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CLOSE RANGE PHOTOGRAMMETRY AND ITS APPLICATIONS IN VARIOUS SCIENCE FIELDS

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Abstract: Nowadays, we talk more and more about three dimensional models. They have become a part of our life, for example virtual tours of cultural heritage objectives, geospatial applications, games or TV/movie post-production and special effects.
From the beginning of its development there have been a sufficient number of attempts to apply Photogrammetry in various fields of science.
Close Range Photogrammetry (CRP), a part of Photogrammetry, is able to produce the objects 3D model using 2D images.
This paper aims to highlight the applications of CRP in other science fields (Criminology, Medicine, Historical and Cultural Heritage Preservation and Archaeology), different form its regular ones from Geodesy.
Keywords: Close Range Photogrammetry, 2D images, 3D model, non contact measurements.

1. INTRODUCTION

In generally, Digital Photogrammetry is a well-established technique for acquiring dense 3D geometric information for real-world objects from stereoscopic image overlap and has been shown to have extensive applications in a variety of fields [1]. It implies one or two photos/photogramms analysis with specialized programs, for determining spatial relations.

Close Range Photogrammetry finds its application in various fields like medicine (plastic surgery, ophthalmology, stomatology), archaeology and historical and cultural heritage preservation because of its well known advantages: the measuring method is without direct contact with the studied object, the results are precise and reliable, the data collection is made in a short time with low costs and at any time the saved images can be remodelled [2].

2. DATA ACQUISITION

In The data acquisition principle using the photogrammetric method aims obtaining information referring to physical objects and to the environment, from distance, without physical contact through photographic images recording, measuring and processing.

Not all these projects are the same, but in general a Close Range Photogrammetry project has the following work flow:

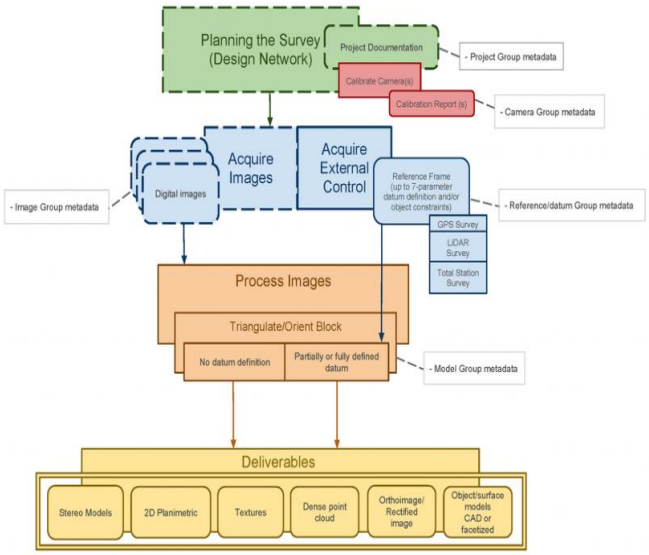

Figure 1. Close Range Photogrammetry workflow [3]

3. APPLICATIONS

The recent developments of digital technologies, especially the digital camera and the specific software, created a loophole for a lot of application from the field of Photogrammetry.

Bellow is presented an example of an application of Close Range Photogrammetry where was required to acquire information about the vehicle deformation during full-width frontal crash test of a vehicle, which was followed by crash rescue demonstration. The time between the actual impact and rescue demonstration was only few minutes. Therefore, the actual measurement of vehicle deformations after the crash test itself had to be carried within a very narrow time window. This time limitation was the crucial problem for any standard measuring technique such as total station, 3D scanner or hand-on measurements, [4].

Using Close Range Photogrammetry all the necessary was gathered and it can be highlighted that the made measurements can be performed under any conditions like rain or/and time pressure.

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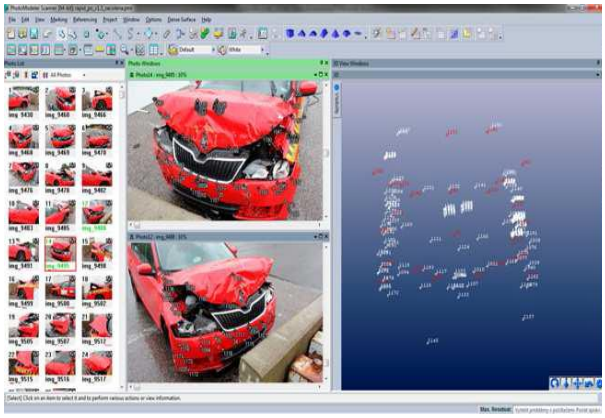


Figure 2. Vehicle deformation measurements using Close Range Photogrammetry [4]

Photogrammetry has been used in medicine for measurements of human body for many years. Yet, its techniques and methods were limited by the necessity to use expensive and sophisticated equipment requiring appropriate knowledge and skills [5].

The most frequently measured body parts, functions and associated phenomena:

- the face – changes monitoring after cosmetic operations and in orthodontics;
- the teeth – micro defects and shape examination – for dental prostheses making;
- the skin –melanoma detection, deep and widespread wounds measurements for the purpose of grafting;
-the extremities –shape monitoring as surgery following, measurements for prosthesis formation;
- the posterior part of the body, especially the back – in examination of scoliosis and back curvature;
- posture analysis – in medical rehabilitation;
- motion analysis – in medical rehabilitation, sport medicine, sport and cinematography;
- the internal body parts and their situation with regard to the external parts – positioning for cancer therapy, in telemedicine [5].

One application that combines the medical field and geodesy is monitoring the growth and development of jaws and teeth using Close Range Photogrammetric method. Points to consider in monitoring the development of teeth and jaws are the number of teeth, tooth shape and size of teeth that interfere with the function. In addition to health, monitoring is also useful for aesthetic aspects [6].

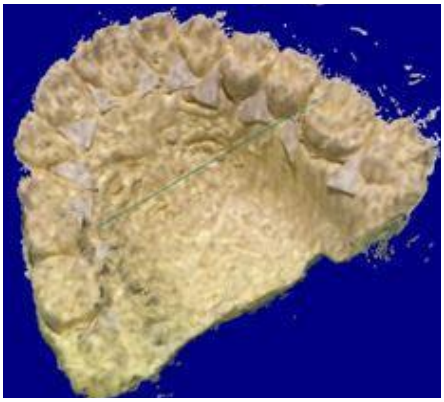


Figure 3. Teeth micro defects and shape examination using Close Range Photogrammetry [6]

The field of Ophthalmology is particularly suitable for Photogrammetry. The eye as an object of research has very specific properties which make almost any measurements by conventional methods extremely difficult. The fundamental problem of measurements is the mobility of the living eye. To solve that problem Photogrammetry may be the ideal measuring tool [7].

The research at the University of British Columbia has shown that Stereophotogrammetry may now be an additional tool in evaluating and following glaucoma patients and might be particularly valuable in following the progress of ocular hypertensives, patients unreliable on visual field testing and congenital glaucomas [7].

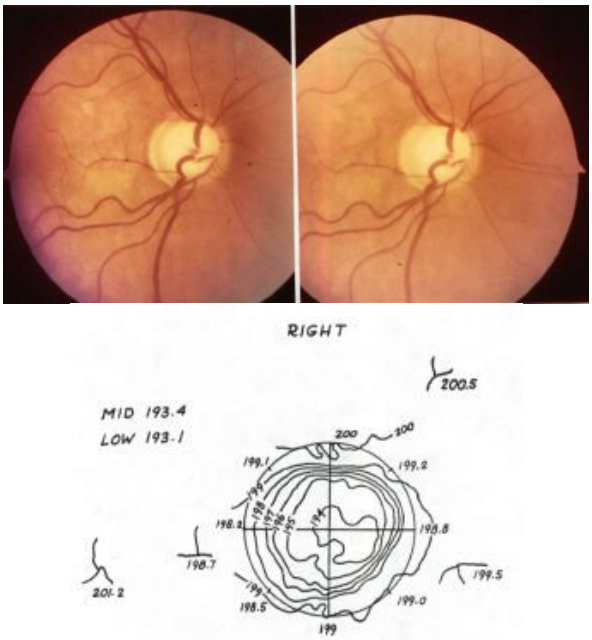


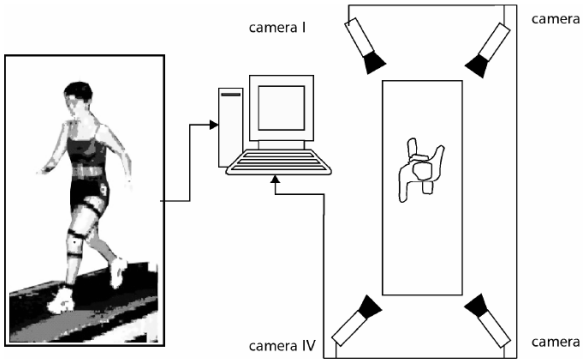
Figure 4. Stereogram and plotting the eye fundus [7]

Another field of medicine where Close Range Photogrammetry can be used is Medical Rehabilitation.

Digital images in combination with a computer-assisted technique provide data fast acquisition, processing, automatic measurements and also obtaining desired results in a short period of time.

The measurements allow a comparison of real position to the optimal one. The system of human body segments in motion remains in the field of

forces of gravity. Maintained erect posture signifies that those forces are balanced. Quality of this balance is determined by spatial relationships of the studied segments [5].



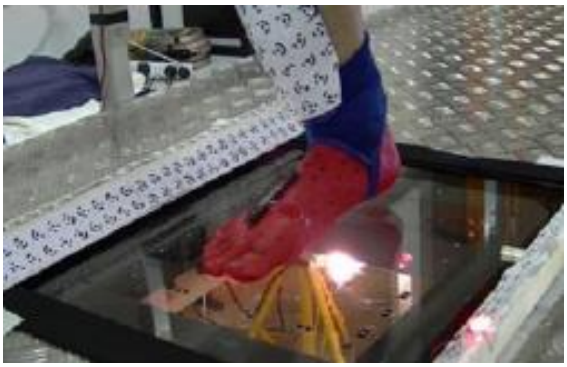


Figure 5. Photogrammetric body measurement used for movement analysis

For archaeological research, it is important to appropriately record, document, and survey artifacts and sites because an accurate and complete digital documentation is a prerequisite for further analysis and interpretation of artifacts and archaeological areas [9].

Data acquisition can be performed using image based methods (passive techniques) such as Photogrammetry, or by using range-based methods (active sensors) such as the laser scanner, or by integrating both methods.

Figure 6. A wall 3D model produced using 123D Catch software [9]

Textured 3D models of archaeological sites are also useful for visualization purposes to engage the public and assist archaeologists in interpretations of past uses of space [9].

It must be highlighted that the photogrammetric techniques require experience and the images have to be properly acquired, otherwise the results are incorrect. Also, another important aspect is that the software, which gives the opportunity to see a 3D model, can be used for many purposes, one of these being the restoration of objects by the archeologists.

4. CONCLUSIONS

3D modeling technique based on 2D images highlights the Digital Photogrammetry useful character of real life objects 3D visualization and modeling. The obtained 3D models have a precision that can make Close Range Photogrammetry an alternative to classical measuring techniques.

Close range Photogrammetry as a research method has many advantages, like:

- It has low expenses on one area surface;
- The images can be processed for free online or on the downloaded software;
- Image processing is made on a computer cloud;
- Using it you can print a 3D model of the studied object at different scales;
- The final result can be exported as a file in dwg, fbx, obj extensions which allow a further processing in other programs;
- The beneficiary can use the studied object animation;
- It is the fastest solution in case of a large data volume, creating the research possibility for vast and/or inaccessible areas.

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