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Section: Technologies of Geodesy and Cadastre

Using optical NIR handheld scanner for close range 3d mapping

Maciej Wrona

Military University of Technology, Kaliskiego 2 Str., Warsaw 00-908, Poland

Abstract

This paper describes results of first in Poland using of optical handheld scanner for 3d close range mapping. Author use very new Israel army based technology to develop customized measurement solutions and applications. Results of tests carried at the laboratory of Applied Geomatics Center at Military University of Technology are shown in this paper. Key aspects of using this technology in different applications are described also in details. Presented instrument and measurement method based on it is unique and so far only one in the global measurement equipment market. ACG MUT starts cooperation with instrument developer to take part in developing new applications based on it.

Keywords: 3d MAPPING; structural light; scanning; handheld scanner.

1. Introduction

In 2008 Israel military authorities requires to use fast mapping measurement tool to provide fast 3d mapping. Military forces released a tender who was won by one of the Israel local high-tech industry. After few years a new product was released and implicated for military purposes. From about one year the product was released for civilian market use. First presentation of this product in Poland took a place at Military University of Technology in June 2013. The meeting was organized by Technology Transfer Office at MUT. From that time international cooperation was made to develop new solutions based on this new method. From the beginning of 2014 MUT starts first stage of test to investigate possibilities of this new mapping tool. This new tool is a handheld 3d scanner F-5 from MantisVision. It base on structured light technology [1, 2, 4] but gives much more possibilities by using near infrared light to make 3d mapping process.

This technology has been developed to enable 3D model capturing of highly dynamic scenes. H igh resolution 3D shapes and objects are captured suring free motion, and can even be operated from moving platforms. This is achieved by projecting a single coded – Light pattern, which contains all the indexing information required by the tr iangulation algorithm. Thus, a complete 3D range – image is captured by a single "camera snapshot". Mantis Vision has developed a unique single pattern codification method that allows the distinct identification of hundred times more points than all the other on the market. Despite its code "shortness" (i.e. consisting of only a single pat
tern),it incorporates a powerful error detection/correction mechanism.

The complete product comprises of two system components: a 3D acquisition unit (Imager) and a software application (Processing) to process, manipulate and visualize the 3D data.The user single- handedlyholds the imager con sisting of a video camera channel and light projector embedded within an ergonomic handgrip. Capturing the 3D environment is similar to using a regular (2D) video camera. The only difference between a 2D video camera and MVC -F5 is the type of flash light (projector) used. The system acquires the scene's depth by projecting invisible (infrared) light onto the environment through a mask (i.e., a slide) containing one of Mantis Vision's proprietary patterns.

An active triangulation is the common method for 3D coordinate data acquisition. The principle of the method is the use of stereoscopic parallax to get the information about third dimension. The video sensor channel (the camera) captures the video frames containing the light reflected from the environment with the pattern draped over it.

After acquisition, the videos are downloaded onto a PC (laptop or a desktop) where the MVP software can decode each video frame into a dense point – cloud of the three dimensional distance measurements (~ 50,000 points of data per frame). The MVP then automatically registers (aligns) the frames in the 3D video to recreate the 3D geometry of the scene and its grayscale (i.e. intensity image). Using the various tools in the MVP, the user can work with and analyze the captured scene,

Corresponding author: Maciej Wrona. E-mail address: mwrona@wat.edu.pl

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create 3D models of objects from the scene and export them to 3D CAD applications for reverse engineering and manufacturing. Dimensions from the captured scenes can also be extracted using MVP's advanced measurement tool.

2. Innovation

Because of military background, MVC-F5 scanner has very individual functionality comparing to solutions existing on the market. The main capabilities of this tool is:

- High speed of data acquisition – Scanner is able to measure up to 0.5 million points per second.
- No scene preparation – It does not need any reference point, special light matching or scene preparation
- Rugged and small – Whole device is easy to care and not need to be plugged in to any devices during
- Highest range – The MVC-F5 is the only handheld imager on the market today that can be used in combination of a wide working distance from 0.5 to 5 meter
- Capture motion – Scanner is able to record 3d point cloud of moving object with 50 000 points per frame (1/10 s = 1 frame).
- High accuracy – Producer points that using MVC-F5 it is able to get 0,1mm accuracy at 1m distance
- Wide field of view – from 344×410 up to 3100×3630 mm at furthest distance
- Sun flashes resistant – using infrared waves for pattern projection makes possible to scan in day light with no negative influence of light changes

Fig. 1. MVC-F5 Handheld scanner (www.mantisvision.com)

All above shows that MVC-F5 is a device with functionality somewhere between terrestrial laser scanners and short range scanner based on structured light method. Potential of this tool might be very useful for small object scanning like statues or cars but also for mapping rooms and closed space. During few weeks of experimental test, three case studies were chosen to present in this paper.

3. Case studies

3.1. Mining

On of the biggest fields where quick and precise information about the local area is mining. Mapping solutions were always needed in this industry because of safety and efficiency purposes. Harsh environment disabled to use all of the devices that could be used in underground work. MVC-F5 might be one of the better way for precise mapping of undergroung corrifors.

First in Poland mining test were taken with MantisVision personel. The campaign was taken in the underground testfield at Central Mining Rescue Station in Bytom. The main aim of the test was to find out how this solution will be able to measure black coal in totally black and smoked corridors. Result showed that the influence of the darkness on the results is none and the smoke is critical because to much smoke disabled measurement with this device. Figure 2 shows result of 5 seconds scan of testing corridor of CMRS. The construction that can be seen is the rescue equipment using during catastrophes. Figure 3 shows zoom at the construction. Resolution enables to read size of the single elements, even screws.

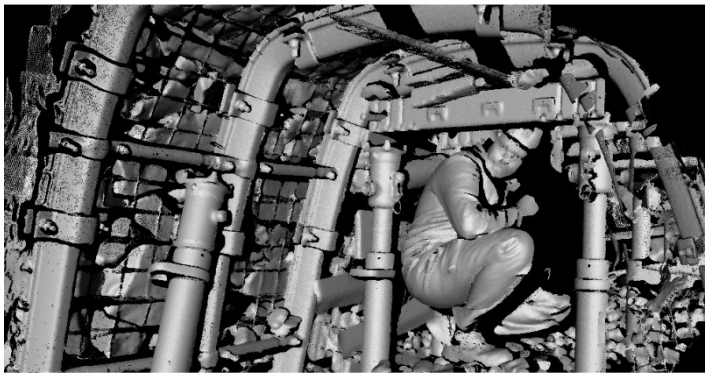

Fig. 2. 3d model captured in testing underground field in CMRS

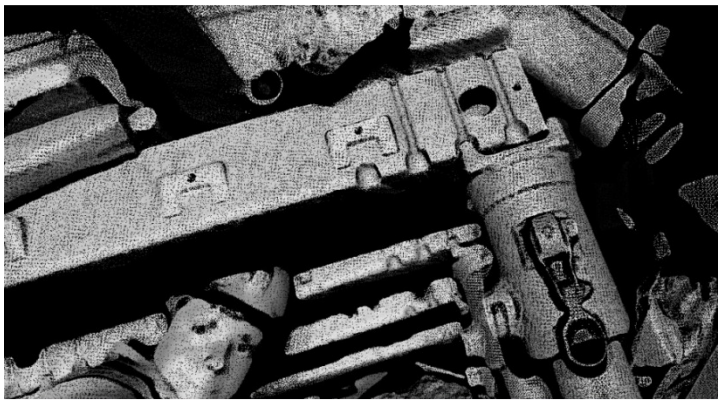

Fig. 3. 3d model of CMRS rescue construction

The main disadvantage of this devise is that for work underground it would need to be certified by the special mining laboratories and the producer does not provide such certification. Future work will take in to account preparing the construction of the device for use in underground mining environment.

3.2. Room mapping

Because of fast acquisition time and high data precision this device was thought as a tool for small closed area mapping. Today used terrestrial scanner are good enough as it goes to the quality but not fills requirements of mobility and efficiency [3]. MVC-F5 device thanks to range of 5 meters enables to map rooms and close spaces much faster than with laser scanning. Mobility of the scanner enables also to reach hided spots in the scene which could not be captured by the laser scanning from the one stationary site [5].

Few test of mapping closed spaces was taken. It was assumed that acquiring the scene for the space 3×10×10 m take maximum 2 minutes and computing need about 15 minutes to complete model. This functionality related with full mobility makes this device great tool for crime scene investigation. Additional analytical options implemented in the software enable to make fast measurements at the scene (Fig. 4).

Fig. 4. 3d model of the sample room

Important experience in mapping room using MVC-F5 is possibility of measurement more precisely of those parts of the scene that are much valuable for investigation process. It is also use to make a whole overall scene and after that add precise measurement elements in to the overall the scene. Measured reference elements of the scene showed accuracy of the model at level < 1 mm.

3.3. Bioengineering

On of the areas where the MVC-F5 could be use is bioengineering. Military university of Technology is involved in scope of work related with using bioengineering technology in access systems. First brief test was made to get a sample of scanning human body. Results are shown at Fig. 5 and Fig. 6. Time of data acquisition to capture this scene was about 20 seconds. Data computing was done fully automatically and took around 5 minutes to compute final model. What can be clearly seen is a very high point density which enables to get very precise and accurate 3d model. Figure 6 shows zoom of the 3d face model that was compute during this session. All details of the face can be seen precise enough to investigate personal recognition.

Fig. 5. 3d model of a person

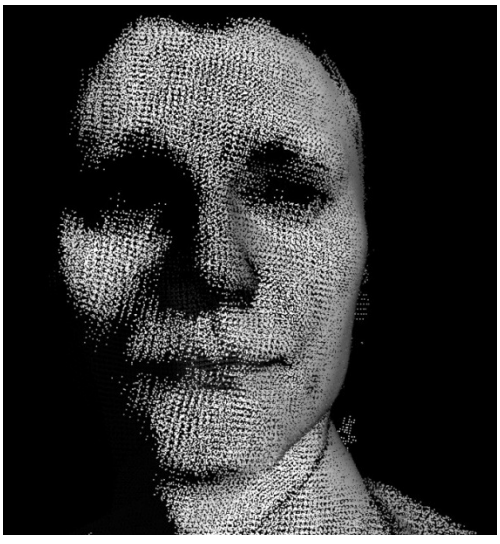

Fig. 6. 3d face model

Small construction and low weight enables to use small UAVs (Unmanned Airborne Vehicles) to carry the device. First brief tet was taken in Warsaw. In this case octocopter with 5 kg payload was used. The main task of this test was to check if it wold be possible to operate the scanner on the flying platform for 3d mapping of unreachable places. After the device was mounted on the flying platform, UAV fly around the open park with different speed. Result show that for the best quality of the measurement 0,5 m/s speed should not be increase. Sample shot is shown on the Figure 7. One of the testing group members was laying down on the branch in the park. UAV with scanner mounted under flown over him with low speed. It can be noticed that resolution of the data and its quality enables to make a detail analysis based on 5 seconds scan.

Fig. 7. 3d human model captured from the UAV flying with ground speed about 0.5 m/s

Despite of making test on the static objects, few test were take on dynamic objects. First test shows that capture human dynamics using this tool got a one great advantage – it does not need any reference point mounted on the human body. Another great advantage is the possibility of connecting few devices in one integrated system. That gives opportunity to record all the 3d scene in few meters square area. Now, one the project carry on by the Faculty of Mechatronics at MUT use this device for ergonomics investigation. Real world data is captured in one case and analyses in many different purposes.

4. Summary

Above test were just a brief introduction for the detail test which will be start from March 2014. Main goal of this project will be to implement MVC-F5 device in to the polish police operational procedures. It will need to be special tested from the point of repeatability, efficiency, accuracy and reliability.

Test which were taken so far shows that hand-held imager is the only imager available in the market today specifically designed to meet the stringent demands of field operational use. The F5 imager works in both indoor and outdoor environments, and in virtually any lighting conditions, providing the usable solution to environment and planning-sensitive operational demands. The Mantisvision has a big potential to develop new solutions based on this technology.

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