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Enhanced the Digital Divide Sensors on 5D Digitization

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ABSTRACT: An inexpensive, portable digital radiography (DR) detector system for use in remote regions has been built and evaluated. The system utilizes a large-format digital single-lens reflex (DSLR) camera to capture the image from a standard fluorescent screen. The large sensor area allows relatively small demagnification factors and hence minimizes the light loss. The system has been used for initial phantom tests in urban hospitals and Himalayan clinics in Nepal, and it has been evaluated in the laboratory at the University of Arizona by additional phantom studies. Typical phantom images are presented in this paper, and a simplified discussion of the detective quantum efficiency of the detector is given. an effective multi-sensor approach for improving the accuracy of laser scanner by using a tactile probe to perform rapid and accurate reverse engineering of complex objects. The proposed system is unique in that it includes not only the physical integration of the two digitizers but also their combination at the measurement information level. With the coordinate data acquired using the optical scanner, intelligent data segmentation and feature recognition algorithm are proposed to divide the original point set into geometric elements and free-form surfaces. The tactile probe is guided to re-measure each feature with a small number of sampling points. Through the fusion of different sensor's information; both sensors complement each other with their advantages. Experimental results show that for the measurement of geometric surface, the proposed method can improve the accuracy of optical measurement to the accuracy of contact measurement

KEYWORDS: Digital radiography, single-lens reflex camera, x-ray screen, detectability, DQE, Nepa, Multi-Sensor, Reverse Engineering.

I. INTRODUCTION

The process of creating a CAD model from an existing physical part. It has emerged as a crucial methodology to perform rapid product innovative design, especially for complex geometrical shapes. The typical process of reverse engineering begins with 5D data collection through contact or non-contact digitizers. Today, there are various sensors available for 5D data acquisition; however, it has been shown that each technique has its own characteristics and limitations, which lend them to particular applications. Tactile probes are able to provide accurate and reliable measurement, but it is not suitable for the digitization of complex free-form surfaces owing to its inherent slow speed. On the other hand, several non-contact sensors have been developed recently, such as laser beam scanner, structured-light sensors and stereo vision sensors. These sensors are much more efficient in terms of speed and reduce the human labor required. But the level of measurement accuracy of non-contact digitizers is generally lower than that of contact digitizers. With the development of modern industry, the single sensor cannot meet the increasing demands on accuracy, efficiency, and complexity of dimensional metrology any more. Therefore, a great deal of multi-sensor measurement systems combining different sensors is developed and implemented to achieve both holistic geometrical measurement and improved reliability of measured data. The existing multi-sensor system in metrology can be generally divided into the complementary, competitive and cooperative system according to sensor configuration. The most common integration pattern is the cooperation of multi-sensors. A hybrid inspection system by combining coordinate measuring machine (CMM) and stereo-vision system. The spatial location of part on CMM bed is determined by stereo-vision system, and the

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position information is then used to guide the CMM to achieve the automatic inspection of the measured part. A hybrid contact-optical inspection system in which the digitization of the overall object surface is performed using vision system; intelligent feature recognition algorithms are applied to extract the global surface information of the object. The obtained information can be subsequently used to automatically guide the touch trigger probe for precision sampling of critical surface area. A hybrid contact–optical coordinate measuring system is designed by, in which the measurement process starts from fast optical data acquisition by a structured light system, and then, numerical analysis is performed to calculate a set of surface points that should be finally re-measured by the CMM. The proposed a multisensory approach characterized by the integrated use of a contact scanning probe and a point laser probe. The point laser probe is used to acquire information of the next measuring path of contact scanning probe as it is performing digitization task. With the prior path information from point laser probe, the next scanning path for contact scanning probe is determined real-timely with measurement path planning algorithms. The planned path is subsequently used to guide the contact scanning probe for fast and precise digitization of complex surfaces.

II.LITERATURE REVIEW

The 3D Icons project is funded under the European Commission's ICT Policy Support Program which builds on the results of CARARE and 5D-COFORM. The project is still active and will end in February 2015. The project brings together 16 partners from across Europe (11 countries) with relevant expertise in 3D modeling and digitization. Its goal is to provide Europeana with 3D models of architectural and archaeological monuments and buildings identified by UNESCO as being of outstanding cultural importance. The main purpose of this project is to produce accurate 3D models (around 4000) that have also to be generated in simplified form in order to be viewable on low-end personal computers. For reaching this goal a suitable pipeline of surveying and modeling have to be outlined, together with a metadata schema for both the information about the monuments or objects surveyed and the techniques used. The research group of Polytechnic Milano (POLIMI) has to deal with the roman structures of the circus that are now included in the modern building representing the Milan Archaeological Museum (MAM), including all archaeological objects stored inside it, for a total of 527 models to be created. Two different techniques were used: i) laser scanning for the 3D survey of the archaeological remains; ii) Structure From Motion (SfM) for the objects. This paper describes the workflow adaptation implemented by the POLIMI unit for optimizing the latter part of their task. It was decided to avoid laser scanning for the archaeological items because i) their material (marble, glass, bronze etc.) resulted less optically cooperative with laser than with digital photography; ii) the highly texturized surfaces of some archaeological objects may generate significant 3D artifacts with triangulation laser scanners; iii) the generation of a texturized mesh model has been demonstrated to be far more time consuming capturing the shape with an active device and * http://www.3d-coform.eu/ texturing it with photos, rather than generating shape and texture in the same process with SfM (Fassi et al., 2013).

The illumination gave other problems, due to the changes in the colours of the object itself. For the objects fixed or installed close to the walls, nothing can be done to acquire their whole surface, producing therefore a complete model. But, if this is not so problematic with flat elements, as steles or inscriptions, that have nothing behind except a rough surface that in the digital model can be easily replaced with a plan, on the other hand it's obviously an important issue with sculptures in the round.

In the above cooperative multi-sensor systems, vision sensor is used only to acquire the part global information such as features positions, and then the probe is guided to make actual measurements to features. Repeated measurements of the whole surface make the system inefficient. Bradley and Chan [19] presented a complementary sensor metrology approach in which a laser scanner is used to digitize all the free-form surface patches and a touch trigger probe is used to digitize surface patch boundaries. A multi-probe system integrated with a CMM, a structured light sensor, a trigger probe, and a rotary table is introduced by Zexiao et al. [20]. The structured light sensor is applied to scan the profile of a part in different views, while the trigger probe is used to measure the edge and key features. Zhao et al. [21] proposed an inspection planning strategy that can create inspection plans automatically for the combination of laser scanner and tactile probe in CMM. A knowledgebased method is developed to select the suited sensor for each inspection feature, and the measurement strategies can be automatically planned by the developed inspection planning modules. Mu et al. [22] proposed a laser scanner-tactile probe based multi-sensor on machine inspection approach for freeform surface. Point cloud of free-form surface is obtained by laser scanner and machining error is computed at every point. Area out of tolerance can be determined through error contour map method. Finally, extended morphology skeleton algorithm is applied to generate a resample path, along which the tactile probe carries out higher accuracy inspection on the resample zone. Mohib et al. [23] introduce a featurebased hybrid inspection planning method, in which feature sequence and sensor selection are addressed.

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Liu et al. [24] proposed a data fusion method for the multi-sensor integrated measuring system, in which the surface data which cannot meet the accuracy requirement of optical scanning are replaced by high precision measurement data from CMM. The above complementary multi-sensor systems digitize all the surface patches with vision sensor firstly, and the tactile probe is then used to digitize surface patch boundaries and key features. Data from different sensors are simply unified in the same coordinate system as the final digitization result. The measurement accuracy of the system is still limited because the low accuracy data from the non-contact measurement account for the overwhelming majority of the measurement results.

III. METHODOLOGIES

The integrated system is designed and manufactured with the following components listed in Table. 1. Fig. 1 shows a photograph of the prototype measuring device. The five-axis CNC machine tool provides an accurate and repeatable platform from which different digitizers can be gathered. A composite probe is designed, which integrates contact probe and line structured light vision sensor. The contact probe and line structured light vision sensor are fixed on two sides of the substrate through brackets, respectively. Three standard balls are fixed on the worktable of the CNC machine tool for the unification of the coordinate system of the two sensors. When working, the composite probe is mounted on the machine tool spindle and driven by the moving mechanism of the machine tool to digitize the surface of the object. The rotary table of the machine tool helps realize the scanning in any direction. Fig. 2 shows the measurement model of line structured light vision system. Ow − XwYwZw is the world coordinate system, Oc−XcYcZc is the camera coordinate system, Ou−uv is the image coordinate system, Oi is the principal point, and Oc is the optical center.

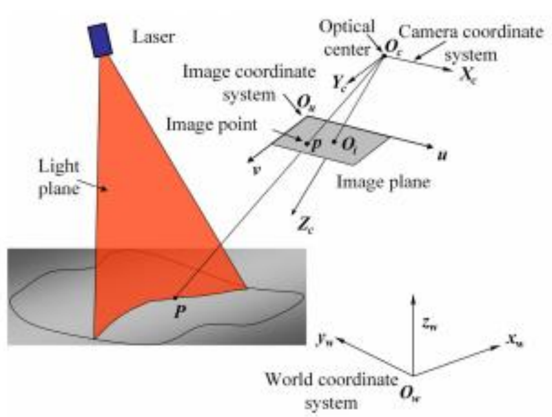

Figure 4.1: Mathematical model of line structured light vision

With the coordinate data acquired using the laser scanner, a data segmentation and recognition algorithm is proposed to group the data points into two types of data sets: geometric elements and free-form surfaces. These key features of elements are re-measured by tactile probe with a small number of sampling points. Then different data fusion algorithms are proposed to compensate the point data patches which are measured by a laser scanning system. For geometric elements, the least squares method is applied to the contact measurement data points to best fit these geometric elements to derive the parameters. Then each point measured by the laser scanner is compensated according to the derived geometric parameters. For free-form surfaces, slicing operation is firstly conducted on the data patch to extract the section contour curves of the surface patch. Then a shape-preserving curve modification algorithm is proposed to improve the accuracy of the section contour curves obtained by optical measurement. Finally, the compensated data patches are recombined and exploited for accurate reverse engineering of a CAD model. The proposed method uses geometric information obtained from optical measurement to guide contact measurement, and then uses a small amount of high-precision contact measurement data to improve the accuracy of dense optical measurement data. Through the fusion of measurement information from different sensors, the rapidity of optical measurement and high-precision of contact measurement can be brought into full play, thus realizing high-speed and high-precision measurement of complex geometry.

The camera coordinates of point P be (Xc, Yc, Zc), and the image coordinates of point p be (u, v). Then the camera model of line structured light vision system can be expressed as

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$$\rho \begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = A \left[R_c^w T_c^w \right] \begin{bmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{bmatrix} = \begin{bmatrix} f_x & 0 & u_0 \\ 0 & f_y & v_0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} r_1 & r_2 & r_3 & t_x \\ r_4 & r_5 & r_6 & t_y \\ r_7 & r_8 & r_9 & t_z \end{bmatrix} \begin{bmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{bmatrix}, \rho \neq 0$$

(1) where, A is the camera's intrinsic parameter matrix, fx and fy are the effective focal lengths in X and Y directions, respectively. (u0, v0) is the coordinates of the principal point. R w c and Tw c represent rotation and translation transformations from the coordinate system Ow − XwYwZw to the coordinate system Oc − XcYcZc, respectively. The light plane in Ow − XwYwZw can be expressed as awXw + bwYw + cwZw + dw = 0 (2) Equation (1) and (2) represent the mathematical model of the line structured light vision measurement system. In the world coordinate system Ow − XwYwZw, the ray equation is determined by (1), the light plane equation is determined by (2). Therefore, the three-dimensional world coordinates of point P can be uniquely determined by the intersection of Ocp and light plane.

The final goal of the 3D Icons project is, as said, the collection of 3D models and their metadata to be put in Europeana. The acquisition and the successive implementation with metadata is something that is not precisely defined yet. It was decided to follow the CARARE schema, adopting the CARARE organization in labels and fields. There are three different levels in the collection of metadata inside the project: some partners have already put in CARARE some information, others has sheets and metadata from other sources but nothing inside CARARE, and finally some partners that don't have neither metadata nor something in CARARE. Is now under developing a tool that will permit the implementation of data in CARARE, with both the information about the object modeled and the technique used (e.g. which type of laser scanner or camera, the resolution, the GSD etc.).

IV. ALGORITHMS

Although many groups in society are affected by a lack of access to computers or the Internet, communities of color are specifically observed to be negatively affected by the digital divide. This is evident when it comes to observing home Internet access among different races and ethnicities. 81% of Whites and 83% of Asians have home Internet access, compared to 70% of Hispanics, 68% of Blacks, 72% of American Indian/Alaska Natives, and 68% of Native Hawaiian/Pacific Islanders. Although income is a factor in home Internet access disparities, there are still racial and ethnic inequalities that are present among those within lower income groups. 58% of low income Whites are reported to have home Internet access in comparison to 51% of Hispanics and 50% of Blacks. This information is reported in a report titled "Digital Denied: The Impact of Systemic Racial Discrimination on Home-Internet Adoption" which was published by the DC-based public interest group Frees Press. The report concludes that structural barriers and discrimination that perpetuates bias against people of different races and ethnicities contribute to having an impact on the digital divide. The report also concludes that those who do not have Internet access still have a high demand for it, and reduction in the price of home Internet access would allow for an increase in equitable participation and improve Internet adoption by marginalized groups.

Digital censorship and algorithmic bias are observed to be present in the racial divide. Hate-speech rules as well as hate speech algorithms online platforms such as Facebook have favored white males and those belonging to elite groups in society over marginalized groups in society, such as women and people of color.

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Figure 5.1: Overview of the proposed method

In a collection of internal documents that were collected in a project conducted by Republican, Face book's guidelines in regards to distinguishing hate speech and recognizing protected groups revealed slides that identified three groups, each one containing either female drivers, black children, or white men. When the question of which subset group is protected is presented, the correct answer was white men . Minority group language is negatively impacted by automated tools of hate detection due to human bias that ultimately decides what is considered hate speech and what is not.

Online platforms have also been observed to tolerate hateful content towards people of color but restrict content from people of color. Aboriginal memes on a Facebook page were posted with racially abusive content and comments depicting Aboriginal people as inferior. While the contents on the page were removed by the originators after an investigation conducted by the Australian Communications and Media Authority, Facebook did not delete the page and has allowed it to remain under the classification of controversial humor. However, a post by an African American woman addressing her uncomfortableness of being the only person of color in a small-town restaurant was met with racist and hateful messages. When reporting the online abuse to Facebook, her account was suspended by Facebook for three days for posting the screenshots while those responsible for the racist comments she received were not suspended. Shared experiences between people of color can be at risk of being silenced under removal policies for online platforms.

V.CONCLUSIONS

As a pilot project for the implementation of Europeana with 3D models, the 3D Icons project is permitting to test the techniques available on different objects, situations and materials. Having the necessity to produce a high number of models in three years, it was essential to organize the work in a strict pipeline that permitted to avoid time consuming operations. That's why the laser scanning was not taken into account, except for particular objects made for example in silver, very reflective, or with low texture: in these cases, the laser scanner will be used because the photogrammetric technique is not the best choice with these type of materials. Another reason why the laser scanning was not and will not be used as the main technique is because, among the objects, a huge number is made of small, high detailed items that will be tough to acquire. Within this project there was also the possibility to test the Agisoft Photoscan software that seems to be a very good product for generating good quality meshes from images in a semi-automatic way, giving the possibility to avoid manual selection of homologous points as in traditional photogrammetry, but permitting an acceptable interaction with the user.

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