USING OF NON-EXPENSIVE 3D SCANNING INSTRUMENTS FOR CULTURAL HERITAGE DOCUMENTATION

[1]Karel Pavelka, [2]Tomáš Dolanský

[1]Head of Laboratory of Photogrammetry, Tel.:+420224354951, Fax:+420224310774, E-mail: pavelka@fsv.cvut.cz
[2] Dept. Mapping and Cartography,Tel.:+420224354605, Fax:+420224310774, E-mail: dolansky@fsv.cvut.cz

Czech Technical University in Prague, Faculty of Civil Engineering,
Dept. Mapping and Cartography, Thákurova 7, 166 29, Prague 6, Czech Republic

KEY WORDS: 3D documentation, laser scanning

ABSTRACT:

In the framework of co-operation between the Laboratory of Photogrammetry of the Department of Mapping and Cartography, the Department of Special Geodesy and the Laboratory of Quantitative Methods of Monuments Research (Faculty of Nuclear Physics and Physical Engineering), new methods of 3D objects documentation are tested on school level. There are two types of 3D scanners under development: the first type uses triangulation method: the laser is used only as a point or profile marker (rotating platform system) and the system with 2 cameras and image projector as a structured light source. The second type uses a pure laser technology "time of flight". Three small devices for 3D object co-ordinates capturing are being developed at present at the CTU in Prague. The aim of this research is to develop a small inexpensive device for special purposes of 3D documentation. A combination of several electronic parts such as CCD camera, laser marker, computer and distance measuring device and laser sensor head (time of flight) has been used for the instrument development.

1. NEW DEVICES FOR 3D OBJECT MEASURING

In the framework of co-operation between the Laboratory of Photogrammetry and the Laboratory of Quantitative Methods of Monuments Research (Faculty of Nuclear Physics and Physical Engineering), new methods of 3D objects documentation as a part of the project are tested. Two devices for 3D object co-ordinates capturing are being developed at present. The aim of the project is to develop a small inexpensive device for special purposes of 3D documentation. By combining several electronic parts such as CCD camera, laser marker, computer and distance measuring device, a new laser sensor has been developed. There are only few possibilities how to construct laser based 3D sensors. The principle of these devices is the same: the laser beam is used as an object point marker (single point or line on object) and the laser track is recorded by using of a small CCD camera. The camera and laser position are convergent to the object, 3D co-ordinates can be computed from laser-camera basis.

2. LASER SYSTEM WITH CCD CAMERA AND ROTATING PLATFORM

For small objects such as small sculptures, vessels or models a system with rotating platform has been constructed. A laser beam optically modified to a thin line on the object is recorded from a basis with CCD camera. A maximum of 25 frames per second can be used. The measured object is situated on a rotating platform with a possibility to change the rotating velocity. All the images are stored on a PC and processed by using of special software. From the image co-ordinates of marked object points the real 3D co-ordinates are computed. The scanning process is demonstrated on Fig.3.

Figure 1. The rotating platform and laser

Figure 2. Theodolite and CCD camera

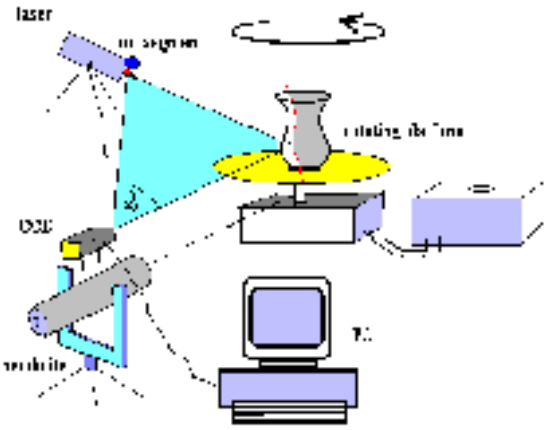

Figure 3. Principe of rotating platform

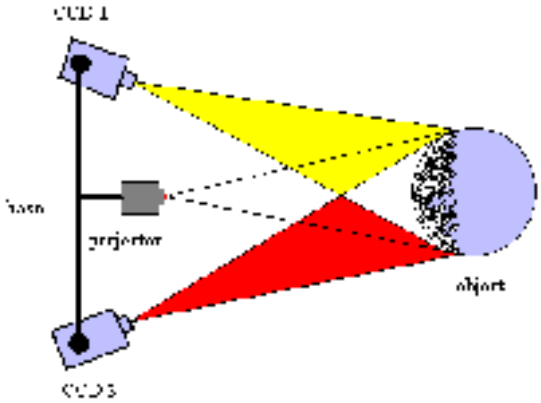

Figure 4. Principe of two cameras

3. TWO CAMERAS AND STRUCTURED LIGHT SOURCE

This device uses the principle of an image – the correlation. The image projector sends the structured light on the object and the object is recorded by using of two CCD cameras from a known basis. This system can by combined with rotating platform for complete documentation of object (0-360deg). Every image pair must be post–processed by using image correlation for 3D co-ordinates of object points determination.

4. LASER SCANNER HEAD SICK

In autumn 2002 a small inexpensive laser 3D scanner based on "time of flight" was developed. The laser head SICK is the main part of 3D scanner. There are two possibilities for its use: the first one as a linear laser scanner (on Fig. 3) and the second one as a rotating head (Fig.4). In the linear scheme the SICK head was used as a 3D scanner for sculpture documentation, but the resolution on about 50cm was not very high (it is a good idea for more precision scanners). Next, the head was completed with a motorised PC- controlled rotating part with incremental device for angle measurement. It is a "classical" laser scanner scheme. All the control software was made at the CTU Prague and it will be used as a "school laser scanner".

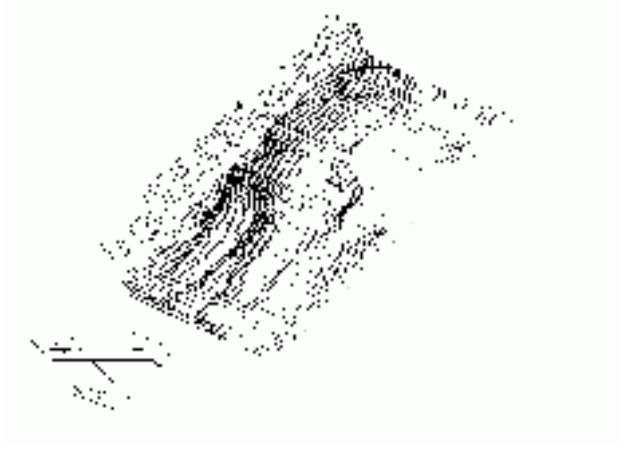

Figure 5. Linear scanner Sick

Technical details:

- Laser head for technical using (security, working process control…)
- relatively inexpensive (5000Euro)

- accuracy cca 8mm (0.1-10m)
- accuracy cca 8cm (10-80m)

Disadvantage:

- wide laser beam = big laser trace (low detail resolution)
- without rotating or motion device for practical using (all must be „hand-made")
- without control and processing software

Figure 6. Laser scanner Sick

5. CONCLUSION

Examples of inexpensive systems based on simple digital camera and laser are discussed in the paper. All systems are under construction at the Czech Technical University in Prague and they are used for technology testing and for teaching.

6. REFERENCES

Pavelka, K., 1999, Using of Close Range Photogrammetry for Historical Buildings Documentation, In: *Proceedings of Workshop CVUT Prague*, pp.589-592

Pavelka, K., 2000, Using of Digital Photogrammetry, GIS and Internet Technology for Historical Buildings Documentation and Presentation, Istanbul, In: *Conference TICT 2000, Bosphosus University*, Proceeding on CD

Pavelka,K.: Using of Laser and Digital Camera Based Systems for 3d Object Documentation, Commission CIPA, WG 6, Korfu,Greece, 9/2002, proceeding of workshop

REFERENCES FROM WEBSITES:

Laboratory of Photogrammetry, 2002, CTU Prague Web Site: http://gama.fsv.cvut.cz/k153/

7. ACKNOWLEDGEMENTS

Grant Czech Grant Agency Nr.103/02/0357 and Czech Technical University Research Programme 210000007 and 210000019 sponsor this project.