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Photogrammetry based dynamic metrology system using an industrial Robot

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Abstract-

Most of the robotic systems rely upon their rigidity to perform tasks. Combining a measurement system and a robot makes use of the ability of the robot to move precisely and overcomes the accuracy deficiencies. Photogrammetry provides a suitable method to measure the six degrees of freedom of many objects simultaneously. Photogrammetry provides the ability to simultaneously measure the six degrees of freedom of multiple objects at instant in time. This characteristic can be used in with the cameras viewing the robot's entire working volume or the only viewing the volume close to an end-effector.

In the proposed work, development of an end-effector based system integrated with an industrial robot will be carried out. The development of the physical and software components shall be considered. The physical aspects include: the image processing hardware, configuration of the cameras, lighting, coded targets and location of the targets with respect to the CAD model of the components. The software aspects concern the methods, by which targets are identified, the 3-D estimation of the target locations, matching the targets to the CAD information of the components, and estimation of the robot tool centre point. The functionality of the system shall be demonstrated with prototype operations.

Key Words: **photogrammetry, 3-D model**

1.INTRODUCTION

Project concept is to measure the dimension of any object through the photogrammetry with the help of the industrial robot and control the end effector of the robot. This paper is useful in the dimension measurement of any object present in the workplace during the maintenance and inspection operations done by the remote handling equipment. Also can be used to check the deformation of in-vessel components i.e. tiles etc. occurs due to plasma activity inside the nuclear reactor. The objective of the project is to extract the information of any object (i.e. deformation and dimension) using photogrammetry technique. As computer vision technique is more reliable, efficient and easy as compared to other techniques. The project aims at creation of 3D model using the photomodeler scanner which is the photogrammetry software by just taking the photographs of any object. Dynamic metrology system is an approach to dynamic evaluation of measurement systems is presented. On the one hand, it separates physical experiments, analysis and signal processing methods into successive steps of evaluation. On the other hand, the structure allows for resolution of an entire measurement system into its components for dedicated analyses. There is no limitation to particular applications except that it should be possible to model the response of the measurement system with differential equations with constant coefficients. Proposed tools such as estimation of error and uncertainty and direct mapping methods for synthesis of signal restoration filters

are new published, while others like system identification are well known but not previously systematically used in the context of calibration.

2. PHOTO BASED 3D MODELLING

Photogrammetry is best for making the 3d model because it cover areas quickly, it has Low costs compare with the other technologies. It is the easiest way to obtain/access information from air and it illustrates great detail than other technologies. Photogrammetry provides the unusual ability to simultaneously measure the six degrees of freedom of Multiple objects at instant in time. This characteristic can be used in many ways, how robotic systems might benefit. There are two alternative ways in which photogrammetric systems might be used: with the cameras viewing the robot's entire working volume (Beyer, 1999) or the only viewing the volume close to an end-effector (Clarke, 1999). Both schemes have advantages and disadvantages. In the former case a high relative accuracy is required but the robot position can be computed in a large area, while in the second case a lower relative accuracy may be acceptable but targets must be placed in known positions close to the task.

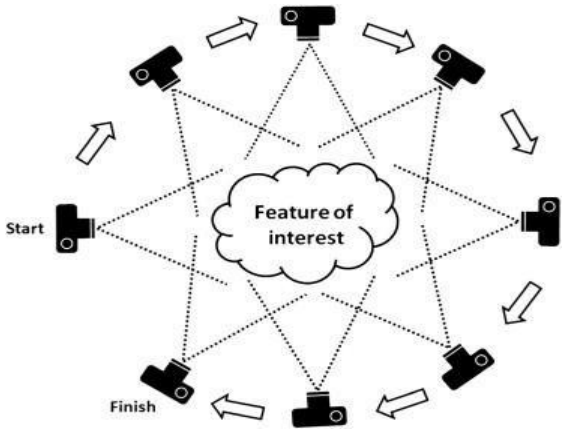

Figure- 1: Photogrammetry method

Photogrammetry is an engineering discipline and as such heavily influenced by developments in computer science and electronics. The ever increasing use of computers has had and will continue to have a great impact on photogrammetry. Photogrammetry and remote sensing are two related fields. The principle difference between photogrammetry and remote sensing is in the application; while photogrammetrists produce maps and precise threedimensional positions of points, remote sensing specialists analyse and interpret images for deriving information about the earth's land and water areas.Photogrammetry is the science of obtaining reliable information about the properties of surfaces and objects without physical contact with the objects, and of measuring and interpreting this information. Photogrammetry is the science of obtaining reliable information about the properties of surfaces and objects without physical contact with the objects, and of measuring and interpreting this information. The fundamental principle used by photogrammetry is triangulation. By taking photographs from at least two different locations, so-called "lines of sight" can be developed from each camera to points on the object. These lines of sight are mathematically intersected to produce the 3-dimensional coordinates of the points of interest. Photography is the first important part of photogrammetry. To obtain the high accuracy, reliability and automation the system is capable of, photographs must be of the highest quality. The Photomodeler Software extracts 3D Measurements and Models from photographs taken with an ordinary camera. A cost-effective way for accurate 3D scanning, measurement, surveying and reality capture. Some advantages about photomodeler scanner are:

- Efficient - especially saving time in the field
- No expensive hardware or equipment
- Standard camera equipment is rugged and easily portable
- Non-contact

3. CALIBRATION METHOD

The calibration method for photomodeler scanner is done through the following steps.

Fig - 2: Calibration block diagram

After following the steps at the end the camera parameter which are required for the camera for making the 3d models are as follow.

- Focal length f (mm): The minimum and maximum **focal** lengths are stated, for example 18–55 mm.
- Principle point : Xp , Yp
- Fx format width (mm) , Fy format height (mm)
- K radial distortion (p1,p2)
- P decentering distortion
- exterior orientation :
  - The omega, phi, kappa angles are the ones used in order to rotate the (X, Y, Z) geodetic coordinate system in order to make it parallel with the image coordinate system.
  - Xc , Yc , Zc camera center coordinate system parameters.

4. CREATION OF 3D MODEL

For creating the 3D model in photomodeler scanner follow the steps.

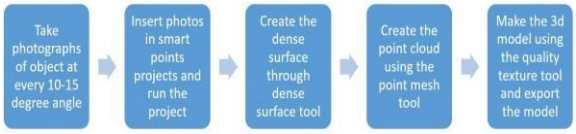

Fig - 3: Block diagram of 3D modelling

For making the 3D model the object should be visible clearly and each part of the object should be clearly visible in at least 3 photos for making the point 3d through the triangulation.

5. MEASURE OBJECT DEFORMATION IN PHOTOMODELER SCANNER

The Photomodeler scanner also provides the tools for measuring the distance between any two coded targets.so from that if any object is deform by its original size and shape than we can measure how much it deforms by its original form. The steps for the same is shown as follow.

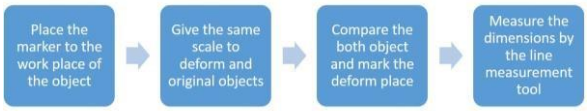

Fig - 4: Measurement block diagram

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