 3. More than 85% of the measurements received in an error of 1" or more. Similar results can also be seen in the table 4.7., and 4.8. This suggested that the initial layout could have been inaccurately measured.

Table 4.6. Point Analysis of Point P11 – P13 in Experiment 2 and 3

Points	Camera Type	Resolution	10'		15'		20'		25'	
			Exp. 2	Exp. 3	Exp. 2	Exp. 3	Exp. 2	Exp. 3	Exp. 2	Exp. 3
P11 - P13	Samsung Galaxy S6	2.4MP	NIF	NIF	0"	2"	1"	0"	0"	1"
		8.0MP	NIF	NIF	1"	NIF	0"	1"	0"	1"
		16.0MP	NIF	NIF	1"	1"	2"	1"	1"	1"
	Olympus Digital Camera	2.0MP	NIF	NIF	2"	2"	1"	2"	1"	1"
		8.0MP	NIF	NIF	1"	2"	2"	1"	1"	2"
		16.0MP	NIF	NIF	1"	1"	2"	2"	1"	2"
	Nikon DSLR	Basic	NIF	NIF	2"	2"	2"	2"	1"	2"
		Normal	NIF	NIF	0"	2"	2"	2"	1"	2"
		Fine	NIF	NIF	1"	2"	2"	1"	2"	2"
Total number of Observations			0	0	9	8	9	9	9	9
Total Errors			0	0	7	7	8	8	7	9
% Error			**86.79**							

Table 4.7. Point Analysis of Point P10 – P12 in Experiment 2 and 3

Points	Camera Type	Resolution	10'		15'		20'		25'	
			Exp. 2	Exp. 3	Exp. 2	Exp. 3	Exp. 2	Exp. 3	Exp. 2	Exp. 3
P10 - P12	Samsung Galaxy S6	2.4MP	1"	1"	0"	0"	1"	0"	0"	1"
		8.0MP	NIF	NIF	0"	1"	0"	0"	0"	1"
		16.0MP	1"	1"	0"	0"	1"	0"	1"	1"
	Olympus Digital Camera	2.0MP	0"	1"	1"	1"	1"	1"	1"	1"
		8.0MP	2"	1"	1"	1"	1"	1"	0"	1"
		16.0MP	2"	2"	1"	1"	1"	1"	0"	1"
	Nikon DSLR	Basic	1"	1"	1"	1"	1"	1"	1"	1"
		Normal	3"	0"	0"	1"	1"	2"	0"	1"
		Fine	0"	1"	0"	1"	1"	0"	1"	1"
Total number of Observations			8	8	9	9	9	9	9	9
Total Errors			6	7	4	7	8	5	4	9
% Error			**71.43**							

Table 4.8. Point Analysis of Point P12 – P14 in Experiment 2 and 3

Points	Camera Type	Resolution	10'		15'		20'		25'	
			Exp. 2	Exp. 3	Exp. 2	Exp. 3	Exp. 2	Exp. 3	Exp. 2	Exp. 3
P12 - P14	Samsung Galaxy S6	2.4MP	NIF	NIF	1"	1"	0"	0"	1"	0"
		8.0MP	NIF	NIF	0"	NIF	1"	0"	1"	0"
		16.0MP	NIF	NIF	0"	0"	2"	0"	1"	0"
	Olympus Digital Camera	2.0MP	NIF	NIF	1"	1"	1"	1"	1"	1"
		8.0MP	NIF	NIF	1"	1"	1"	0"	1"	1"
		16.0MP	NIF	NIF	0"	0"	1"	1"	1"	1"
	Nikon DSLR	Basic	NIF	NIF	1"	1"	2"	1"	1"	1"
		Normal	NIF	NIF	1"	1"	1"	2"	0"	1"
		Fine	NIF	NIF	0"	1"	2"	0"	1"	1"
Total number of Observations			0	0	9	8	9	9	9	9
Total Errors			0	0	5	6	8	4	8	6
% Error			**69.81**							

An observation in the data was a possible difference in "y" measurements vs "x" measurements. The total number of errors recorded for x and y were compared by totaling x and y separately. The results show that there were n_x and n_y errors in a total of $N_{(total)}x$ and $N_{(total)}y$. % error in x is nearly equal to % error in y.

Table 4.9. Directional Error (x-y) Analysis in Experiment 2

Experiment 2					
Equipment	Resolution	$N_{(total)}x$	n_x	$N_{(total)}y$	n_y
Samsung Galaxy S6	2.4MP	68	25	54	9
	8.0MP	65	14	52	15
	16.0MP	68	35	54	14
Olympus Digital Camera	2.0MP	68	20	54	21
	8.0MP	68	22	54	19
	16.0MP	68	19	54	20
Nikon DSLR	Basic	68	28	54	25
	Normal	68	22	54	24
	Fine	68	21	54	21
Total		609	206	484	168
% Error		**33.83**		**34.71**	

Table 4.10. Directional Error (x-y) Analysis in Experiment 3

Experiment 3					
Equipment	Resolution	$N_{(total)}x$	n_x	$N_{(total)}y$	n_y
Samsung Galaxy S6	2.4MP	67	25	52	20
	8.0MP	57	22	46	19
	16.0MP	68	28	54	9
Olympus Digital Camera	2.0MP	68	23	54	18
	8.0MP	68	13	54	10
	16.0MP	68	20	54	18
Nikon DSLR	Basic	68	26	54	22
	Normal	68	27	54	27
	Fine	67	16	54	19
Total		599	200	476	162
% Error		**33.39**		**34.03**	

In considering the camera resolutions, general intuition would suggest that lower resolutions should result in lower performance (higher Error %). Table 4.11. suggests that a mid-range resolution is less prone to measurement errors than low and high resolution.

Table 4.11. The Errors Observed at Various Resolutions in all 3 Experiments

Resolution (MP)	Total Points	Total Errors	Error (%)
2.4 (Low)	918	323	35.19
8.0 (Medium)	891	262	29.41
16.0 (High)	1013	327	32.28

CHAPTER 5. SPECIFICATIONS

5.1. Equipment

a. The measurement obtained in the research suggested that a digital camera or cell-phone camera of reputable brand which can produce JPEG format images and capable of collecting images suitable for construction documentation.

b. The Camera resolutions at most levels are acceptable but a mid-range 8.0MP setting can be recommended.

c. For maximum area in the frame of equipment at any distance. The aspect ratio should be set at 16:9.

d. Limit rotation of the camera with respect to the object through the use of grid option. In absence of grid option in camera, use borders of frame or aperture for a point of reference.

e. Keep equipment flash setting on “Auto”.

f. Multiple modes are available in the camera such as manual, panorama, night mode, etc. Keep equipment mode on “Auto”.

5.2. Specifications for Capturing Images

a. Equipment should be held in landscape position and the lens surface should be parallel to the object. This provides for consistency in all images.

b. Images should be taken on daily basis or prior to any work being covered

c. Multiple images should be taken of the area. The clearest and visually best aligned image should be retained.

d. To get maximum surface area of object in frame, the distance between object and equipment should kept maximum.

5.3. Specifications for Database Creation

a. Images should be in JPEG format.

b. All images should be transfer into the computer on daily basis.

c. All images should be saved to designated folders named according to the project Work Breakdown Structure (WBS) or project schedule activities. If specific milestones are known in the project documents or schedule, a set of photographs documenting the milestone should be covered.

CHAPTER 6. CONCLUSION AND RECOMMENDATIONS

6.1. Conclusion

The purpose of this research was to investigate a process for gathering site data without specification of camera. From this research it can be concluded that 70 percent of 2-dimensional information can be accurately extracted from images produced either by an ordinary digital camera or a camera included in the smartphone. There are no special skills or software required to process images to extract information. Images can be scaled by applying commonly used drafting software such as AutoCAD. Finally, a brief set of guideline specifications for equipment, image capturing, and format of the database of the images was drafted as a result of this research. Care should be taken that measurements recorded on site are done appropriately, as this study has shown that field conditions may cause errors in the images taken. If target points are to be used to measure distances, they should be placed as accurately as possible so as to avoid measurement errors resulting due to field challenges. The database of images captured during and after the construction of buildings can be used for future modification purposes.

6.2. Limitations in the Research

Field layout and measurement of the target points resulted in a significant number of points with errors as noted in the data analysis. This is limitation in the research since the errors were not discovered until after all the data were collected. Future research using a similar targeting technique should use more accurate layout techniques for the targeted points.

A second possible limitation in the results is the use of AutoCAD. While it has many advantages in ease of use and availability, the software is not primarily designed for working with image data and information. Another limitation of using AutoCAD is that the measurements may vary for different users owing to personal judgment

Data was not collected from an actual construction site. Site conditions will provide other challenges in terms of line of sight to images, access to areas, and changing conditions. Shadows and other possible issues may be possible that were not considered in this work.

6.3. Recommendations

This research demonstrated, the cameras used can provide reasonably accurate results. It is recommended to expand the research to three-dimensional data collection. Since images are two dimensional, the information extracted from these images will be in two dimensions as well. In order to collect information in the third dimension, the images have to be processed using specific software tools.

Further field testing of cameras and their resolution settings is recommended to see if the results in this research can be replicated. Specific consideration would be to examine error sources obtained10 feet and under images range.

Begin to test linkages from Building Information Model (BIM) data to images through either time-stamping or adding location information digitally to the image. A future application is to be able to identify an area in the Building Information Model (BIM) documents and automatically retrieve images specific to the area or element selected.

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APPENDIX A. EXPERIMENT 1

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	20'-0"	30'-0"	40'-0"	10'-0"	20'-0"	30'-0"	40'-0"
2	Samsung Galaxy S6 (2.4MP)	W1	x	x-axis	2'-0"	NIF	2'-0"	2'-1"	2'-0"	NIF	0"	1"	0"
		W2	x	x-axis	2'-0"	NIF	2'-0"	2'-1"	2'-0"	NIF	0"	1"	0"
		W3	x	x-axis	2'-0"	2'-1"	2'-0"	2'-0"	2'-0"	1"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-1"	2'-0"	2'-0"	2'-0"	1"	0"	0"	0"
		W5	x	x-axis	2'-0"	2'-1"	2'-0"	2'-0"	2'-0"	1"	0"	0"	0"
		W6	x	x-axis	2'-0"	2'-1"	2'-0"	2'-0"	2'-0"	1"	0"	0"	0"
		W7	x	x-axis	2'-0"	NIF	2'-1"	2'-0"	2'-0"	NIF	1"	0"	0"
		W8	x	x-axis	2'-0"	NIF	2'-1"	2'-0"	2'-0"	NIF	1"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									100.00	25.00	25.00	0.00
	ZERO ERROR (%)									0.00	75.00	75.00	100.00
	Samsung Galaxy S6 (2.4MP)	W1	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W4	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W6	y	y-axis	2'-5"	2'-6"	2'-5"	2'-5"	2'-5"	1"	0"	0"	0"
		W7	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-4"	NIF	0"	0"	1"
		W8	y	y-axis	2'-5"	NIF	2'-6"	2'-5"	2'-5"	NIF	1"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									25.00	12.50	0.00	12.50
	ZERO ERROR (%)									75.00	87.50	100.00	100.00
	Samsung Galaxy S6 (2.4MP)	P1-P2	a	P1 to P2	2'-7"	NIF	2'-7"	2'-8"	2'-7"	NIF	0"	1"	0"
		P2-P3	b	P2 to P3	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	0"	0"	0"	0"
		P2-P4	c	P2 to P4	2'-8"	2'-7"	2'-8"	2'-8"	2'-8"	1"	0"	0"	0"
		P3-P5	d	P3 to P5	4'-11"	5'-0"	4'-10"	5'-0"	5'-0"	1"	1"	1"	1"
		P4-P5	e	P4 to P5	2'-7"	2'-8"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P5-P6	f	P5 to P6	2'-7"	2'-8"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P5-P8	g	P5 to P8	5'-4"	5'-5"	5'-6"	5'-4"	5'-5"	1"	1"	0"	1"
		P5-P7	h	P5 to P7	4'-11"	5'-1"	5'-1"	4'-11"	5'-0"	1"	1"	0"	1"
		P6-P7	i	P6 to P7	2'-5"	NIF	2'-6"	2'-5"	2'-5"	NIF	1"	0"	0"
		P7-P9	j	P7 to P9	3'-1"	NIF	3'-4"	3'-2"	3'-2"	NIF	3"	1"	1"
3	ERROR > 1" (%)									0.00	10.00	0.00	0.00
4	ERROR = 1" (%)									85.71	40.00	30.00	40.00
5	ZERO ERROR (%)									14.29	50.00	70.00	60.00

*NIF = Not in Frame

	ERROR > 1"
	ERROR = 1"
	ZERO ERROR

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	20'-0"	30'-0"	40'-0"	10'-0"	20'-0"	30'-0"	40'-0"
2	Samsung Galaxy S6 (8.0MP)	W1	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W2	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W3	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W5	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W6	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W7	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W8	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									0.00	0.00	0.00	0.00
	ZERO ERROR (%)									100.00	100.00	100.00	100.00
	Samsung Galaxy S6 (8.0MP)	W1	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W4	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W6	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W7	y	y-axis	2'-5"	NIF	2'-5"	2'-4"	2'-5"	NIF	0"	1"	0"
		W8	y	y-axis	2'-5"	NIF	2'-6"	2'-5"	2'-5"	NIF	1"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									0.00	12.50	12.50	0.00
	ZERO ERROR (%)									100.00	87.50	87.50	100.00
	Samsung Galaxy S6 (8.0MP)	P1-P2	a	P1 to P2	2'-7"	NIF	2'-7"	2'-8"	2'-7"	NIF	0"	1"	0"
		P2-P3	b	P2 to P3	4'-0"	NIF	4'-0"	4'-0"	4'-0"	NIF	0"	0"	0"
		P2-P4	c	P2 to P4	2'-8"	NIF	2'-8"	2'-8"	2'-8"	NIF	0"	0"	0"
		P3-P5	d	P3 to P5	4'-11"	4'-10"	4'-11"	5'-0"	5'-0"	NIF	0"	1"	1"
		P4-P5	e	P4 to P5	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P5-P6	f	P5 to P6	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P5-P8	g	P5 to P8	5'-4"	NIF	5'-5"	5'-3"	5'-4"	1"	1"	1"	0"
		P5-P7	h	P5 to P7	4'-11"	5'-0"	5'-1"	4'-11"	5'-0"	1"	1"	0"	1"
		P6-P7	i	P6 to P7	2'-5"	NIF	2'-5"	2'-4"	2'-5"	NIF	0"	1"	0"
		P7-P9	j	P7 to P9	3'-1"	NIF	3'-4"	3'-2"	3'-2"	NIF	3"	1"	1"
3	ERROR > 1" (%)									0.00	10.00	0.00	0.00
4	ERROR = 1" (%)									50.00	20.00	50.00	30.00
5	ZERO ERROR (%)									50.00	70.00	50.00	70.00

*NIF = Not in Frame

	ERROR > 1"
	ERROR = 1"
	ZERO ERROR

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	20'-0"	30'-0"	40'-0"	10'-0"	20'-0"	30'-0"	40'-0"
2	Samsung Galaxy S6 (16.0MP)	W1	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W2	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W3	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W5	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W6	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W7	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W8	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									0.00	0.00	0.00	0.00
	ZERO ERROR (%)									100.00	100.00	100.00	100.00
	Samsung Galaxy S6 (16.0MP)	W1	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-4"	0"	0"	0"	1"
		W4	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-4"	0"	0"	0"	1"
		W6	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W7	y	y-axis	2'-5"	NIF	2'-5"	2'-4"	2'-4"	NIF	0"	1"	1"
		W8	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									0.00	0.00	12.50	37.50
	ZERO ERROR (%)									100.00	100.00	87.50	62.50
	Samsung Galaxy S6 (16.0MP)	P1-P2	a	P1 to P2	2'-7"	NIF	2'-7"	2'-8"	2'-7"	NIF	0"	1"	0"
		P2-P3	b	P2 to P3	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	0"	0"	0"	0"
		P2-P4	c	P2 to P4	2'-8"	2'-7"	2'-8"	2'-8"	2'-8"	1"	0"	0"	0"
		P3-P5	d	P3 to P5	4'-11"	4'-11"	4'-11"	5'-0"	5'-0"	0"	0"	1"	1"
		P4-P5	e	P4 to P5	2'-7"	2'-8"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P5-P6	f	P5 to P6	2'-7"	2'-7"	2'-7"	2'-6"	2'-6"	0"	0"	1"	1"
		P5-P8	g	P5 to P8	5'-4"	5'-6"	5'-4"	5'-3"	5'-3"	1"	0"	1"	1"
		P5-P7	h	P5 to P7	4'-11"	5'-0"	4'-11"	4'-10"	4'-11"	1"	0"	1"	0"
		P6-P7	i	P6 to P7	2'-5"	2'-5"	2'-5"	2'-4"	2'-4"	0"	0"	1"	1"
		P7-P9	j	P7 to P9	3'-1"	NIF	3'-3"	3'-1"	3'-0"	NIF	2"	0"	1"
3	ERROR > 1" (%)									0.00	10.00	0.00	0.00
4	ERROR = 1" (%)									50.00	0.00	60.00	50.00
5	ZERO ERROR (%)									50.00	90.00	40.00	50.00

*NIF = Not in Frame

	ERROR > 1"
	ERROR = 1"
	ZERO ERROR

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	20'-0"	30'-0"	40'-0"	10'-0"	20'-0"	30'-0"	40'-0"
2	Olympus Digital Camera (2.0MP)	W1	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W2	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W3	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W5	x	x-axis	2'-0"	2'-2"	2'-0"	2'-0"	2'-0"	2"	0"	0"	0"
		W6	x	x-axis	2'-0"	2'-2"	2'-0"	2'-0"	2'-0"	2"	0"	0"	0"
		W7	x	x-axis	2'-0"	NIF	2'-1"	2'-0"	2'-0"	NIF	1"	0"	0"
		W8	x	x-axis	2'-0"	NIF	2'-1"	2'-0"	2'-0"	NIF	1"	0"	0"
	ERROR > 1" (%)									50.00	0.00	0.00	0.00
	ERROR = 1" (%)									0.00	25.00	0.00	0.00
	ZERO ERROR (%)									50.00	75.00	100.00	100.00
	Olympus Digital Camera (2.0MP)	W1	y	y-axis	2'-5"	NIF	2'-5"	2'-4"	2'-5"	NIF	0"	1"	0"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W4	y	y-axis	2'-5"	2'-6"	2'-5"	2'-5"	2'-5"	1"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-6"	2'-6"	2'-5"	2'-5"	1"	1"	0"	0"
		W6	y	y-axis	2'-5"	2'-7"	2'-6"	2'-5"	2'-5"	2"	1"	0"	0"
		W7	y	y-axis	2'-5"	NIF	2'-6"	2'-4"	2'-5"	NIF	1"	1"	0"
		W8	y	y-axis	2'-5"	NIF	2'-6"	2'-5"	2'-5"	NIF	1"	0"	0"
	ERROR > 1" (%)									25.00	0.00	0.00	0.00
	ERROR = 1" (%)									50.00	50.00	25.00	0.00
	ZERO ERROR (%)									25.00	50.00	75.00	100.00
	Olympus Digital Camera (2.0MP)	P1-P2	a	P1 to P2	2'-7"	NIF	2'-7"	2'-7"	2'-7"	NIF	0"	0"	0"
		P2-P3	b	P2 to P3	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	0"	0"	0"	0"
		P2-P4	c	P2 to P4	2'-8"	2'-7"	2'-8"	2'-7"	2'-7"	1"	0"	1"	1"
		P3-P5	d	P3 to P5	4'-11"	4'-11"	4'-11"	4'-11"	4'-11"	0"	0"	0"	0"
		P4-P5	e	P4 to P5	2'-7"	2'-8"	2'-8"	2'-7"	2'-8"	1"	1"	0"	1"
		P5-P6	f	P5 to P6	2'-7"	2'-8"	2'-8"	2'-7"	2'-7"	1"	1"	0"	0"
		P5-P8	g	P5 to P8	5'-4"	5'-11"	5'-5"	5'-4"	5'-4"	7"	1"	0"	0"
		P5-P7	h	P5 to P7	4'-11"	5'-3"	5'-1"	5'-0"	5'-0"	4"	1"	1"	1"
		P6-P7	i	P6 to P7	2'-5"	2'-7"	2'-6"	2'-5"	2'-5"	2"	1"	0"	0"
		P7-P9	j	P7 to P9	3'-1"	NIF	3'-4"	3'-1"	3'-2"	NIF	3"	0"	1"
3	ERROR > 1" (%)									37.50	10.00	0.00	0.00
4	ERROR = 1" (%)									37.50	50.00	20.00	40.00
5	ZERO ERROR (%)									25.00	40.00	80.00	60.00

*NIF = Not in Frame

	ERROR > 1"
	ERROR = 1"
	ZERO ERROR

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	20'-0"	30'-0"	40'-0"	10'-0"	20'-0"	30'-0"	40'-0"
2	Olympus Digital Camera (8.0MP)	W1	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W2	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W3	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W5	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W6	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W7	x	x-axis	2'-0"	NIF	1'-11"	2'-0"	2'-0"	NIF	1"	0"	0"
		W8	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									0.00	12.50	0.00	0.00
	ZERO ERROR (%)									100.00	87.50	100.00	100.00
	Olympus Digital Camera (8.0MP)	W1	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W4	y	y-axis	2'-5"	2'-6"	2'-5"	2'-5"	2'-5"	1"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W6	y	y-axis	2'-5"	2'-6"	2'-5"	2'-5"	2'-5"	1"	0"	0"	0"
		W7	y	y-axis	2'-5"	NIF	2'-6"	2'-4"	2'-5"	NIF	1"	1"	0"
		W8	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									50.00	12.50	12.50	0.00
	ZERO ERROR (%)									50.00	87.50	87.50	100.00
	Olympus Digital Camera (8.0MP)	P1-P2	a	P1 to P2	2'-7"	NIF	2'-7"	2'-7"	2'-7"	NIF	0"	0"	0"
		P2-P3	b	P2 to P3	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	0"	0"	0"	0"
		P2-P4	c	P2 to P4	2'-8"	2'-7"	2'-7"	2'-7"	2'-8"	1"	1"	1"	0"
		P3-P5	d	P3 to P5	4'-11"	4'-11"	4'-11"	4'-11"	4'-11"	0"	0"	0"	0"
		P4-P5	e	P4 to P5	2'-7"	2'-8"	2'-7"	2'-7"	2'-8"	1"	0"	0"	1"
		P5-P6	f	P5 to P6	2'-7"	2'-8"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P5-P8	g	P5 to P8	5'-4"	5'-9"	5'-4"	5'-3"	5'-4"	5"	0"	1"	0"
		P5-P7	h	P5 to P7	4'-11"	5'-2"	4'-11"	4'-11"	4'-11"	3"	0"	0"	0"
		P6-P7	i	P6 to P7	2'-5"	2'-6"	2'-5"	2'-4"	2'-5"	1"	0"	1"	0"
		P7-P9	j	P7 to P9	3'-1"	NIF	3'-1"	3'-1"	3'-1"	NIF	0"	0"	0"
3	ERROR > 1" (%)									25.00	0.00	0.00	0.00
4	ERROR = 1" (%)									50.00	10.00	30.00	10.00
5	ZERO ERROR (%)									25.00	90.00	70.00	90.00

*NIF = Not in Frame

	ERROR > 1"
	ERROR = 1"
	ZERO ERROR

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	20'-0"	30'-0"	40'-0"	10'-0"	20'-0"	30'-0"	40'-0"
2	Olympus Digital Camera (16.0MP)	W1	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W2	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W3	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W5	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W6	x	x-axis	2'-0"	2'-0"	2'-1"	2'-0"	2'-0"	0"	1"	0"	0"
		W7	x	x-axis	2'-0"	NIF	2'-1"	2'-0"	2'-0"	NIF	1"	0"	0"
		W8	x	x-axis	2'-0"	NIF	2'-1"	2'-0"	2'-0"	NIF	1"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									0.00	37.50	0.00	0.00
	ZERO ERROR (%)									100.00	62.50	100.00	100.00
	Olympus Digital Camera (16.0MP)	W1	y	y-axis	2'-5"	NIF	2'-5"	2'-4"	2'-5"	NIF	0"	1"	0"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W4	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-5"	2'-5"	2'-4"	2'-5"	0"	0"	1"	0"
		W6	y	y-axis	2'-5"	2'-6"	2'-6"	2'-5"	2'-5"	1"	1"	0"	0"
		W7	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W8	y	y-axis	2'-5"	NIF	2'-6"	2'-5"	2'-5"	NIF	1"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									25.00	25.00	25.00	0.00
	ZERO ERROR (%)									75.00	75.00	75.00	100.00
	Olympus Digital Camera (16.0MP)	P1-P2	a	P1 to P2	2'-7"	NIF	2'-6"	2'-7"	2'-7"	NIF	1"	0"	0"
		P2-P3	b	P2 to P3	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	0"	0"	0"	0"
		P2-P4	c	P2 to P4	2'-8"	2'-7"	2'-7"	2'-7"	2'-8"	1"	1"	1"	0"
		P3-P5	d	P3 to P5	4'-11"	4'-11"	4'-11"	4'-11"	4'-11"	0"	0"	0"	0"
		P4-P5	e	P4 to P5	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P5-P6	f	P5 to P6	2'-7"	2'-8"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P5-P8	g	P5 to P8	5'-4"	5'-8"	5'-6"	5'-4"	5'-4"	4"	2"	0"	0"
		P5-P7	h	P5 to P7	4'-11"	5'-1"	5'-1"	4'-11"	4'-11"	2"	2"	0"	0"
		P6-P7	i	P6 to P7	2'-5"	2'-5"	2'-6"	2'-4"	2'-5"	0"	1"	1"	0"
		P7-P9	j	P7 to P9	3'-1"	NIF	3'-3"	3'-1"	3'-1"	NIF	2"	0"	0"
3	ERROR > 1" (%)									25.00	30.00	0.00	0.00
4	ERROR = 1" (%)									25.00	30.00	20.00	0.00
5	ZERO ERROR (%)									50.00	40.00	80.00	100.00

*NIF = Not in Frame

	ERROR > 1"
	ERROR = 1"
	ZERO ERROR

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	20'-0"	30'-0"	40'-0"	10'-0"	20'-0"	30'-0"	40'-0"
2	Nikon DSLR (Fine)	W1	x	x-axis	2'-0"	NIF	1'-11"	2'-0"	2'-0"	NIF	1"	0"	0"
		W2	x	x-axis	2'-0"	NIF	1'-11"	2'-0"	2'-0"	NIF	1"	0"	0"
		W3	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W5	x	x-axis	2'-0"	2'-1"	2'-1"	2'-0"	2'-0"	1"	1"	0"	0"
		W6	x	x-axis	2'-0"	2'-1"	2'-1"	2'-0"	2'-0"	1"	1"	0"	0"
		W7	x	x-axis	2'-0"	NIF	2'-1"	2'-0"	2'-0"	NIF	1"	0"	0"
		W8	x	x-axis	2'-0"	NIF	2'-1"	2'-0"	2'-0"	NIF	1"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									50.00	75.00	0.00	0.00
	ZERO ERROR (%)									50.00	25.00	100.00	100.00
	Nikon DSLR (Fine)	W1	y	y-axis	2'-5"	NIF	2'-4"	2'-4"	2'-4"	NIF	1"	1"	1"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-5"	2'-5"	2'-4"	2'-4"	0"	0"	1"	1"
		W4	y	y-axis	2'-5"	2'-6"	2'-6"	2'-5"	2'-5"	1"	1"	0"	0"
		W5	y	y-axis	2'-5"	2'-5"	2'-5"	2'-4"	2'-4"	0"	0"	1"	1"
		W6	y	y-axis	2'-5"	2'-6"	2'-6"	2'-6"	2'-5"	1"	1"	1"	0"
		W7	y	y-axis	2'-5"	NIF	2'-5"	2'-4"	2'-4"	NIF	0"	1"	1"
		W8	y	y-axis	2'-5"	NIF	2'-6"	2'-5"	2'-5"	NIF	1"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									50.00	50.00	75.00	50.00
	ZERO ERROR (%)									50.00	50.00	25.00	50.00
	Nikon DSLR (Fine)	P1-P2	a	P1 to P2	2'-7"	NIF	2'-6"	2'-6"	2'-6"	NIF	1"	1"	1"
		P2-P3	b	P2 to P3	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	0"	0"	0"	0"
		P2-P4	c	P2 to P4	2'-8"	2'-7"	2'-7"	2'-7"	2'-7"	1"	1"	1"	1"
		P3-P5	d	P3 to P5	4'-11"	4'-11"	4'-11"	4'-11"	4'-11"	0"	0"	0"	0"
		P4-P5	e	P4 to P5	2'-7"	2'-8"	2'-8"	2'-8"	2'-8"	1"	1"	1"	1"
		P5-P6	f	P5 to P6	2'-7"	2'-8"	2'-7"	2'-7"	2'-6"	1"	0"	0"	1"
		P5-P8	g	P5 to P8	5'-4"	5'-10"	5'-7"	5'-5"	5'-5"	6"	3"	1"	1"
		P5-P7	h	P5 to P7	4'-11"	5'-2"	5'-1"	5'-0"	5'-0"	3"	1"	1"	1"
		P6-P7	i	P6 to P7	2'-5"	2'-6"	2'-6"	2'-5"	2'-5"	1"	1"	0"	0"
		P7-P9	j	P7 to P9	3'-1"	NIF	3'-3"	3'-1"	3'-1"	NIF	2"	0"	0"
3	ERROR > 1" (%)									25.00	20.00	0.00	0.00
4	ERROR = 1" (%)									50.00	50.00	50.00	60.00
5	ZERO ERROR (%)									25.00	30.00	50.00	40.00

*NIF = Not in Frame

	ERROR > 1"
	ERROR = 1"
	ZERO ERROR

Summary of Experiment 1

Equipment	Resolution (MP)	Location	ERROR > 1" (%)				Average	ERROR = 1" (%)				Average	ZERO ERROR (%)				Average
			10'-0"	20'-0"	30'-0"	40'-0"	(%)	10'-0"	20'-0"	30'-0"	40'-0"	(%)	10'-0"	20'-0"	30'-0"	40'-0"	(%)
Samsung Galaxy S6	2.4	W (x)	0.00	0.00	0.00	0.00	0.00	100.00	25.00	25.00	0.00	28.57	0.00	75.00	75.00	100.00	71.43
		W (y)	0.00	0.00	0.00	0.00	0.00	25.00	12.50	0.00	0.00	10.71	75.00	87.50	100.00	100.00	89.29
		Target Points	0.00	10.00	0.00	0.00	2.70	85.71	40.00	30.00	40.00	45.95	14.29	50.00	70.00	60.00	51.35
	8.0	W (x)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	100.00	100.00	100.00	100.00
		W (y)	0.00	0.00	0.00	0.00	0.00	0.00	12.50	12.50	0.00	7.14	100.00	87.50	87.50	100.00	92.86
		Target Points	0.00	10.00	0.00	0.00	2.94	50.00	20.00	50.00	30.00	35.29	50.00	70.00	50.00	70.00	61.76
	16.0	W (x)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	100.00	100.00	100.00	100.00
		W (y)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.50	37.50	14.29	100.00	100.00	87.50	62.50	85.71
		Target Points	0.00	10.00	0.00	0.00	2.63	50.00	0.00	60.00	50.00	39.47	50.00	90.00	40.00	50.00	57.89
	Average	W (x)					0.00	W (x)				9.52	W (x)				90.48
		W (y)					0.00	W (y)				10.71	W (y)				89.29
		Target Points					2.76	Target Points				40.24	Target Points				57.00
Olympus Digital Camera	2.0	W (x)	50.00	0.00	0.00	0.00	7.14	0.00	25.00	0.00	0.00	7.14	50.00	75.00	100.00	100.00	85.71
		W (y)	25.00	0.00	0.00	0.00	3.57	50.00	50.00	25.00	0.00	28.57	25.00	50.00	75.00	100.00	67.86
		Target Points	37.50	10.00	0.00	0.00	7.89	37.50	50.00	20.00	40.00	36.84	25.00	40.00	80.00	60.00	55.26
	8.0	W (x)	0.00	0.00	0.00	0.00	0.00	0.00	12.50	0.00	0.00	3.57	100.00	87.50	100.00	100.00	96.43
		W (y)	0.00	0.00	0.00	0.00	0.00	50.00	12.50	12.50	0.00	14.29	50.00	87.50	87.50	100.00	85.71
		Target Points	25.00	0.00	0.00	0.00	5.26	50.00	10.00	30.00	10.00	23.68	25.00	90.00	70.00	90.00	71.05
	16.0	W (x)	0.00	0.00	0.00	0.00	0.00	0.00	37.50	0.00	0.00	10.71	100.00	62.50	100.00	100.00	89.29
		W (y)	0.00	0.00	0.00	0.00	0.00	25.00	25.00	25.00	0.00	17.86	75.00	75.00	75.00	100.00	82.14
		Target Points	25.00	30.00	0.00	0.00	13.16	25.00	30.00	20.00	0.00	18.42	50.00	40.00	80.00	100.00	68.42
	Average	W (x)					2.38	W (x)				7.14	W (x)				90.48
		W (y)					1.19	W (y)				20.24	W (y)				78.57
		Target Points					8.77	Target Points				26.32	Target Points				64.91
Nikon DSLR	Fine	W (x)	0.00	0.00	0.00	0.00	0.00	50.00	75.00	0.00	0.00	28.57	50.00	25.00	100.00	100.00	71.43
		W (y)	0.00	0.00	0.00	0.00	0.00	50.00	50.00	75.00	50.00	53.57	50.00	50.00	25.00	50.00	46.43
		Target Points	25.00	20.00	0.00	0.00	10.53	50.00	50.00	50.00	60.00	52.63	25.00	30.00	50.00	40.00	36.84

APPENDIX B. EXPERIMENT 2

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	15'-0"	20'-0"	25'-0"	10'-0"	15'-0"	20'-0"	25'-0"
	Samsung Galaxy S6 (2.4MP)	W1	x	x-axis	2'-0"	NIF	2'-0"	2'-1"	2'-0"	NIF	0"	1"	0"
		W2	x	x-axis	2'-0"	NIF	2'-1"	2'-1"	2'-0"	NIF	1"	1"	0"
		W3	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W5	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W6	x	x-axis	2'-0"	2'-1"	2'-0"	2'-0"	2'-0"	1"	0"	0"	0"
		W7	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W8	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									25.00	12.50	25.00	0.00
	ZERO ERROR (%)									75.00	87.50	75.00	100.00
	Samsung Galaxy S6 (2.4MP)	W1	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-5"	2'-4"	2'-4"	2'-5"	0"	1"	1"	0"
		W4	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-5"	2'-4"	2'-4"	2'-4"	0"	1"	1"	1"
		W6	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W7	y	y-axis	2'-5"	NIF	2'-5"	2'-4"	2'-5"	NIF	0"	1"	0"
		W8	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									0.00	25.00	37.50	12.50
2	ZERO ERROR (%)									100.00	75.00	62.50	87.50
	Samsung Galaxy S6 (2.4MP)	P1-P3	b (x-axis)	P2 to P3	2'-8"	NIF	2'-9"	2'-10"	2'-9"	NIF	1"	2"	1"
		P2-P6	d (x-axis)	P3 to P5	5'-4"	NIF	5'-5"	5'-6"	5'-4"	NIF	1"	1"	0"
		P3-P5	e (x-axis)	P4 to P5	2'-7"	2'-7"	2'-8"	2'-8"	2'-8"	0"	1"	1"	1"
		P6-P8	g (x-axis)	P5 to P8	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P5-P7	h (x-axis)	P5 to P7	2'-7"	2'-8"	2'-7"	2'-7"	2'-8"	1"	0"	0"	1"
		P7-P9	j (x-axis)	P7 to P9	2'-7"	2'-8"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P8-P10	k (x-axis)	P8 to P10	2'-7"	2'-8"	2'-7"	2'-6"	2'-7"	1"	0"	1"	0"
		P9-P11	m (x-axis)	P9 to P11	2'-5"	2'-6"	2'-6"	2'-5"	2'-6"	1"	1"	0"	1"
		P10-P12	n (x-axis)	P10 to P12	2'-7"	2'-6"	2'-7"	2'-6"	2'-7"	1"	0"	1"	0"
		P11-P13	p (x-axis)	P11 to P13	3'-1"	NIF	3'-1"	3'-0"	3'-1"	NIF	0"	1"	0"
		P12-P14	q (x-axis)	P12 to P14	3'-0"	NIF	3'-1"	3'-0"	3'-1"	NIF	1"	0"	1"
	ERROR > 1" (%)									0.00	0.00	9.09	0.00
	ERROR = 1" (%)									71.43	45.45	45.45	45.45
	ZERO ERROR (%)									28.57	54.55	45.45	54.55
	Samsung Galaxy S6 (2.4MP)	P1-P2	a (y-axis)	P1 to P2	2'-6"	NIF	2'-6"	2'-7"	2'-6"	NIF	0"	1"	0"
		P3-P4	c (y-axis)	P2 to P4	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	0"	0"	0"	0"
		P5-P6	f (y-axis)	P5 to P6	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"	0"	0"	0"	0"
		P7-P8	i (y-axis)	P6 to P7	2'-6"	2'-7"	2'-6"	2'-6"	2'-6"	1"	0"	0"	0"
		P9-P10	l (y-axis)	P9 to P10	2'-6"	2'-7"	2'-6"	2'-6"	2'-6"	1"	0"	0"	0"
		P11-P12	o (y-axis)	P11 to P12	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	0"	0"	0"	0"
		P13-P14	r (y-axis)	P13 to P16	2'-6"	NIF	2'-6"	2'-6"	2'-6"	NIF	0"	0"	0"
3	ERROR > 1" (%)									0.00	0.00	0.00	0.00
4	ERROR = 1" (%)									40.00	0.00	14.29	0.00
5	ZERO ERROR (%)									60.00	100.00	85.71	100.00

*NIF = Not in Frame

	ERROR > 1"
	ERROR = 1"
	ZERO ERROR

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	15'-0"	20'-0"	25'-0"	10'-0"	15'-0"	20'-0"	25'-0"
	Samsung Galaxy S6 (8.0MP)	W1	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W2	x	x-axis	2'-0"	NIF	2'-0"	2'-1"	2'-0"	NIF	0"	1"	0"
		W3	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W5	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W6	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W7	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W8	x	x-axis	2'-0"	NIF	2'-0"	2'-1"	2'-1"	NIF	0"	1"	1"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									0.00	0.00	25.00	12.50
	ZERO ERROR (%)									100.00	100.00	75.00	87.50
	Samsung Galaxy S6 (8.0MP)	W1	y	y-axis	2'-5"	NIF	2'-4"	2'-5"	2'-4"	NIF	1"	0"	1"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-4"	2'-4"	2'-4"	2'-4"	1"	1"	1"	1"
		W4	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-4"	2'-4"	2'-4"	2'-4"	1"	1"	1"	1"
		W6	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W7	y	y-axis	2'-5"	NIF	2'-4"	2'-5"	2'-5"	NIF	1"	0"	0"
		W8	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									50.00	50.00	25.00	37.50
2	ZERO ERROR (%)									50.00	50.00	75.00	62.50
	Samsung Galaxy S6 (8.0MP)	P1-P3	b (x-axis)	P2 to P3	2'-8"	NIF	2'-9"	2'-9"	2'-9"	NIF	1"	1"	1"
		P2-P6	d (x-axis)	P3 to P5	5'-4"	NIF	5'-5"	5'-4"	5'-4"	NIF	1"	0"	0"
		P3-P5	e (x-axis)	P4 to P5	2'-7"	NIF	2'-8"	2'-7"	2'-7"	NIF	1"	0"	0"
		P6-P8	g (x-axis)	P5 to P8	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P5-P7	h (x-axis)	P5 to P7	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P7-P9	j (x-axis)	P7 to P9	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P8-P10	k (x-axis)	P8 to P10	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P9-P11	m (x-axis)	P9 to P11	2'-5"	NIF	2'-6"	2'-6"	2'-6"	NIF	1"	1"	1"
		P10-P12	n (x-axis)	P10 to P12	2'-7"	NIF	2'-7"	2'-7"	2'-7"	NIF	0"	0"	0"
		P11-P13	p (x-axis)	P11 to P13	3'-1"	NIF	3'-0"	3'-1"	3'-1"	NIF	1"	0"	0"
		P12-P14	q (x-axis)	P12 to P14	3'-0"	NIF	3'-0"	3'-1"	3'-1"	NIF	0"	1"	1"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									0.00	45.45	27.27	27.27
	ZERO ERROR (%)									100.00	54.55	72.73	72.73
	Samsung Galaxy S6 (8.0MP)	P1-P2	a (y-axis)	P1 to P2	2'-6"	NIF	2'-6"	2'-6"	2'-6"	NIF	0"	0"	0"
		P3-P4	c (y-axis)	P2 to P4	4'-0"	NIF	4'-0"	4'-0"	4'-0"	NIF	0"	0"	0"
		P5-P6	f (y-axis)	P5 to P6	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"	0"	0"	0"	0"
		P7-P8	i (y-axis)	P6 to P7	2'-7"	2'-6"	2'-6"	2'-6"	2'-6"	1"	1"	1"	1"
		P9-P10	l (y-axis)	P9 to P10	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"	0"	0"	0"	0"
		P11-P12	o (y-axis)	P11 to P12	3'-0"	NIF	3'-0"	3'-0"	3'-0"	NIF	0"	0"	0"
		P13-P14	r (y-axis)	P13 to P16	2'-6"	NIF	2'6"	2'-6"	2'-6"	NIF	0"	0"	0"
3	ERROR > 1" (%)									0.00	0.00	0.00	0.00
4	ERROR = 1" (%)									33.33	14.29	14.29	14.29
5	ZERO ERROR (%)									66.67	85.71	85.71	85.71

*NIF = Not in Frame

	ERROR > 1"
	ERROR = 1"
	ZERO ERROR

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	15'-0"	20'-0"	25'-0"	10'-0"	15'-0"	20'-0"	25'-0"
	Samsung Galaxy S6 (16.0MP)	W1	x	x-axis	2'-0"	NIF	2'-0"	2'-1"	2'-1"	NIF	0"	1"	1"
		W2	x	x-axis	2'-0"	NIF	2'-1"	2'-1"	2'-1"	NIF	1"	1"	1"
		W3	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W5	x	x-axis	2'-0"	2'-0"	2'-0"	1'-11"	2'-0"	0"	0"	1"	0"
		W6	x	x-axis	2'-0"	2'-1"	2'-0"	1'-11"	2'-0"	1"	0"	1"	0"
		W7	x	x-axis	2'-0"	NIF	2'-0"	1'-11"	2'-0"	NIF	0"	1"	0"
		W8	x	x-axis	2'-0"	NIF	2'-0"	1'-11"	2'-0"	NIF	0"	1"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									25.00	12.50	75.00	25.00
	ZERO ERROR (%)									75.00	87.50	25.00	75.00
	Samsung Galaxy S6 (16.0MP)	W1	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-5"	2'-5"	2'-4"	2'-4"	0"	0"	1"	1"
		W4	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-5"	2'-5"	2'-4"	2'-4"	0"	0"	1"	1"
		W6	y	y-axis	2'-5"	2'-5"	2'-5"	2'-4"	2'-5"	0"	0"	1"	0"
		W7	y	y-axis	2'-5"	NIF	2'-5"	2'-3"	2'-4"	NIF	0"	2"	1"
		W8	y	y-axis	2'-5"	NIF	2'-5"	2'-4"	2'-5"	NIF	0"	1"	0"
	ERROR > 1" (%)									0.00	0.00	12.50	0.00
	ERROR = 1" (%)									0.00	0.00	50.00	37.50
2	ZERO ERROR (%)									100.00	100.00	37.50	62.50
	Samsung Galaxy S6 (16.0MP)	P1-P3	b (x-axis)	P2 to P3	2'-8"	NIF	2'-9"	2'-10"	2'-9"	NIF	1"	2"	1"
		P2-P6	d (x-axis)	P3 to P5	5'-4"	NIF	5'-5"	5'-6"	5'-5"	NIF	1"	1"	1"
		P3-P5	e (x-axis)	P4 to P5	2'-7"	2'-8"	2'-8"	2'-8"	2'-8"	1"	1"	1"	1"
		P6-P8	g (x-axis)	P5 to P8	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P5-P7	h (x-axis)	P5 to P7	2'-7"	2'-8"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P7-P9	j (x-axis)	P7 to P9	2'-7"	2'-7"	2'-7"	2'-6"	2'-7"	0"	0"	1"	0"
		P8-P10	k (x-axis)	P8 to P10	2'-7"	2'-7"	2'-6"	2'-6"	2'-7"	0"	1"	1"	0"
		P9-P11	m (x-axis)	P9 to P11	2'-5"	2'-6"	2'-6"	2'-5"	2'-6"	1"	1"	0"	1"
		P10-P12	n (x-axis)	P10 to P12	2'-7"	2'-6"	2'-7"	2'-6"	2'-6"	1"	0"	1"	1"
		P11-P13	p (x-axis)	P11 to P13	3'-1"	NIF	3'-0"	2'-11"	3'-0"	NIF	1"	2"	1"
		P12-P14	q (x-axis)	P12 to P14	3'-0"	NIF	3'-0"	2'-10"	2'-11"	NIF	0"	2"	1"
	ERROR > 1" (%)									0.00	0.00	27.27	0.00
	ERROR = 1" (%)									57.14	54.55	45.45	63.64
	ZERO ERROR (%)									42.86	45.45	27.27	36.36
	Samsung Galaxy S6 (16.0MP)	P1-P2	a (y-axis)	P1 to P2	2'-6"	NIF	2'-6"	2'-6"	2'-6"	NIF	0"	0"	0"
		P3-P4	c (y-axis)	P2 to P4	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	0"	0"	0"	0"
		P5-P6	f (y-axis)	P5 to P6	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"	0"	0"	0"	0"
		P7-P8	i (y-axis)	P6 to P7	2'-7"	2'-7"	2'-6"	2'-6"	2'-6"	0"	1"	1"	1"
		P9-P10	l (y-axis)	P9 to P10	2'-6"	2'-6"	2'-6"	2'-5"	2'-6"	0"	0"	1"	0"
		P11-P12	o (y-axis)	P11 to P12	3'-0"	3'-0"	3'-0"	2'-11"	3'-0"	0"	0"	1"	0"
		P13-P14	r (y-axis)	P13 to P16	2'-6"	NIF	2'-6"	2'-5"	2'-6"	NIF	0"	1"	0"
3	ERROR > 1" (%)									0.00	0.00	0.00	0.00
4	ERROR= 1" (%)									0.00	14.29	57.14	14.29
5	ZERO ERROR (%)									100.00	85.71	42.86	85.71

*NIF = Not in Frame

	ERROR > 1"
	ERROR = 1"
	ZERO ERROR

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	15'-0"	20'-0"	25'-0"	10'-0"	15'-0"	20'-0"	25'-0"
	Olympus Digital Camera (2.0MP)	W1	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W2	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W3	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W5	x	x-axis	2'-0"	2'-1"	2'-0"	2'-0"	2'-0"	1"	0"	0"	0"
		W6	x	x-axis	2'-0"	2'-1"	2'-0"	2'-0"	2'-0"	1"	0"	0"	0"
		W7	x	x-axis	2'-0"	NIF	1'-11"	2'-0"	1'-11"	NIF	1"	0"	1"
		W8	x	x-axis	2'-0"	NIF	1'-11"	2'-0"	2'-0"	NIF	1"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									50.00	25.00	0.00	12.50
	ZERO ERROR (%)									50.00	75.00	100.00	87.50
	Olympus Digital Camera (2.0MP)	W1	y	y-axis	2'-5"	NIF	2'-4"	2'-4"	2'-4"	NIF	1"	1"	1"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-5"	2'-4"	2'-4"	2'-4"	0"	1"	1"	1"
		W4	y	y-axis	2'-5"	2'-6"	2'-5"	2'-5"	2'-5"	1"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-5"	2'-4"	2'-4"	2'-4"	0"	1"	1"	1"
		W6	y	y-axis	2'-5"	2'-6"	2'-5"	2'-5"	2'-5"	1"	0"	0"	0"
		W7	y	y-axis	2'-5"	NIF	2'-4"	2'-4"	2'-4"	NIF	1"	1"	1"
		W8	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									50.00	50.00	50.00	50.00
2	ZERO ERROR (%)									50.00	50.00	50.00	50.00
	Olympus Digital Camera (2.0MP)	P1-P3	b (x-axis)	P2 to P3	2'-8"	NIF	2'-9"	2'-8"	2'-8"	NIF	1"	0"	0"
		P2-P6	d (x-axis)	P3 to P5	5'-4"	NIF	5'-4"	5'-4"	5'-4"	NIF	0"	0"	0"
		P3-P5	e (x-axis)	P4 to P5	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P6-P8	g (x-axis)	P5 to P8	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P5-P7	h (x-axis)	P5 to P7	2'-7"	2'-8"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P7-P9	j (x-axis)	P7 to P9	2'-7"	2'-8"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P8-P10	k (x-axis)	P8 to P10	2'-7"	2'-8"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P9-P11	m (x-axis)	P9 to P11	2'-5"	2'-7"	2'-5"	2'-6"	2'-5"	2"	0"	1"	0"
		P10-P12	n (x-axis)	P10 to P12	2'-7"	2'-7"	2'-6"	2'-6"	2'-6"	0"	1"	1"	1"
		P11-P13	p (x-axis)	P11 to P13	3'-1"	NIF	2'-11"	3'-0"	3'-0"	NIF	2"	1"	1"
		P12-P14	q (x-axis)	P12 to P14	3'-0"	NIF	2'-11"	2'-11"	2'-11"	NIF	1"	1"	1"
	ERROR > 1" (%)									14.29	9.09	0.00	0.00
	ERROR = 1" (%)									42.86	27.27	36.36	27.27
	ZERO ERROR (%)									42.86	63.64	63.64	72.73
	Olympus Digital Camera (2.0MP)	P1-P2	a (y-axis)	P1 to P2	2'-6"	NIF	2'-6"	2'-6"	2'-6"	NIF	0"	0"	0"
		P3-P4	c (y-axis)	P2 to P4	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	0"	0"	0"	0"
		P5-P6	f (y-axis)	P5 to P6	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"	0"	0"	0"	0"
		P7-P8	i (y-axis)	P6 to P7	2'-7"	2'-7"	2'-6"	2'-6"	2'-6"	0"	1"	1"	1"
		P9-P10	l (y-axis)	P9 to P10	2'-6"	2'-7"	2'-6"	2'-6"	2'-6"	1"	0"	0"	0"
		P11-P12	o (y-axis)	P11 to P12	3'-0"	3'-1"	3'-0"	3'-0"	3'-0"	1"	0"	0"	0"
		P13-P14	r (y-axis)	P13 to P16	2'-6"	NIF	2'-5"	2'-6"	2'-5"	NIF	1"	0"	1"
3	ERROR > 1" (%)									0.00	0.00	0.00	0.00
4	ERROR = 1" (%)									40.00	28.57	14.29	28.57
5	ZERO ERROR (%)									60.00	71.43	85.71	71.43

*NIF = Not in Frame

ERROR > 1"

ERROR = 1"

ZERO ERROR

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	15'-0"	20'-0"	25'-0"	10'-0"	15'-0"	20'-0"	25'-0"
	Olympus Digital Camera (8.0MP)	W1	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W2	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W3	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-1"	2'-0"	2'-0"	2'-0"	1"	0"	0"	0"
		W5	x	x-axis	2'-0"	2'-2"	2'-0"	1'-11"	2'-0"	2"	0"	1"	0"
		W6	x	x-axis	2'-0"	2'-2"	2'-0"	2'-0"	2'-0"	2"	0"	0"	0"
		W7	x	x-axis	2'-0"	NIF	2'-0"	1'-11"	1'-11"	NIF	0"	1"	1"
		W8	x	x-axis	2'-0"	NIF	2'-0"	1'-11"	2'-0"	NIF	0"	1"	0"
	ERROR > 1" (%)									50.00	0.00	0.00	0.00
	ERROR = 1" (%)									25.00	0.00	37.50	12.50
	ZERO ERROR (%)									25.00	100.00	62.50	87.50
	Olympus Digital Camera (8.0MP)	W1	y	y-axis	2'-5"	NIF	2'-4"	2'-4"	2'-5"	NIF	1"	1"	0"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-5"	2'-4"	2'-4"	2'-5"	0"	1"	1"	0"
		W4	y	y-axis	2'-5"	2'-6"	2'-5"	2'-5"	2'-5"	1"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-5"	2'-4"	2'-4"	2'-5"	0"	1"	1"	0"
		W6	y	y-axis	2'-5"	2'-7"	2'-5"	2'-5"	2'-5"	2"	0"	0"	0"
		W7	y	y-axis	2'-5"	NIF	2'-4"	2'-3"	2'-4"	NIF	1"	2"	1"
		W8	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
	ERROR > 1" (%)									25.00	0.00	12.50	0.00
	ERROR = 1" (%)									25.00	50.00	37.50	12.50
2	ZERO ERROR (%)									50.00	50.00	50.00	87.50
	Olympus Digital Camera (8.0MP)	P1-P3	b (x-axis)	P2 to P3	2'-8"	NIF	2'-8"	2'-8"	2'-8"	NIF	0"	0"	0"
		P2-P6	d (x-axis)	P3 to P5	5'-4"	NIF	5'-4"	5'-4"	5'-4"	NIF	0"	0"	0"
		P3-P5	e (x-axis)	P4 to P5	2'-7"	2'-7"	2'-7"	2'-7"	2'-8"	0"	0"	0"	1"
		P6-P8	g (x-axis)	P5 to P8	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P5-P7	h (x-axis)	P5 to P7	2'-7"	2'-8"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P7-P9	j (x-axis)	P7 to P9	2'-7"	2'-9"	2'-7"	2'-7"	2'-7"	2"	0"	0"	0"
		P8-P10	k (x-axis)	P8 to P10	2'-7"	2'-9"	2'-7"	2'-7"	2'-7"	2"	0"	0"	0"
		P9-P11	m (x-axis)	P9 to P11	2'-5"	2'-8"	2'-5"	2'-5"	2'-6"	3"	0"	0"	1"
		P10-P12	n (x-axis)	P10 to P12	2'-7"	2'-9"	2'-6"	2'-6"	2'-7"	2"	1"	1"	0"
		P11-P13	p (x-axis)	P11 to P13	3'-1"	NIF	3'-0"	2'-11"	3'-0"	NIF	1"	2"	1"
		P12-P14	q (x-axis)	P12 to P14	3'-0"	NIF	2'-11"	2'-11"	2'-11"	NIF	1"	1"	1"
	ERROR > 1" (%)									57.14	0.00	9.09	0.00
	ERROR = 1" (%)									14.29	27.27	18.18	36.36
	ZERO ERROR (%)									28.57	72.73	72.73	63.64
	Olympus Digital Camera (8.0MP)	P1-P2	a (y-axis)	P1 to P2	2'-6"	NIF	2'-6"	2'-6"	2'-6"	NIF	0"	0"	0"
		P3-P4	c (y-axis)	P2 to P4	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	0"	0"	0"	0"
		P5-P6	f (y-axis)	P5 to P6	2'-6"	2'-7"	2'-6"	2'-6"	2'-6"	1"	0"	0"	0"
		P7-P8	i (y-axis)	P6 to P7	2'-7"	2'-8"	2'-6"	2'-6"	2'-6"	1"	1"	1"	1"
		P9-P10	l (y-axis)	P9 to P10	2'-6"	2'-8"	2'-6"	2'-6"	2'-6"	2"	0"	0"	0"
		P11-P12	o (y-axis)	P11 to P12	3'-0"	3'-3"	3'-0"	3'-0"	3'-0"	3"	0"	0"	0"
		P13-P14	r (y-axis)	P13 to P16	2'-6"	NIF	2'-6"	2'-5"	2'-6"	NIF	0"	1"	0"
3	ERROR > 1" (%)									40.00	0.00	0.00	0.00
4	ERROR = 1" (%)									40.00	14.29	28.57	14.29
5	ZERO ERROR (%)									20.00	85.71	71.43	85.71

*NIF = Not in Frame

	ERROR > 1"
	ERROR = 1"
	ZERO ERROR

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	15'-0"	20'-0"	25'-0"	10'-0"	15'-0"	20'-0"	25'-0"
	Olympus Digital Camera (16.0MP)	W1	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W2	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W3	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W5	x	x-axis	2'-0"	2'-1"	2'-0"	2'-0"	2'-0"	1"	0"	0"	0"
		W6	x	x-axis	2'-0"	2'-1"	2'-0"	2'-0"	2'-0"	1"	0"	0"	0"
		W7	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	1'-11"	NIF	0"	0"	1"
		W8	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									50.00	0.00	0.00	12.50
	ZERO ERROR (%)									50.00	100.00	100.00	87.50
	Olympus Digital Camera (16.0MP)	W1	y	y-axis	2'-5"	NIF	2'-4"	2'-4"	2'-4"	NIF	1"	1"	1"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-5"	2'-4"	2'-4"	2'-4"	0"	1"	1"	1"
		W4	y	y-axis	2'-5"	2'-6"	2'-5"	2'-5"	2'-5"	1"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-5"	2'-4"	2'-4"	2'-4"	0"	1"	1"	1"
		W6	y	y-axis	2'-5"	2'-6"	2'-5"	2'-5"	2'-5"	1"	0"	0"	0"
		W7	y	y-axis	2'-5"	NIF	2'-4"	2'-4"	2'-4"	NIF	1"	1"	1"
		W8	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									50.00	50.00	50.00	50.00
2	ZERO ERROR (%)									50.00	50.00	50.00	50.00
	Olympus Digital Camera (16.0MP)	P1-P3	b (x-axis)	P2 to P3	2'-8"	NIF	2'-9"	2'-8"	2'-8"	NIF	1"	0"	0"
		P2-P6	d (x-axis)	P3 to P5	5'-4"	NIF	5'-4"	5'-4"	5'-4"	NIF	0"	0"	0"
		P3-P5	e (x-axis)	P4 to P5	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P6-P8	g (x-axis)	P5 to P8	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P5-P7	h (x-axis)	P5 to P7	2'-7"	2'-8"	2'-8"	2'-7"	2'-7"	1"	1"	0"	0"
		P7-P9	j (x-axis)	P7 to P9	2'-7"	2'-9"	2'-7"	2'-7"	2'-7"	2"	0"	0"	0"
		P8-P10	k (x-axis)	P8 to P10	2'-7"	2'-9"	2'-7"	2'-7"	2'-7"	2"	0"	0"	0"
		P9-P11	m (x-axis)	P9 to P11	2'-5"	2'-8"	2'-6"	2'-5"	2'-6"	3"	1"	0"	1"
		P10-P12	n (x-axis)	P10 to P12	2'-7"	2'-9"	2'-6"	2'-6"	2'-7"	2"	1"	1"	0"
		P11-P13	p (x-axis)	P11 to P13	3'-1"	NIF	3'-0"	2'-11"	3'-0"	NIF	1"	2"	1"
		P12-P14	q (x-axis)	P12 to P14	3'-0"	NIF	3'-0"	2'-11"	2'-11"	NIF	0"	1"	1"
	ERROR > 1" (%)									57.14	0.00	9.09	0.00
	ERROR = 1" (%)									14.29	45.45	18.18	27.27
	ZERO ERROR (%)									28.57	54.55	72.73	72.73
	Olympus Digital Camera (16.0MP)	P1-P2	a (y-axis)	P1 to P2	2'-6"	NIF	2'-6"	2'-6"	2'-6"	NIF	0"	0"	0"
		P3-P4	c (y-axis)	P2 to P4	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	0"	0"	0"	0"
		P5-P6	f (y-axis)	P5 to P6	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"	0"	0"	0"	0"
		P7-P8	i (y-axis)	P6 to P7	2'-7"	2'-8"	2'-7"	2'-6"	2'-6"	1"	0"	1"	1"
		P9-P10	l (y-axis)	P9 to P10	2'-6"	2'-7"	2'-6"	2'-6"	2'-6"	1"	0"	0"	0"
		P11-P12	o (y-axis)	P11 to P12	3'-0"	3'-2"	3'-0"	3'-0"	3'-0"	2"	0"	0"	0"
		P13-P14	r (y-axis)	P13 to P16	2'-6"	NIF	2'-6"	2'-5"	2'-6"	NIF	0"	1"	0"
3	ERROR > 1" (%)									20.00	0.00	0.00	0.00
4	ERROR = 1" (%)									40.00	0.00	28.57	14.29
5	ZERO ERROR (%)									40.00	100.00	71.43	85.71

*NIF = Not in Frame

	ERROR > 1"
	ERROR = 1"
	ZERO ERROR

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	15'-0"	20'-0"	25'-0"	10'-0"	15'-0"	20'-0"	25'-0"
	Nikon DSLR (Basic)	W1	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W2	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W3	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-1"	2'-0"	2'-0"	2'-0"	1"	0"	0"	0"
		W5	x	x-axis	2'-0"	2'-1"	1'-11"	1'-11"	2'-0"	1"	1"	1"	0"
		W6	x	x-axis	2'-0"	2'-2"	2'-0"	2'-0"	2'-0"	2"	0"	0"	0"
		W7	x	x-axis	2'-0"	NIF	1'-11"	1'-11"	2'-0"	NIF	1"	1"	0"
		W8	x	x-axis	2'-0"	NIF	1'-11"	1'-11"	2'-0"	NIF	1"	1"	0"
	ERROR > 1" (%)									25.00	0.00	0.00	0.00
	ERROR = 1" (%)									50.00	37.50	37.50	0.00
	ZERO ERROR (%)									25.00	62.50	62.50	100.00
	Nikon DSLR (Basic)	W1	y	y-axis	2'-5"	NIF	2'-4"	2'-4"	2'-4"	NIF	1"	1"	1"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-5"	2'-4"	2'-4"	2'-4"	0"	1"	1"	1"
		W4	y	y-axis	2'-5"	2'-6"	2'-5"	2'-5"	2'-5"	1"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-5"	2'-4"	2'-4"	2'-4"	0"	1"	1"	1"
		W6	y	y-axis	2'-5"	2'-6"	2'-5"	2'-5"	2'-5"	1"	0"	0"	0"
		W7	y	y-axis	2'-5"	NIF	2'-3"	2'-3"	2'-4"	NIF	2"	2"	1"
		W8	y	y-axis	2'-5"	NIF	2'-5"	2'-4"	2'-5"	NIF	0"	1"	0"
	ERROR > 1" (%)									0.00	12.50	12.50	0.00
	ERROR = 1" (%)									50.00	37.50	37.50	50.00
2	ZERO ERROR (%)									50.00	50.00	50.00	50.00
	Nikon DSLR (Basic)	P1-P3	b (x-axis)	P2 to P3	2'-8"	NIF	2'-8"	2'-9"	2'-8"	NIF	0"	1"	0"
		P2-P6	d (x-axis)	P3 to P5	5'-4"	NIF	5'-4"	5'-4"	5'-4"	NIF	0"	0"	0"
		P3-P5	e (x-axis)	P4 to P5	2'-7"	2'-7"	2'-7"	2'-8"	2'-7"	0"	0"	1"	0"
		P6-P8	g (x-axis)	P5 to P8	2'-7"	2'-8"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P5-P7	h (x-axis)	P5 to P7	2'-7"	2'-8"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P7-P9	j (x-axis)	P7 to P9	2'-7"	2'-9"	2'-7"	2'-7"	2'-7"	2"	0"	0"	0"
		P8-P10	k (x-axis)	P8 to P10	2'-7"	2'-9"	2'-7"	2'-6"	2'-7"	2"	0"	1"	0"
		P9-P11	m (x-axis)	P9 to P11	2'-5"	2'-8"	2'-5"	2'-5"	2'-6"	3"	0"	0"	1"
		P10-P12	n (x-axis)	P10 to P12	2'-7"	2'-8"	2'-6"	2'-6"	2'-6"	1"	1"	1"	1"
		P11-P13	p (x-axis)	P11 to P13	3'-1"	NIF	2'-11"	2'-11"	3'-0"	NIF	2"	2"	1"
		P12-P14	q (x-axis)	P12 to P14	3'-0"	NIF	2'-11"	2'-10"	2'-11"	NIF	1"	2"	1"
	ERROR > 1" (%)									42.86	9.09	18.18	0.00
	ERROR = 1" (%)									42.86	18.18	36.36	36.36
	ZERO ERROR (%)									14.29	72.73	45.45	63.64
	Nikon DSLR (Basic)	P1-P2	a (y-axis)	P1 to P2	2'-6"	NIF	2'-6"	2'-6"	2'-6"	NIF	0"	0"	0"
		P3-P4	c (y-axis)	P2 to P4	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	0"	0"	0"	0"
		P5-P6	f (y-axis)	P5 to P6	2'-6"	2'-7"	2'-6"	2'-6"	2'-6"	1"	0"	0"	0"
		P7-P8	i (y-axis)	P6 to P7	2'-7"	2'-8"	2'-6"	2'-6"	2'-6"	1"	1"	1"	1"
		P9-P10	l (y-axis)	P9 to P10	2'-6"	2'-7"	2'-6"	2'-6"	2'-6"	1"	0"	0"	0"
		P11-P12	o (y-axis)	P11 to P12	3'-0"	3'-2"	3'-0"	2'-11"	3'-0"	2"	0"	1"	0"
		P13-P14	r (y-axis)	P13 to P16	2'-6"	NIF	2'-5"	2'-5"	2'-6"	NIF	1"	1"	0"
3	ERROR > 1" (%)									20.00	0.00	0.00	0.00
4	ERROR = 1" (%)									60.00	28.57	42.86	14.29
5	ZERO ERROR (%)									20.00	71.43	57.14	85.71

*NIF = Not in Frame

	ERROR > 1"
	ERROR = 1"
	ZERO ERROR

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	15'-0"	20'-0"	25'-0"	10'-0"	15'-0"	20'-0"	25'-0"
	Nikon DSLR (Normal)	W1	x	x-axis	2'-0"	NIF	1'-11"	2'-0"	2'-0"	NIF	1"	0"	0"
		W2	x	x-axis	2'-0"	NIF	1'-11"	2'-0"	2'-0"	NIF	1"	0"	0"
		W3	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W5	x	x-axis	2'-0"	1'-11"	2'-0"	2'-0"	2'-0"	1"	0"	0"	0"
		W6	x	x-axis	2'-0"	1'-11"	2'-1"	2'-0"	2'-0"	1"	1"	0"	0"
		W7	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W8	x	x-axis	2'-0"	NIF	2'-1"	2'-0"	2'-0"	NIF	1"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									50.00	50.00	0.00	0.00
	ZERO ERROR (%)									50.00	50.00	100.00	100.00
	Nikon DSLR (Normal)	W1	y	y-axis	2'-5"	NIF	2'-4"	2'-4"	2'-4"	NIF	1"	1"	1"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-4"	2'-4"	2'-4"	2'-4"	1"	1"	1"	1"
		W4	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-3"	2'-4"	2'-4"	2'-4"	2"	1"	1"	1"
		W6	y	y-axis	2'-5"	2'-4"	2'-6"	2'-5"	2'-5"	1"	1"	0"	0"
		W7	y	y-axis	2'-5"	NIF	2'-5"	2'-4"	2'-4"	NIF	0"	1"	1"
		W8	y	y-axis	2'-5"	NIF	2'-6"	2'-5"	2'-5"	NIF	1"	0"	0"
	ERROR > 1" (%)									25.00	0.00	0.00	0.00
	ERROR = 1" (%)									50.00	62.50	50.00	50.00
2	ZERO ERROR (%)									25.00	37.50	50.00	50.00
	Nikon DSLR (Normal)	P1-P3	b (x-axis)	P2 to P3	2'-8"	NIF	2'-8"	2'-9"	2'-8"	NIF	0"	1"	0"
		P2-P6	d (x-axis)	P3 to P5	5'-4"	NIF	5'-3"	5'-4"	5'-4"	NIF	1"	0"	0"
		P3-P5	e (x-axis)	P4 to P5	2'-7"	2'-8"	2'-7"	2'-8"	2'-7"	1"	0"	1"	0"
		P6-P8	g (x-axis)	P5 to P8	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P5-P7	h (x-axis)	P5 to P7	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P7-P9	j (x-axis)	P7 to P9	2'-7"	2'-6"	2'-8"	2'-7"	2'-7"	1"	1"	0"	0"
		P8-P10	k (x-axis)	P8 to P10	2'-7"	2'-6"	2'-8"	2'-7"	2'-7"	1"	1"	0"	0"
		P9-P11	m (x-axis)	P9 to P11	2'-5"	2'-3"	2'-7"	2'-5"	2'-6"	2"	2"	0"	1"
		P10-P12	n (x-axis)	P10 to P12	2'-7"	2'-4"	2'-7"	2'-6"	2'-7"	3"	0"	1"	0"
		P11-P13	p (x-axis)	P11 to P13	3'-1"	NIF	3'-1"	2'-11"	3'-0"	NIF	0"	2"	1"
		P12-P14	q (x-axis)	P12 to P14	3'-0"	NIF	3'-1"	2'-11"	3'-0"	NIF	1"	1"	0"
	ERROR > 1" (%)									28.57	9.09	9.09	0.00
	ERROR = 1" (%)									42.86	36.36	36.36	18.18
	ZERO ERROR (%)									28.57	54.55	54.55	81.82
	Nikon DSLR (Normal)	P1-P2	a (y-axis)	P1 to P2	2'-6"	NIF	2'-6"	2'-6"	2'-6"	NIF	0"	0"	0"
		P3-P4	c (y-axis)	P2 to P4	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	NIF	0"	0"	0"
		P5-P6	f (y-axis)	P5 to P6	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"	0"	0"	0"	0"
		P7-P8	i (y-axis)	P6 to P7	2'-7"	2'-6"	2'-7"	2'-6"	2'-6"	1"	0"	1"	1"
		P9-P10	l (y-axis)	P9 to P10	2'-6"	2'-5"	2'-7"	2'-6"	2'-6"	1"	1"	0"	0"
		P11-P12	o (y-axis)	P11 to P12	3'-0"	2'-9"	3'-1"	3'-0"	3'-0"	3"	1"	0"	0"
		P13-P14	r (y-axis)	P13 to P16	2'-6"	NIF	2'-7"	2'-6"	2'-6"	NIF	1"	0"	0"
3	ERROR > 1" (%)									25.00	0.00	0.00	0.00
4	ERROR = 1" (%)									50.00	42.86	14.29	14.29
5	ZERO ERROR (%)									25.00	57.14	85.71	85.71

*NIF = Not in Frame

	ERROR > 1"
	ERROR = 1"
	ZERO ERROR

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	15'-0"	20'-0"	25'-0"	10'-0"	15'-0"	20'-0"	25'-0"
	Nikon DSLR (Fine)	W1	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W2	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W3	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W5	x	x-axis	2'-0"	2'-1"	2'-0"	1'-11"	2'-0"	1"	0"	1"	0"
		W6	x	x-axis	2'-0"	2'-1"	2'-0"	2'-0"	2'-0"	1"	0"	0"	0"
		W7	x	x-axis	2'-0"	NIF	2'-0"	1'-11"	1'-11"	NIF	0"	1"	1"
		W8	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									50.00	0.00	25.00	12.50
	ZERO ERROR (%)									50.00	100.00	75.00	87.50
	Nikon DSLR (Fine)	W1	y	y-axis	2'-5"	NIF	2'-4"	2'-4"	2'-4"	NIF	1"	1"	1"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-5"	2'-4"	2'-4"	2'-4"	0"	1"	1"	1"
		W4	y	y-axis	2'-5"	2'-6"	2'-5"	2'-5"	2'-5"	1"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-5"	2'-4"	2'-4"	2'-4"	0"	1"	1"	1"
		W6	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W7	y	y-axis	2'-5"	NIF	2'-4"	2'-4"	2'-4"	NIF	1"	1"	1"
		W8	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									25.00	50.00	50.00	50.00
2	ZERO ERROR (%)									75.00	50.00	50.00	50.00
	Nikon DSLR (Fine)	P1-P3	b (x-axis)	P2 to P3	2'-8"	NIF	2'-8"	2'-9"	2'-9"	NIF	0"	1"	1"
		P2-P6	d (x-axis)	P3 to P5	5'-4"	NIF	5'-4"	5'-4"	5'-5"	NIF	0"	0"	1"
		P3-P5	e (x-axis)	P4 to P5	2'-7"	2'-7"	2'-7"	2'-7"	2'-8"	0"	0"	0"	1"
		P6-P8	g (x-axis)	P5 to P8	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P5-P7	h (x-axis)	P5 to P7	2'-7"	2'-8"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P7-P9	j (x-axis)	P7 to P9	2'-7"	2'-8"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P8-P10	k (x-axis)	P8 to P10	2'-7"	2'-8"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P9-P11	m (x-axis)	P9 to P11	2'-5"	2'-7"	2'-6"	2'-5"	2'-5"	2"	1"	0"	0"
		P10-P12	n (x-axis)	P10 to P12	2'-7"	2'-7"	2'-7"	2'-6"	2'-6"	0"	0"	1"	1"
		P11-P13	p (x-axis)	P11 to P13	3'-1"	NIF	3'-0"	2'-11"	2'-11"	NIF	1"	2"	2"
		P12-P14	q (x-axis)	P12 to P14	3'-0"	NIF	3'-0"	2'-10"	2'-11"	NIF	0"	2"	1"
	ERROR > 1" (%)									14.29	0.00	18.18	9.09
	ERROR = 1" (%)									42.86	18.18	18.18	45.45
	ZERO ERROR (%)									42.86	81.82	63.64	45.45
	Nikon DSLR (Fine)	P1-P2	a (y-axis)	P1 to P2	2'-6"	NIF	2'-6"	2'-6"	2'-6"	NIF	0"	0"	0"
		P3-P4	c (y-axis)	P2 to P4	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	0"	0"	0"	0"
		P5-P6	f (y-axis)	P5 to P6	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"	0"	0"	0"	0"
		P7-P8	i (y-axis)	P6 to P7	2'-7"	2'-8"	2'-7"	2'-6"	2'-6"	1"	0"	1"	1"
		P9-P10	l (y-axis)	P9 to P10	2'-6"	2'-7"	2'-6"	2'-6"	2'-6"	1"	0"	0"	0"
		P11-P12	o (y-axis)	P11 to P12	3'-0"	3'-1"	3'-0"	2'-11"	3'-0"	1"	0"	1"	0"
		P13-P14	r (y-axis)	P13 to P16	2'-6"	NIF	2'-6"	2'-5"	2'-5"	NIF	0"	1"	1"
3	ERROR > 1" (%)									0.00	0.00	0.00	0.00
4	ERROR = 1" (%)									60.00	0.00	42.86	28.57
5	ZERO ERROR (%)									40.00	100.00	57.14	71.43

*NIF = Not in Frame

	ERROR > 1"
	ERROR = 1"
	ZERO ERROR

Summary of Experiment 2

Equipment	Resolution (MP)	Location	ERROR > 1" (%)				Average	ERROR = 1" (%)				Average	ZERO ERROR (%)				Average
			10'-0"	15'-0"	20'-0"	25'-0"	%	10'-0"	15'-0"	20'-0"	25'-0"	%	10'-0"	15'-0"	20'-0"	25'-0"	%
Samsung Galaxy S6	2.4	W (x)	0.00	0.00	0.00	0.00	0.00	25.00	12.50	25.00	0.00	14.29	75.00	87.50	75.00	100.00	85.71
		W (y)	0.00	0.00	0.00	0.00	0.00	0.00	25.00	37.50	12.50	21.43	100.00	75.00	62.50	87.50	78.57
		Target Points (x)	0.00	0.00	9.09	0.00	2.50	71.43	45.45	45.45	45.45	50.00	28.57	54.55	45.45	54.55	47.50
		Target Points (y)	0.00	0.00	0.00	0.00	0.00	40.00	0.00	14.29	0.00	11.54	60.00	100.00	85.71	100.00	88.46
	8.0	W (x)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	12.50	10.71	100.00	100.00	75.00	87.50	89.29
		W (y)	0.00	0.00	0.00	0.00	0.00	50.00	50.00	25.00	37.50	39.29	50.00	50.00	75.00	62.50	60.71
		Target Points (x)	0.00	0.00	0.00	0.00	0.00	0.00	45.45	27.27	27.27	29.73	100.00	54.55	72.73	72.73	70.27
		Target Points (y)	0.00	0.00	0.00	0.00	0.00	33.33	14.29	14.29	14.29	16.67	66.67	85.71	85.71	85.71	83.33
	16.0	W (x)	0.00	0.00	0.00	0.00	0.00	25.00	12.50	75.00	25.00	35.71	75.00	87.50	25.00	75.00	64.29
		W (y)	0.00	0.00	12.50	0.00	3.57	0.00	0.00	50.00	37.50	25.00	100.00	100.00	37.50	62.50	71.43
		Target Points (x)	0.00	0.00	27.27	0.00	7.50	57.14	54.55	45.45	63.64	55.00	42.86	45.45	27.27	36.36	37.50
		Target Points (y)	0.00	0.00	0.00	0.00	0.00	0.00	14.29	57.14	14.29	23.08	100.00	85.71	42.86	85.71	76.92
	Average	W (x)					0.00	W (x)				20.24	W (x)				79.76
		W (y)					1.19	W (y)				28.57	W (y)				70.24
		Target Points (x)					3.33	Target Points (x)				44.91	Target Points (x)				51.76
		Target Points (y)					0.00	Target Points (y)				17.09	Target Points (y)				82.91

Equipment	Resolution (MP)	Location	ERROR > 1" (%)				Average	ERROR = 1" (%)				Average	ZERO ERROR (%)				Average
			10'-0"	15'-0"	20'-0"	25'-0"	%	10'-0"	15'-0"	20'-0"	25'-0"	%	10'-0"	15'-0"	20'-0"	25'-0"	%
Olympus Digital Camera	2.0	W (x)	0.00	0.00	0.00	0.00	0.00	50.00	25.00	0.00	12.50	17.86	50.00	75.00	100.00	87.50	82.14
		W (y)	0.00	0.00	0.00	0.00	0.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
		Target Points (x)	14.29	9.09	0.00	0.00	5.00	42.86	27.27	36.36	27.27	32.50	42.86	63.64	63.64	72.73	62.50
		Target Points (y)	0.00	0.00	0.00	0.00	0.00	40.00	28.57	14.29	28.57	26.92	60.00	71.43	85.71	71.43	73.08
	8.0	W (x)	50.00	0.00	0.00	0.00	7.14	25.00	0.00	37.50	12.50	17.86	25.00	100.00	62.50	87.50	75.00
		W (y)	25.00	0.00	12.50	0.00	7.14	25.00	50.00	37.50	12.50	32.14	50.00	50.00	50.00	87.50	60.71
		Target Points (x)	57.14	0.00	9.09	0.00	12.50	14.29	27.27	18.18	36.36	25.00	28.57	72.73	72.73	63.64	62.50
		Target Points (y)	40.00	0.00	0.00	0.00	7.69	40.00	14.29	28.57	14.29	23.08	20.00	85.71	71.43	85.71	69.23
	16.0	W (x)	0.00	0.00	0.00	0.00	0.00	50.00	0.00	0.00	12.50	10.71	50.00	100.00	100.00	87.50	89.29
		W (y)	0.00	0.00	0.00	0.00	0.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
		Target Points (x)	57.14	0.00	9.09	0.00	12.50	14.29	45.45	18.18	27.27	27.50	28.57	54.55	72.73	72.73	60.00
		Target Points (y)	20.00	0.00	0.00	0.00	3.85	40.00	0.00	28.57	14.29	19.23	40.00	100.00	71.43	85.71	76.92
	Average	W (x)					2.38	W (x)				15.48	W (x)				82.14
		W (y)					2.38	W (y)				44.05	W (y)				53.57
		Target Points (x)					10.00	Target Points (x)				28.33	Target Points (x)				61.67
		Target Points (y)					3.85	Target Points (y)				23.08	Target Points (y)				73.08

Equipment	Resolution (MP)	Location	ERROR > 1" (%)				Average %	ERROR = 1" (%)				Average %	ZERO ERROR (%)				Average %
			10'-0"	15'-0"	20'-0"	25'-0"		10'-0"	15'-0"	20'-0"	25'-0"		10'-0"	15'-0"	20'-0"	25'-0"	
Nikon DSLR	Basic	W (x)	25.00	0.00	0.00	0.00	3.57	50.00	37.50	37.50	0.00	28.57	25.00	62.50	62.50	100.00	67.86
		W (y)	0.00	12.50	12.50	0.00	7.14	50.00	37.50	37.50	50.00	46.43	50.00	50.00	50.00	50.00	46.43
		Target Points (x)	42.86	9.09	18.18	0.00	15.00	42.86	18.18	36.36	36.36	32.50	14.29	72.73	45.45	63.64	52.50
		Target Points (y)	20.00	0.00	0.00	0.00	3.85	60.00	28.57	42.86	14.29	34.62	20.00	71.43	57.14	85.71	61.54
	Normal	W (x)	0.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00	21.43	50.00	50.00	100.00	100.00	78.57
		W (y)	25.00	0.00	0.00	0.00	3.57	50.00	62.50	50.00	50.00	53.57	25.00	37.50	50.00	50.00	42.86
		Target Points (x)	28.57	9.09	9.09	0.00	7.50	42.86	36.36	36.36	18.18	32.50	28.57	54.55	54.55	81.82	60.00
		Target Points (y)	25.00	0.00	0.00	0.00	4.00	50.00	42.86	14.29	14.29	28.00	25.00	57.14	85.71	85.71	68.00
	Fine	W (x)	0.00	0.00	0.00	0.00	0.00	50.00	0.00	25.00	12.50	17.86	50.00	100.00	75.00	87.50	82.14
		W (y)	0.00	0.00	0.00	0.00	0.00	25.00	50.00	50.00	50.00	46.43	75.00	50.00	50.00	50.00	53.57
		Target Points (x)	14.29	0.00	18.18	9.09	10.00	42.86	18.18	18.18	45.45	30.00	42.86	81.82	63.64	45.45	60.00
		Target Points (y)	0.00	0.00	0.00	0.00	0.00	60.00	0.00	42.86	28.57	30.77	40.00	100.00	57.14	71.43	69.23
	Average	W (x)					1.19	W (x)				22.62	W (x)				76.19
		W (y)					3.57	W (y)				48.81	W (y)				47.62
		Target Points (x)					10.83	Target Points (x)				31.67	Target Points (x)				57.50
		Target Points (y)					2.62	Target Points (y)				31.13	Target Points (y)				66.26

APPENDIX C. EXPERIMENT 3

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	15'-0"	20'-0"	25'-0"	10'-0"	15'-0"	20'-0"	25'-0"
	Samsung Galaxy S6 (2.4MP)	W1	x	x-axis	2'-0"	NIF	1'-11"	2'-0"	2'-1"	NIF	1"	0"	1"
		W2	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-1"	NIF	0"	0"	1"
		W3	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W5	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W6	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W7	x	x-axis	2'-0"	NIF	1'-11"	2'-0"	2'-0"	NIF	1"	0"	0"
		W8	x	x-axis	2'-0"	NIF	1'-11"	2'-0"	2'-0"	NIF	1"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									0.00	37.50	0.00	25.00
	ZERO ERROR (%)									100.00	62.50	100.00	75.00
	Samsung Galaxy S6 (2.4MP)	W1	y	y-axis	2'-5"	NIF	2'-4"	2'-5"	2'-5"	NIF	1"	0"	0"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-4"	2'-4"	2'-4"	2'-4"	1"	1"	1"	1"
		W4	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W5	y	y-axis	2'-5"	NIF	2'-4"	2'-4"	2'-4"	NIF	1"	1"	1"
		W6	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W7	y	y-axis	2'-5"	NIF	2'-4"	2'-5"	2'-4"	NIF	1"	0"	1"
		W8	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									50.00	50.00	25.00	37.50
2	ZERO ERROR (%)									50.00	50.00	75.00	62.50
	Samsung Galaxy S6 (2.4MP)	P1-P3	b (x-axis)	P2 to P3	2'-8"	NIF	2'-8"	2'-9"	2'-10"	NIF	0"	1"	2"
		P2-P6	d (x-axis)	P3 to P5	5'-4"	4'-11"	5'-4"	5'-5"	5'-6"	5"	0"	1"	1"
		P3-P5	e (x-axis)	P4 to P5	2'-7"	2'-6"	2'-8"	2'-8"	2'-8"	1"	1"	1"	1"
		P6-P8	g (x-axis)	P5 to P8	2'-7"	2'-6"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P5-P7	h (x-axis)	P5 to P7	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P7-P9	j (x-axis)	P7 to P9	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P8-P10	k (x-axis)	P8 to P10	2'-7"	2'-7"	2'-6"	2'-7"	2'-6"	0"	1"	0"	1"
		P9-P11	m (x-axis)	P9 to P11	2'-5"	2'-5"	2'-6"	2'-6"	2'-6"	0"	1"	1"	1"
		P10-P12	n (x-axis)	P10 to P12	2'-7"	2'-6"	2'-7"	2'-7"	2'-6"	1"	0"	0"	1"
		P11-P13	p (x-axis)	P11 to P13	3'-1"	NIF	2'-11"	3'-1"	3'-0"	NIF	2"	0"	1"
		P12-P14	q (x-axis)	P12 to P14	3'-0"	NIF	2'-11"	3'-0"	3'-0"	NIF	1"	0"	0"
	ERROR > 1" (%)									12.50	9.09	0.00	9.09
	ERROR = 1" (%)									37.50	36.36	36.36	54.55
	ZERO ERROR (%)									50.00	54.55	63.64	36.36
	Samsung Galaxy S6 (2.4MP)	P1-P2	a (y-axis)	P1 to P2	2'-6"	NIF	2'-6"	2'-6"	2'-7"	NIF	0"	0"	1"
		P3-P4	c (y-axis)	P2 to P4	4'-0"	3'-11"	4'-0"	4'-0"	4'-0"	1"	0"	0"	0"
		P5-P6	f (y-axis)	P5 to P6	2'-6"	2'-5"	2'-6"	2'-6"	2'-6"	1"	0"	0"	0"
		P7-P8	i (y-axis)	P6 to P7	2'-7"	2'-6"	2'-6"	2'-6"	2'-6"	1"	1"	1"	1"
		P9-P10	l (y-axis)	P9 to P10	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"	0"	0"	0"	0"
		P11-P12	o (y-axis)	P11 to P12	3'-0"	2'-11"	3'-0"	3'-0"	2'-11"	1"	0"	0"	1"
		P13-P14	r (y-axis)	P13 to P16	2'-6"	NIF	2'-5"	2'-6"	2'-6"	NIF	1"	0"	0"
3	ERROR > 1" (%)									0.00	0.00	0.00	0.00
4	ERROR = 1" (%)									80.00	28.57	14.29	42.86
5	ZERO ERROR (%)									20.00	71.43	85.71	57.14

*NIF = Not in Frame

ERROR > 1"

ERROR = 1"

ZERO ERROR

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	15'-0"	20'-0"	25'-0"	10'-0"	15'-0"	20'-0"	25'-0"
	Samsung Galaxy S6 (8.0MP)	W1	x	x-axis	2'-0"	NIF	NIF	2'-0"	2'-1"	NIF	NIF	0"	1"
		W2	x	x-axis	2'-0"	NIF	NIF	2'-1"	2'-1"	NIF	NIF	1"	1"
		W3	x	x-axis	2'-0"	1'-11"	2'-0"	2'-0"	2'-0"	1"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W5	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W6	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W7	x	x-axis	2'-0"	NIF	NIF	2'-0"	2'-0"	NIF	NIF	0"	0"
		W8	x	x-axis	2'-0"	NIF	NIF	2'-0"	2'-0"	NIF	NIF	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									25.00	0.00	12.50	25.00
	ZERO ERROR (%)									75.00	100.00	87.50	75.00
	Samsung Galaxy S6 (8.0MP)	W1	y	y-axis	2'-5"	NIF	NIF	2'-4"	2'-4"	NIF	NIF	1"	1"
		W2	y	y-axis	2'-5"	NIF	NIF	2'-5"	2'-5"	NIF	NIF	0"	0"
		W3	y	y-axis	2'-5"	2'-3"	2'-4"	2'-4"	2'-4"	2"	1"	1"	1"
		W4	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-3"	2'-4"	2'-4"	2'-4"	2"	1"	1"	1"
		W6	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W7	y	y-axis	2'-5"	NIF	NIF	2'-4"	2'-4"	NIF	NIF	1"	1"
		W8	y	y-axis	2'-5"	NIF	NIF	2'-5"	2'-5"	NIF	NIF	0"	0"
	ERROR > 1" (%)									50.00	0.00	0.00	0.00
	ERROR = 1" (%)									0.00	50.00	50.00	50.00
2	ZERO ERROR (%)									50.00	50.00	50.00	50.00
	Samsung Galaxy S6 (8.0MP)	P1-P3	b (x-axis)	P2 to P3	2'-8"	NIF	NIF	2'-9"	2'-9"	NIF	NIF	1"	1"
		P2-P6	d (x-axis)	P3 to P5	5'-4"	NIF	NIF	5'-5"	5'-5"	NIF	NIF	1"	1"
		P3-P5	e (x-axis)	P4 to P5	2'-7"	NIF	2'-7"	2'-8"	2'-8"	NIF	0"	1"	1"
		P6-P8	g (x-axis)	P5 to P8	2'-7"	2'-6"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P5-P7	h (x-axis)	P5 to P7	2'-7"	2'-6"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P7-P9	j (x-axis)	P7 to P9	2'-7"	2'-6"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P8-P10	k (x-axis)	P8 to P10	2'-7"	2'-5"	2'-7"	2'-6"	2'-7"	2"	0"	1"	0"
		P9-P11	m (x-axis)	P9 to P11	2'-5"	NIF	2'-7"	2'-6"	2'-6"	NIF	2"	1"	1"
		P10-P12	n (x-axis)	P10 to P12	2'-7"	NIF	2'-8"	2'-7"	2'-6"	NIF	1"	0"	1"
		P11-P13	p (x-axis)	P11 to P13	3'-1"	NIF	NIF	3'-0"	3'-0"	NIF	NIF	1"	1"
		P12-P14	q (x-axis)	P12 to P14	3'-0"	NIF	NIF	3'-0"	3'-0"	NIF	NIF	0"	0"
	ERROR > 1" (%)									25.00	14.29	0.00	0.00
	ERROR = 1" (%)									75.00	14.29	54.55	54.55
	ZERO ERROR (%)									0.00	71.43	45.45	45.45
	Samsung Galaxy S6 (8.0MP)	P1-P2	a (y-axis)	P1 to P2	2'-6"	NIF	NIF	2'-6"	2'-6"	NIF	NIF	0"	0"
		P3-P4	c (y-axis)	P2 to P4	4'-0"	NIF	4'-0"	4'-0"	4'-0"	NIF	0"	0"	0"
		P5-P6	f (y-axis)	P5 to P6	2'-6"	2'-5"	2'-6"	2'-6"	2'-6"	1"	0"	0"	0"
		P7-P8	i (y-axis)	P6 to P7	2'-7"	2'-6"	2'-6"	2'-6"	2'-6"	1"	1"	1"	1"
		P9-P10	l (y-axis)	P9 to P10	2'-6"	2'-5"	2'-6"	2'-6"	2'-6"	1"	0"	0"	0"
		P11-P12	o (y-axis)	P11 to P12	3'-0"	NIF	3'-1"	3'-0"	3'-0"	NIF	1"	0"	0"
		P13-P14	r (y-axis)	P13 to P16	2'-6"	NIF	NIF	2'-6"	2'-6"	NIF	NIF	0"	0"
3	ERROR > 1" (%)									0.00	0.00	0.00	0.00
4	ERROR = 1" (%)									100.00	40.00	14.29	14.29
5	ZERO ERROR (%)									0.00	60.00	85.71	85.71

*NIF = Not in Frame

ERROR > 1"

ERROR = 1"

ZERO ERROR

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	15'-0"	20'-0"	25'-0"	10'-0"	15'-0"	20'-0"	25'-0"
	Samsung Galaxy S6 (16.0MP)	W1	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-1"	NIF	0"	0"	1"
		W2	x	x-axis	2'-0"	NIF	2'-0"	2'-1"	2'-1"	NIF	0"	1"	1"
		W3	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-1"	2'-0"	2'-0"	2'-0"	1"	0"	0"	0"
		W5	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	1'-11"	0"	0"	0"	1"
		W6	x	x-axis	2'-0"	2'-1"	2'-0"	2'-0"	2'-0"	1"	0"	0"	0"
		W7	x	x-axis	2'-0"	NIF	1'-11"	2'-0"	2'-0"	NIF	1"	0"	0"
		W8	x	x-axis	2'-0"	NIF	1'-11"	2'-0"	2'-0"	NIF	1"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									50.00	25.00	12.50	37.50
	ZERO ERROR (%)									50.00	75.00	87.50	62.50
	Samsung Galaxy S6 (16.0MP)	W1	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-5"	2'-5"	2'-4"	2'-4"	0"	0"	1"	1"
		W4	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-5"	2'-5"	2'-4"	2'-4"	0"	0"	1"	0"
		W6	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W7	y	y-axis	2'-5"	NIF	2'-5"	2'-4"	2'-4"	NIF	0"	1"	1"
		W8	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									0.00	0.00	37.50	25.00
2	ZERO ERROR (%)									100.00	100.00	62.50	75.00
	Samsung Galaxy S6 (16.0MP)	P1-P3	b (x-axis)	P2 to P3	2'-8"	NIF	2'-9"	2'-9"	2'-10"	NIF	1"	1"	2"
		P2-P6	d (x-axis)	P3 to P5	5'-4"	NIF	5'-4"	5'-5"	5'-6"	NIF	0"	1"	1"
		P3-P5	e (x-axis)	P4 to P5	2'-7"	2'-8"	2'-8"	2'-8"	2'-8"	1"	1"	1"	1"
		P6-P8	g (x-axis)	P5 to P8	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P5-P7	h (x-axis)	P5 to P7	2'-7"	2'-8"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P7-P9	j (x-axis)	P7 to P9	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P8-P10	k (x-axis)	P8 to P10	2'-7"	2'-7"	2'-7"	2'-6"	2'-6"	0"	0"	1"	1"
		P9-P11	m (x-axis)	P9 to P11	2'-5"	2'-6"	2'-6"	2'-6"	2'-5"	1"	1"	1"	0"
		P10-P12	n (x-axis)	P10 to P12	2'-7"	2'-6"	2'-7"	2'-7"	2'-6"	1"	0"	0"	1"
		P11-P13	p (x-axis)	P11 to P13	3'-1"	NIF	3'-0"	3'-0"	3'-0"	NIF	1"	1"	1"
		P12-P14	q (x-axis)	P12 to P14	3'-0"	NIF	3'-0"	3'-0"	3'-0"	NIF	0"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	9.09
	ERROR = 1" (%)									57.14	36.36	54.55	45.45
	ZERO ERROR (%)									42.86	63.64	45.45	45.45
	Samsung Galaxy S6 (16.0MP)	P1-P2	a (y-axis)	P1 to P2	2'-6"	NIF	2'-6"	2'-6"	2'-6"	NIF	0"	0"	0"
		P3-P4	c (y-axis)	P2 to P4	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	0"	0"	0"	0"
		P5-P6	f (y-axis)	P5 to P6	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"	0"	0"	0"	0"
		P7-P8	i (y-axis)	P6 to P7	2'-7"	2'-7"	2'-6"	2'-6"	2'-6"	0"	1"	1"	1"
		P9-P10	l (y-axis)	P9 to P10	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"	0"	0"	0"	0"
		P11-P12	o (y-axis)	P11 to P12	3'-0"	3'-0"	3'-0"	3'-0"	2'-11"	0"	0"	0"	1"
		P13-P14	r (y-axis)	P13 to P16	2'-6"	NIF	2'-6"	2'-6"	2'-6"	NIF	0"	0"	0"
3	ERROR > 1" (%)									0.00	0.00	0.00	0.00
4	ERROR = 1" (%)									0.00	14.29	14.29	28.57
5	ZERO ERROR (%)									100.00	85.71	85.71	71.43

*NIF = Not in Frame

	ERROR > 1"
	ERROR = 1"
	ZERO ERROR

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	15'-0"	20'-0"	25'-0"	10'-0"	15'-0"	20'-0"	25'-0"
	Olympus Digital Camera (2.0MP)	W1	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W2	x	x-axis	2'-0"	NIF	2'-1"	2'-0"	2'-0"	NIF	1"	0"	0"
		W3	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W5	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W6	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W7	x	x-axis	2'-0"	NIF	1'-11"	1'-11"	1'-11"	NIF	1"	1"	1"
		W8	x	x-axis	2'-0"	NIF	1'-11"	1'-11"	2'-0"	NIF	1"	1"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									0.00	37.50	25.00	12.50
	ZERO ERROR (%)									100.00	62.50	75.00	87.50
	Olympus Digital Camera (2.0MP)	W1	y	y-axis	2'-5"	NIF	2'-4"	2'-4"	2'-4"	NIF	1"	1"	1"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-4"	2'-4"	2'-4"	2'-4"	1"	1"	1"	1"
		W4	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-4"	2'-4"	2'-4"	2'-4"	1"	1"	1"	1"
		W6	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W7	y	y-axis	2'-5"	NIF	2'-4"	2'-4"	2'-4"	NIF	1"	1"	1"
		W8	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									50.00	50.00	50.00	50.00
2	ZERO ERROR (%)									50.00	50.00	50.00	50.00
	Olympus Digital Camera (2.0MP)	P1-P3	b (x-axis)	P2 to P3	2'-8"	NIF	2'-9"	2'-9"	2'-9"	NIF	1"	1"	1"
		P2-P6	d (x-axis)	P3 to P5	5'-4"	NIF	5'-4"	5'-4"	5'-4"	NIF	0"	0"	0"
		P3-P5	e (x-axis)	P4 to P5	2'-7"	2'-7"	2'-7"	2'-7"	2'7"	0"	0"	0"	0"
		P6-P8	g (x-axis)	P5 to P8	2'-7"	2'-7"	2'-7"	2'-7"	2'7"	0"	0"	0"	0"
		P5-P7	h (x-axis)	P5 to P7	2'-7"	2'-7"	2'-8"	2'-7"	2'-8"	0"	1"	0"	1"
		P7-P9	j (x-axis)	P7 to P9	2'-7"	2'-7"	2'7"	2'-7"	2'-7"	0"	0"	0"	0"
		P8-P10	k (x-axis)	P8 to P10	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P9-P11	m (x-axis)	P9 to P11	2'-5"	2'-5"	2'-6"	2'-5"	2'-6"	0"	1"	0"	1"
		P10-P12	n (x-axis)	P10 to P12	2'-7"	2'-6"	2'-6"	2'-6"	2'-6"	1"	1"	1"	1"
		P11-P13	p (x-axis)	P11 to P13	3'-1"	NIF	2'-11"	2'-11"	3'-0"	NIF	2"	2"	1"
		P12-P14	q (x-axis)	P12 to P14	3'-0"	NIF	2'-11"	2'-11"	2'-11"	NIF	1"	1"	1"
	ERROR > 1" (%)									0.00	9.09	9.09	0.00
	ERROR = 1" (%)									14.29	45.45	27.27	54.55
	ZERO ERROR (%)									85.71	45.45	63.64	45.45
	Olympus Digital Camera (2.0MP)	P1-P2	a (y-axis)	P1 to P2	2'-6"	NIF	2'-6"	2'-6"	2'-6"	NIF	0"	0"	0"
		P3-P4	c (y-axis)	P2 to P4	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	0"	0"	0"	0"
		P5-P6	f (y-axis)	P5 to P6	2'-6"	2'-6"	2'-6"	2'-6"	2'6"	0"	0"	0"	0"
		P7-P8	i (y-axis)	P6 to P7	2'-7"	2'-7"	2'-7"	2'-6"	2'-6"	0"	0"	1"	1"
		P9-P10	l (y-axis)	P9 to P10	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"	0"	0"	0"	0"
		P11-P12	o (y-axis)	P11 to P12	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	0"	0"	0"	0"
		P13-P14	r (y-axis)	P13 to P16	2'-6"	NIF	2'-5"	2'-5"	2'-6"	NIF	1"	1"	0"
3	ERROR > 1" (%)									0.00	0.00	0.00	0.00
4	ERROR = 1" (%)									0.00	14.29	28.57	14.29
5	ZERO ERROR (%)									100.00	85.71	71.43	85.71

*NIF = Not in Frame

ERROR > 1"

ERROR = 1"

ZERO ERROR

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	15'-0"	20'-0"	25'-0"	10'-0"	15'-0"	20'-0"	25'-0"
	Olympus Digital Camera (8.0MP)	W1	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W2	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W3	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W5	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W6	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W7	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W8	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									0.00	0.00	0.00	0.00
	ZERO ERROR (%)									100.00	100.00	100.00	100.00
	Olympus Digital Camera (8.0MP)	W1	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-4"	2'-4"	2'-5"	2'-5"	1"	1"	0"	0"
		W4	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-4"	2'-4"	2'-4"	2'-4"	1"	1"	1"	1"
		W6	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W7	y	y-axis	2'-5"	NIF	2'-4"	2'-4"	2'-4"	NIF	1"	1"	1"
		W8	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									50.00	37.50	25.00	25.00
2	ZERO ERROR (%)									50.00	62.50	75.00	75.00
	Olympus Digital Camera (8.0MP)	P1-P3	b (x-axis)	P2 to P3	2'-8"	NIF	2'-9"	2'-8"	2'-9"	NIF	1"	0"	1"
		P2-P6	d (x-axis)	P3 to P5	5'-4"	NIF	5'-4"	5'-4"	5'-4"	NIF	0"	0"	0"
		P3-P5	e (x-axis)	P4 to P5	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P6-P8	g (x-axis)	P5 to P8	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P5-P7	h (x-axis)	P5 to P7	2'-7"	2'-8"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P7-P9	j (x-axis)	P7 to P9	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P8-P10	k (x-axis)	P8 to P10	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P9-P11	m (x-axis)	P9 to P11	2'-5"	2'-5"	2'-5"	2'-6"	2'-5"	0"	0"	1"	0"
		P10-P12	n (x-axis)	P10 to P12	2'-7"	2'-6"	2'-6"	2'-6"	2'-6"	1"	1"	1"	1"
		P11-P13	p (x-axis)	P11 to P13	3'-1"	NIF	2'-11"	3'-0"	2'-11"	NIF	2"	1"	2"
		P12-P14	q (x-axis)	P12 to P14	3'-0"	NIF	2'-11"	3'-0"	2'-11"	NIF	1"	0"	1"
	ERROR > 1" (%)									0.00	9.09	0.00	9.09
	ERROR = 1" (%)									28.57	27.27	27.27	27.27
	ZERO ERROR (%)									71.43	63.64	72.73	63.64
	Olympus Digital Camera (8.0MP)	P1-P2	a (y-axis)	P1 to P2	2'-6"	NIF	2'-6"	2'-6"	2'-6"	NIF	0"	0"	0"
		P3-P4	c (y-axis)	P2 to P4	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	0"	0"	0"	0"
		P5-P6	f (y-axis)	P5 to P6	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"	0"	0"	0"	0"
		P7-P8	i (y-axis)	P6 to P7	2'-7"	2'-7"	2'-7"	2'-7"	2'-6"	0"	0"	0"	1"
		P9-P10	l (y-axis)	P9 to P10	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"	0"	0"	0"	0"
		P11-P12	o (y-axis)	P11 to P12	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	0"	0"	0"	0"
		P13-P14	r (y-axis)	P13 to P16	2'-6"	NIF	2'-6"	2'-6"	2'-6"	NIF	0"	0"	0"
3	ERROR > 1" (%)									0.00	0.00	0.00	0.00
4	ERROR = 1" (%)									0.00	0.00	0.00	14.29
5	ZERO ERROR (%)									100.00	100.00	100.00	85.71

*NIF = Not in Frame

ERROR > 1"

ERROR = 1"

ZERO ERROR

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	15'-0"	20'-0"	25'-0"	10'-0"	15'-0"	20'-0"	25'-0"
	Olympus Digital Camera (16.0MP)	W1	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W2	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W3	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W5	x	x-axis	2'-0"	1'-11"	2'-0"	2'-0"	2'-0"	1"	0"	0"	0"
		W6	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W7	x	x-axis	2'-0"	NIF	2'-0"	1'-11"	1'-11"	NIF	0"	1"	1"
		W8	x	x-axis	2'-0"	NIF	2'-0"	1'-11"	1'-11"	NIF	0"	1"	1"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									25.00	0.00	25.00	25.00
	ZERO ERROR (%)									75.00	100.00	75.00	75.00
	Olympus Digital Camera (16.0MP)	W1	y	y-axis	2'-5"	NIF	2'-4"	2'-5"	2'-5"	NIF	1"	0"	0"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-4"	2'-4"	2'-4"	2'-4"	1"	1"	1"	1"
		W4	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-4"	2'-4"	2'-4"	2'-4"	1"	1"	1"	1"
		W6	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W7	y	y-axis	2'-5"	NIF	2'-4"	2'-4"	2'-4"	NIF	1"	1"	1"
		W8	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									50.00	50.00	50.00	50.00
2	ZERO ERROR (%)									50.00	50.00	50.00	50.00
	Olympus Digital Camera (16.0MP)	P1-P3	b (x-axis)	P2 to P3	2'-8"	NIF	2'-9"	2'-9"	2'-9"	NIF	1"	1"	1"
		P2-P6	d (x-axis)	P3 to P5	5'-4"	NIF	5'-4"	5'-4"	5'-4"	NIF	0"	0"	0"
		P3-P5	e (x-axis)	P4 to P5	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P6-P8	g (x-axis)	P5 to P8	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P5-P7	h (x-axis)	P5 to P7	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P7-P9	j (x-axis)	P7 to P9	2'-7"	2'-6"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P8-P10	k (x-axis)	P8 to P10	2'-7"	2'-6"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P9-P11	m (x-axis)	P9 to P11	2'-5"	2'-4"	2'-5"	2'-5"	2'-5"	1"	0"	0"	0"
		P10-P12	n (x-axis)	P10 to P12	2'-7"	2'-5"	2'-6"	2'-6"	2'-6"	2"	1"	1"	1"
		P11-P13	p (x-axis)	P11 to P13	3'-1"	NIF	3'-0"	2'-11"	2'-11"	NIF	1"	2"	2"
		P12-P14	q (x-axis)	P12 to P14	3'-0"	NIF	3'-0"	2'-11"	2'-11"	NIF	0"	1"	1"
	ERROR > 1" (%)									14.29	0.00	9.09	9.09
	ERROR = 1" (%)									42.86	27.27	27.27	27.27
	ZERO ERROR (%)									42.86	72.73	63.64	63.64
	Olympus Digital Camera (16.0MP)	P1-P2	a (y-axis)	P1 to P2	2'-6"	NIF	2'-6"	2'-6"	2'-6"	NIF	0"	0"	0"
		P3-P4	c (y-axis)	P2 to P4	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	0"	0"	0"	0"
		P5-P6	f (y-axis)	P5 to P6	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"	0"	0"	0"	0"
		P7-P8	i (y-axis)	P6 to P7	2'-7"	2'-7"	2'-7"	2'-6"	2'-6"	0"	0"	1"	1"
		P9-P10	l (y-axis)	P9 to P10	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"	0"	0"	0"	0"
		P11-P12	o (y-axis)	P11 to P12	3'-0"	2'-11"	3'-0"	2'-11"	3'-0"	1"	0"	1"	0"
		P13-P14	r (y-axis)	P13 to P16	2'-6"	NIF	2'-6"	2'-5"	2'-5"	NIF	0"	1"	1"
3	ERROR > 1" (%)									0.00	0.00	0.00	0.00
4	ERROR = 1" (%)									20.00	0.00	42.86	28.57
5	ZERO ERROR (%)									80.00	100.00	57.14	71.43

*NIF = Not in Frame

	ERROR > 1"
	ERROR = 1"
	ZERO ERROR

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	15'-0"	20'-0"	25'-0"	10'-0"	15'-0"	20'-0"	25'-0"
	Nikon DSLR (Basic)	W1	x	x-axis	2'-0"	NIF	1'-11"	2'-0"	2'-0"	NIF	1"	0"	0"
		W2	x	x-axis	2'-0"	NIF	2'-0"	2'-1"	2'-0"	NIF	0"	1"	0"
		W3	x	x-axis	2'-0"	2'-0"	1'-11"	2'-0"	2'-0"	0"	1"	0"	0"
		W4	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W5	x	x-axis	2'-0"	2'-0"	1'-11"	2'-0"	2'-0"	0"	1"	0"	0"
		W6	x	x-axis	2'-0"	2'-1"	2'-0"	2'-0"	2'-0"	1"	0"	0"	0"
		W7	x	x-axis	2'-0"	NIF	1'-11"	1'-11"	1'-11"	NIF	1"	1"	1"
		W8	x	x-axis	2'-0"	NIF	2'-0"	1'-11"	2'-0"	NIF	0"	1"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									25.00	50.00	37.50	12.50
	ZERO ERROR (%)									75.00	50.00	62.50	87.50
	Nikon DSLR (Basic)	W1	y	y-axis	2'-5"	NIF	2'-4"	2'-4"	2'-4"	NIF	1"	1"	1"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-4"	2'-4"	2'-4"	2'-4"	1"	1"	1"	1"
		W4	y	y-axis	2'-5"	2'-6"	2'-5"	2'-5"	2'-5"	1"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-5"	2'-4"	2'-4"	2'-4"	0"	1"	1"	1"
		W6	y	y-axis	2'-5"	2'-6"	2'-5"	2'-5"	2'-5"	1"	0"	0"	0"
		W7	y	y-axis	2'-5"	NIF	2'-4"	2'-4"	2'-4"	NIF	1"	1"	1"
		W8	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									75.00	50.00	50.00	50.00
2	ZERO ERROR (%)									25.00	50.00	50.00	50.00
	Nikon DSLR (Basic)	P1-P3	b (x-axis)	P2 to P3	2'-8"	NIF	2'-8"	2'-9"	2'-8"	NIF	0"	1"	0"
		P2-P6	d (x-axis)	P3 to P5	5'-4"	NIF	5'-3"	5'-4"	5'-4"	NIF	1"	0"	0"
		P3-P5	e (x-axis)	P4 to P5	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P6-P8	g (x-axis)	P5 to P8	2'-7"	2'-8"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P5-P7	h (x-axis)	P5 to P7	2'-7"	2'-8"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P7-P9	j (x-axis)	P7 to P9	2'-7"	2'-8"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P8-P10	k (x-axis)	P8 to P10	2'-7"	2'-8"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P9-P11	m (x-axis)	P9 to P11	2'-5"	2'-6"	2'-5"	2'-5"	2'-5"	1"	0"	0"	0"
		P10-P12	n (x-axis)	P10 to P12	2'-7"	2'-8"	2'-6"	2'-6"	2'-6"	1"	1"	1"	1"
		P11-P13	p (x-axis)	P11 to P13	3'-1"	NIF	2'-11"	2'-11"	2'-11"	NIF	2"	2"	2"
		P12-P14	q (x-axis)	P12 to P14	3'-0"	NIF	2'-11"	2'-11"	2'-11"	NIF	1"	1"	1"
	ERROR > 1" (%)									0.00	9.09	9.09	9.09
	ERROR = 1" (%)									85.71	27.27	27.27	27.27
	ZERO ERROR (%)									14.29	63.64	63.64	63.64
	Nikon DSLR (Basic)	P1-P2	a (y-axis)	P1 to P2	2'-6"	NIF	2'-6"	2'-6"	2'-6"	NIF	0"	0"	0"
		P3-P4	c (y-axis)	P2 to P4	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	0"	0"	0"	0"
		P5-P6	f (y-axis)	P5 to P6	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"	0"	0"	0"	0"
		P7-P8	i (y-axis)	P6 to P7	2'-7"	2'-8"	2'-7"	2'-6"	2'-6"	1"	0"	1"	1"
		P9-P10	l (y-axis)	P9 to P10	2'-6"	2'-7"	2'-6"	2'-6"	2'-6"	1"	0"	0"	0"
		P11-P12	o (y-axis)	P11 to P12	3'-0"	3'-1"	3'-0"	2'-11"	3'-0"	1"	0"	1"	0"
		P13-P14	r (y-axis)	P13 to P16	2'-6"	NIF	2'-6"	2'-5"	2'-6"	NIF	0"	1"	0"
3	ERROR > 1" (%)									0.00	0.00	0.00	0.00
4	ERROR = 1" (%)									60.00	0.00	42.86	14.29
5	ZERO ERROR (%)									40.00	100.00	57.14	85.71

*NIF = Not in Frame

ERROR > 1"

ERROR = 1"

ZERO ERROR

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	15'-0"	20'-0"	25'-0"	10'-0"	15'-0"	20'-0"	25'-0"
	Nikon DSLR (Normal)	W1	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W2	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W3	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W5	x	x-axis	2'-0"	2'-0"	1'-11"	1'-11"	2'-0"	0"	1"	1"	0"
		W6	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W7	x	x-axis	2'-0"	NIF	1'-10"	1'-10"	1'-11"	NIF	2"	2"	0"
		W8	x	x-axis	2'-0"	NIF	1'-11"	1'-11"	1'-11"	NIF	1"	1"	1"
	ERROR > 1" (%)									0.00	12.50	12.50	0.00
	ERROR = 1" (%)									0.00	25.00	25.00	12.50
	ZERO ERROR (%)									100.00	62.50	62.50	87.50
	Nikon DSLR (Normal)	W1	y	y-axis	2'-5"	NIF	2'-4"	2'-4"	2'-5"	NIF	1"	1"	0"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-6"	NIF	0"	0"	1"
		W3	y	y-axis	2'-5"	2'-4"	2'-4"	2'-4"	2'-5"	1"	1"	1"	0"
		W4	y	y-axis	2'-5"	2'-6"	2'-5"	2'-5"	2'-5"	1"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-4"	2'-3"	2'-4"	2'-4"	1"	2"	1"	1"
		W6	y	y-axis	2'-5"	2'-6"	2'-5"	2'-5"	2'-5"	1"	0"	0"	0"
		W7	y	y-axis	2'-5"	NIF	2'-3"	2'-3"	2'-4"	NIF	2"	2"	1"
		W8	y	y-axis	2'-5"	NIF	2'-5"	2'-4"	2'-5"	NIF	0"	1"	0"
	ERROR > 1" (%)									0.00	25.00	12.50	0.00
	ERROR = 1" (%)									100.00	25.00	50.00	37.50
2	ZERO ERROR (%)									0.00	50.00	37.50	62.50
	Nikon DSLR (Normal)	P1-P3	b (x-axis)	P2 to P3	2'-8"	NIF	2'-8"	2'-9"	2'-9"	NIF	0"	1"	1"
		P2-P6	d (x-axis)	P3 to P5	5'-4"	NIF	5'-4"	5'-5"	5'-4"	NIF	0"	1"	0"
		P3-P5	e (x-axis)	P4 to P5	2'-7"	2'-7"	2'-7"	2'-8"	2'-8"	0"	0"	1"	1"
		P6-P8	g (x-axis)	P5 to P8	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P5-P7	h (x-axis)	P5 to P7	2'-7"	2'-7"	2'-7"	2'-7"	2'-8"	0"	0"	0"	1"
		P7-P9	j (x-axis)	P7 to P9	2'-7"	2'-8"	2'-7"	2'-7"	2'-7"	1"	0"	0"	0"
		P8-P10	k (x-axis)	P8 to P10	2'-7"	2'-8"	2'-7"	2'-6"	2'-6"	1"	0"	1"	1"
		P9-P11	m (x-axis)	P9 to P11	2'-5"	2'-6"	2'-5"	2'-5"	2'-5"	1"	0"	0"	0"
		P10-P12	n (x-axis)	P10 to P12	2'-7"	2'-7"	2'-6"	2'-5"	2'-6"	0"	1"	2"	1"
		P11-P13	p (x-axis)	P11 to P13	3'-1"	NIF	2'-11"	2'-10"	2'-11"	NIF	2"	2"	2"
		P12-P14	q (x-axis)	P12 to P14	3'-0"	NIF	2'-11"	2'-10"	2'-11"	NIF	1"	2"	1"
	ERROR > 1" (%)									0.00	9.09	27.27	9.09
	ERROR = 1" (%)									85.71	18.18	36.36	54.55
	ZERO ERROR (%)									14.29	72.73	36.36	36.36
	Nikon DSLR (Normal)	P1-P2	a (y-axis)	P1 to P2	2'-6"	NIF	2'-6"	2'-6"	2'-6"	NIF	0"	0"	0"
		P3-P4	c (y-axis)	P2 to P4	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	0"	0"	0"	0"
		P5-P6	f (y-axis)	P5 to P6	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"	0"	0"	0"	0"
		P7-P8	i (y-axis)	P6 to P7	2'-7"	2'-7"	2'-6"	2'-6"	2'-6"	0"	1"	1"	1"
		P9-P10	l (y-axis)	P9 to P10	2'-6"	2'-7"	2'-6"	2'-6"	2'-6"	1"	0"	0"	0"
		P11-P12	o (y-axis)	P11 to P12	3'-0"	3'-1"	2'-11"	2'-11"	2'-11"	1"	1"	1"	1"
		P13-P14	r (y-axis)	P13 to P16	2'-6"	NIF	2'-5"	2'-5"	2'-5"	NIF	1"	1"	1"
3	ERROR > 1" (%)									0.00	0.00	0.00	0.00
4	ERROR = 1" (%)									40.00	42.86	42.86	42.86
5	ZERO ERROR (%)									60.00	57.14	57.14	57.14

*NIF = Not in Frame

ERROR > 1"

ERROR = 1"

ZERO ERROR

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Equipment and Resolution	Location Shown on Image	Distance	Distance Description	Measured Distance	Image Distance and Distance between Camera and Wall				Difference between Measured Distance and Image Distance (Error)			
						10'-0"	15'-0"	20'-0"	25'-0"	10'-0"	15'-0"	20'-0"	25'-0"
	Nikon DSLR (Fine)	W1	x	x-axis	2'-0"	NIF	1'-11"	1'-11"	2'-0"	NIF	1"	1"	0"
		W2	x	x-axis	2'-0"	NIF	2'-0"	2'-0"	2'-0"	NIF	0"	0"	0"
		W3	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W4	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W5	x	x-axis	2'-0"	2'-0"	1'-11"	2'-0"	2'-0"	0"	1"	0"	0"
		W6	x	x-axis	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	0"	0"	0"	0"
		W7	x	x-axis	2'-0"	NIF	1'-11"	2'-0"	1'-11"	NIF	1"	0"	1"
		W8	x	x-axis	2'-0"	NIF	NIF	2'-0"	2'0"	NIF	NIF	0"	0"
	ERROR > 1" (%)									0.00	0.00	0.00	0.00
	ERROR = 1" (%)									0.00	42.86	12.50	12.50
	ZERO ERROR (%)									100.00	57.14	87.50	87.50
	Nikon DSLR (Fine)	W1	y	y-axis	2'-5"	NIF	2'-4"	2'-4"	2'-4"	NIF	1"	1"	1"
		W2	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
		W3	y	y-axis	2'-5"	2'-4"	2'-4"	2'-4"	2'-4"	1"	1"	1"	1"
		W4	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W5	y	y-axis	2'-5"	2'-4"	2'-4"	2'-4"	2'-4"	1"	1"	1"	1"
		W6	y	y-axis	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	0"	0"	0"	0"
		W7	y	y-axis	2'-5"	NIF	2'-3"	2'-4"	2'-4"	NIF	2"	1"	1"
		W8	y	y-axis	2'-5"	NIF	2'-5"	2'-5"	2'-5"	NIF	0"	0"	0"
	ERROR > 1" (%)									0.00	12.50	0.00	0.00
	ERROR = 1" (%)									50.00	37.50	50.00	50.00
2	ZERO ERROR (%)									50.00	50.00	50.00	50.00
	Nikon DSLR (Fine)	P1-P3	b (x-axis)	P2 to P3	2'-8"	NIF	2'-8"	2'-8"	2'-8"	NIF	0"	0"	0"
		P2-P6	d (x-axis)	P3 to P5	5'-4"	NIF	5'-3"	5'-4"	5'-4"	NIF	1"	0"	0"
		P3-P5	e (x-axis)	P4 to P5	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P6-P8	g (x-axis)	P5 to P8	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P5-P7	h (x-axis)	P5 to P7	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P7-P9	j (x-axis)	P7 to P9	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P8-P10	k (x-axis)	P8 to P10	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	0"	0"	0"	0"
		P9-P11	m (x-axis)	P9 to P11	2'-5"	2'-5"	2'-5"	2'-6"	2'-6"	0"	0"	1"	1"
		P10-P12	n (x-axis)	P10 to P12	2'-7"	2'-6"	2'-6"	2'-7"	2'-6"	1"	1"	0"	1"
		P11-P13	p (x-axis)	P11 to P13	3'-1"	NIF	2'-11"	3'-0"	2'-11"	NIF	2"	1"	2"
		P12-P14	q (x-axis)	P12 to P14	3'-0"	NIF	2'-11"	3'-0"	2'-11"	NIF	1"	0"	1"
	ERROR > 1" (%)									0.00	9.09	0.00	9.09
	ERROR = 1" (%)									14.29	27.27	18.18	27.27
	ZERO ERROR (%)									85.71	63.64	81.82	63.64
	Nikon DSLR (Fine)	P1-P2	a (y-axis)	P1 to P2	2'-6"	NIF	2'-6"	2'-6"	2'-6"	NIF	0"	0"	0"
		P3-P4	c (y-axis)	P2 to P4	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	0"	0"	0"	0"
		P5-P6	f (y-axis)	P5 to P6	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"	0"	0"	0"	0"
		P7-P8	i (y-axis)	P6 to P7	2'-7"	2'-7"	2'-6"	2'-6"	2'-6"	0"	1"	1"	1"
		P9-P10	l (y-axis)	P9 to P10	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"	0"	0"	0"	0"
		P11-P12	o (y-axis)	P11 to P12	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	0"	0"	0"	0"
		P13-P14	r (y-axis)	P13 to P16	2'-6"	NIF	2'-5"	2'-6"	2'-5"	NIF	1"	0"	1"
3	ERROR > 1" (%)									0.00	0.00	0.00	0.00
4	ERROR = 1" (%)									0.00	28.57	28.57	28.57
5	ZERO ERROR (%)									100.00	71.43	71.43	71.43

*NIF = Not in Frame

	ERROR > 1"
	ERROR = 1"
	ZERO ERROR

Summary of Experiment 3

Equipment	Resolution (MP)	Location	ERROR > 1" (%)				Average %	ERROR = 1" (%)				Average %	ZERO ERROR (%)				Average %
			10'-0"	15'-0"	20'-0"	25'-0"		10'-0"	15'-0"	20'-0"	25'-0"		10'-0"	15'-0"	20'-0"	25'-0"	
Samsung Galaxy S6	2.4	W (x)	0.00	0.00	0.00	0.00	0.00	0.00	37.50	0.00	25.00	19.23	100.00	62.50	100.00	75.00	80.77
		W (y)	0.00	0.00	0.00	0.00	0.00	50.00	50.00	25.00	37.50	38.46	50.00	50.00	75.00	62.50	61.54
		Target Points (x)	12.50	9.09	0.00	9.09	7.32	37.50	36.36	36.36	54.55	41.46	50.00	54.55	63.64	36.36	51.22
		Target Points (y)	0.00	0.00	0.00	0.00	0.00	80.00	28.57	14.29	42.86	38.46	20.00	71.43	85.71	57.14	61.54
	8.0	W (x)	0.00	0.00	0.00	0.00	0.00	25.00	0.00	12.50	25.00	16.67	75.00	100.00	87.50	75.00	83.33
		W (y)	50.00	0.00	0.00	0.00	8.33	0.00	50.00	50.00	50.00	41.67	50.00	50.00	50.00	50.00	50.00
		Target Points (x)	25.00	14.29	0.00	0.00	6.06	75.00	14.29	54.55	54.55	48.48	0.00	71.43	45.45	45.45	45.45
		Target Points (y)	0.00	0.00	0.00	0.00	0.00	100.00	40.00	14.29	14.29	31.82	0.00	60.00	85.71	85.71	68.18
	16.0	W (x)	0.00	0.00	0.00	0.00	0.00	50.00	25.00	12.50	37.50	28.57	50.00	75.00	87.50	62.50	71.43
		W (y)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	37.50	25.00	17.86	100.00	100.00	62.50	75.00	82.14
		Target Points (x)	0.00	0.00	0.00	9.09	2.50	57.14	36.36	54.55	45.45	47.50	42.86	63.64	45.45	45.45	50.00
		Target Points (y)	0.00	0.00	0.00	0.00	0.00	0.00	14.29	14.29	28.57	15.38	100.00	85.71	85.71	71.43	84.62
	Average	W (x)					**0.00**	W (x)				**21.49**	W (x)				**78.51**
		W (y)					**2.78**	W (y)				**32.66**	W (y)				**64.56**
		Target Points (x)					**5.29**	Target Points (x)				**45.82**	Target Points (x)				**48.89**
		Target Points (y)					**0.00**	Target Points (y)				**28.55**	Target Points (y)				**71.45**

Equipment	Resolution (MP)	Location	ERROR > 1" (%)				Average %	ERROR = 1" (%)				Average %	ZERO ERROR (%)				Average %
			10'-0"	15'-0"	20'-0"	25'-0"		10'-0"	15'-0"	20'-0"	25'-0"		10'-0"	15'-0"	20'-0"	25'-0"	
Olympus Digital Camera	2.0	W (x)	0.00	0.00	0.00	0.00	0.00	0.00	37.50	25.00	12.50	21.43	100.00	62.50	75.00	87.50	78.57
		W (y)	0.00	0.00	0.00	0.00	0.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
		Target Points (x)	0.00	9.09	9.09	0.00	5.00	14.29	45.45	27.27	54.55	37.50	85.71	45.45	63.64	45.45	57.50
		Target Points (y)	0.00	0.00	0.00	0.00	0.00	0.00	14.29	28.57	14.29	15.38	100.00	85.71	71.43	85.71	84.62
	8.0	W (x)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	100.00	100.00	100.00	100.00
		W (y)	0.00	0.00	0.00	0.00	0.00	50.00	37.50	25.00	25.00	32.14	50.00	62.50	75.00	75.00	67.86
		Target Points (x)	0.00	9.09	0.00	9.09	5.00	28.57	27.27	27.27	27.27	27.50	71.43	63.64	72.73	63.64	67.50
		Target Points (y)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.29	3.85	100.00	100.00	100.00	85.71	96.15
	16.0	W (x)	0.00	0.00	0.00	0.00	0.00	25.00	0.00	25.00	25.00	17.86	75.00	100.00	75.00	75.00	82.14
		W (y)	0.00	0.00	0.00	0.00	0.00	50.00	50.00	50.00	50.00	42.86	50.00	50.00	50.00	50.00	57.14
		Target Points (x)	14.29	0.00	9.09	9.09	7.50	42.86	27.27	27.27	27.27	30.00	42.86	72.73	63.64	63.64	62.50
		Target Points (y)	0.00	0.00	0.00	0.00	0.00	20.00	0.00	42.86	28.57	23.08	80.00	100.00	57.14	71.43	76.92
	Average	W (x)					**0.00**	W (x)				**13.10**	W (x)				**86.90**
		W (y)					**0.00**	W (y)				**41.67**	W (y)				**58.33**
		Target Points (x)					**5.83**	Target Points (x)				**31.67**	Target Points (x)				**62.50**
		Target Points (y)					**0.00**	Target Points (y)				**14.10**	Target Points (y)				**85.90**

Equipment	Resolution (MP)	Location	ERROR > 1" (%)				Average %	ERROR = 1" (%)				Average %	ZERO ERROR (%)				Average %
			10'-0"	15'-0"	20'-0"	25'-0"		10'-0"	15'-0"	20'-0"	25'-0"		10'-0"	15'-0"	20'-0"	25'-0"	
Nikon DSLR	Basic	W (x)	0.00	0.00	0.00	0.00	0.00	25.00	50.00	37.50	12.50	32.14	75.00	50.00	62.50	87.50	67.86
		W (y)	0.00	0.00	0.00	0.00	0.00	75.00	50.00	50.00	50.00	53.57	25.00	50.00	50.00	50.00	46.43
		Target Points (x)	0.00	9.09	9.09	9.09	7.50	85.71	27.27	27.27	27.27	35.00	14.29	63.64	63.64	63.64	57.50
		Target Points (y)	0.00	0.00	0.00	0.00	0.00	60.00	0.00	42.86	14.29	26.92	40.00	100.00	57.14	85.71	73.08
	Normal	W (x)	0.00	12.50	12.50	0.00	7.14	0.00	25.00	25.00	12.50	17.86	100.00	62.50	62.50	87.50	75.00
		W (y)	0.00	25.00	12.50	0.00	10.71	100.00	25.00	50.00	37.50	46.43	0.00	50.00	37.50	62.50	42.86
		Target Points (x)	0.00	9.09	27.27	9.09	12.50	85.71	18.18	36.36	54.55	37.50	14.29	72.73	36.36	36.36	50.00
		Target Points (y)	0.00	0.00	0.00	0.00	0.00	40.00	42.86	42.86	42.86	42.31	60.00	57.14	57.14	57.14	57.69
	Fine	W (x)	0.00	0.00	0.00	0.00	0.00	0.00	42.86	12.50	12.50	17.86	100.00	57.14	87.50	87.50	82.14
		W (y)	0.00	12.50	0.00	0.00	3.57	50.00	37.50	50.00	50.00	46.43	50.00	50.00	50.00	50.00	50.00
		Target Points (x)	0.00	9.09	0.00	9.09	5.00	14.29	27.27	18.18	27.27	22.50	85.71	63.64	81.82	63.64	72.50
		Target Points (y)	0.00	0.00	0.00	0.00	0.00	0.00	28.57	28.57	28.57	19.23	100.00	71.43	71.43	71.43	80.77
	Average	W (x)					2.38	W (x)				22.62	W (x)				75.00
		W (y)					4.76	W (y)				48.81	W (y)				46.43
		Target Points (x)					8.33	Target Points (x)				31.67	Target Points (x)				60.00
		Target Points (y)					0.00	Target Points (y)				29.49	Target Points (y)				70.51