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A Usage of 3D Modeling for Visualizing Problems with GPS Measurements on Urbanized Area**

1. Introduction

The Faculty of Mining and Environmental Engineering at the University of Science and Technology (UST-AGH) has been interested in developing individual interests of its students since the beginning of its existence. It can be helpful for young students to better choose their future work path if they have help during the studies. There have been many initiatives to explore this line of work. One of which is developing student organizations that would supply that purpose.

The Computer Graphics and Geomatics Students' Association is a new group. It was established 16 March 2006. Due to noticeable gross of computer techniques in last 20 years many of its branches become useful and almost irreplaceable in survey use. Also students of the faculty got interested in same techniques not so directly associated with measuring. They set a goal to find a way of using such techniques in survey. Probably the most important part of association's works is enabling student's passions and ideas by providing place and means to evolve them. A tremendous help to achieve that is the AGH-UST Inter-faculty Computer Graphics Laboratory in which the meetings are taking place. It provides the right equipment and environment for work [2].

2. Use of 3D Imaging in Simulations *Visualization of GPS Survey on a Town Square in Gorlice*

One of the projects done by members of the association was *Visualization of GPS survey on Town Square in Gorlice*

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2.1. The Reason of Making the Project

GPS measurements are becoming one of the most important branches of survey. Even though this technology is quite new it is almost unthinkable to work without. It has its disadvantages. It is necessary to have a good visibility of the GPS satellites. What follows it would be ideal to have a clear horizon, not curtained with trees or buildings. A situation like that happens extremely rare. Usually we have to deal with urbanized area. The problem increases in middle parts of towns and cities. It would be useful to have a tool that could estimate if a survey of this sort is possible and where exactly it is possible. First step to creating such a tool was to make an animation that shows the way of assessing that in one particular place [1].

2.2. The Object of Animation – Gorlice

The author chose to make a simulation of town square of a small city. Places of this sort cold potentially have enough view to support the GPS measurements. Gorlice (Fig. 1) was meeting those demands. It is a small town placed in the south part of administrative division of Krakow. It occupies 23.56 km^2. The main part of town has been rebuilt after 2 May 1915 when it was destroyed during the Battle of Gorlice. A new town square is based on a square. It is surrounded by four and five story buildings. The highest of them is Town Hall which has five stories and a clock tower. The square is spread in two by a road that goes from east to west. The road is planted with two lines of trees. The total are of the Town Square is about 110 m^2. It seemed to be a suitable object for this sort of animation due to its relatively large size and a lot of different obstacles to achieve a good GPS reception.

Fig. 1. Picture of Gorlice made on 24 November 2008 (phot. P. Lewińska)

2.3. Gathered Data and Means of Making the Animation

The most important part of the animation was to create a realistic image of the towns square and surroundings. The basic elements ware the shape and the high of buildings trees and other significant objects surrounding the towns square. Since one of the reasons for making that project was to give a 3D animation of the survey the author decided to make a photorealistic image of those object. To achieve that author made over 60 photographs of the buildings. During the making of animation a big emphasis was put on color pallet and texture. The second part of the animation includes GPS satellites. Since there are no real planes of them available the base for creating those images ware photos published in the internet.

The animation was made in Bentleys MicroStation. The process took three months. First stage consisted of creating a 3D model of the objects. Every building was made separately by the author. It also included details like windows, doors, balconies, arches and other. Furthermore smaller objects like lamps gates curves ware also constructed. The author made a point in not using shapes made by other authors. Most of existing man made elements ware done with high accuracy. It was decided to generalize the plant life. Trees war previously proven to have an influence on the reception of GPS so they ware done as solid object. That helped to achieve worst possible conditions for the survey. This means that the assessment would work in any conditions and any time of year.

The second stage of creating the animation was texturasing the model (Fig. 2). Textures are basically a way of giving color and unique shape to solid objects. It is possible to choose a texture that gives an impression of brick or a rock wall. Those options of the program have proven many times to be incredible useful in creating photorealistic animations. However useful, the process is time taking because of the amount of options that include choosing color, reflection ability, material, metal shine or transparency. The same process was used to creating GPS satellites.

The last stage was to create an environment in which all the object are placed. Again texture options ware in use. The model of the buildings was placed inside of a sphere covered with Earth texture. The Earth texture consisted of clouds surrounding the planet. Its movement gave an impression of time passing during the day.

The most important part of the whole animation was placing GPS satellites in right places and assessing their visibility. There are a lot of programs that give information about the number of satellites visible in due date at certain place. It was chosen to simulate the 20 December 2008 from 8.00 am until 5 pm. Theoretically it was possible to have access to 10 satellites in the duration of the day. Those ten satellites ware placed on their orbits and the model of Gorlice was placed on right coronets on a virtual model of earth. To see the range of satellites the author

created special kind of a cone. Its top part was placed on a satellite. The bottom part symbolized the range. They are made of a transpired texture. To incise the effect each cone had different color and had its own source of the light. That helped to see have many of them have a mutual range and at what point in time. At that time the complete model ready for analyses was given [2].

Fig. 2. 3D visualization of the Town Hall in Gorlice

2.4. Analyzing the Simulation

To start with two GPS receivers ware placed at the middle of both parts of towns square. It was assumed that since these are the places with the weightiest range of clear horizon this would be the best place for survey. The simulation was done in about twelve points of view so it was possible to see the receiver's at all actable times of a day and from every angle. The findings proved to be quite surprising. The survey was possible despite small space on the Gorlice Town Square. The best time to it in the basic placemat of the receivers was possible between 10.30 am and 1 pm. While receivers get moved along the road, the time of possible survey and the amount of available satellites groves. The best reception would be it receivers ware placed ten meters from the towns hall. Even thought the hall is the tallest building.

Fig. 3. On the left GPS satelites. On the right Town Square and GPS recivers location

Last conclusion came as a surprise. But it has an easy explanation. The Town Square have a slope that goes down in the direction of a Town Hall. The slope is high enough to make that building considerably less influential for the satellite range. The simulation gave an exact planed location of GPS receivers and best time of survey. If a process like that could be automatised it could be an amazing help for planning the measurements.

The result of the project was a 3 minute long animation showing the photorealistic view of the town, GPS satellites moving in space around Earth and cones or GPS ranges. It shows the basic parts of a project.

3. Project of Automatisation of the Process

There are a few major points to make an automatised version of process on hand. First step would be to have full knowledge of all the GPS and Glonass satellites. Meaning having the information about trajectories and times of appearing and there ranges. After having that data it would be fairly easy to make a 3D model of earth and surrounding satellites [1].

Basic information would be the existence, shape and height of buildings at of area in question. Marek Wątroba during work on his final papers wrote a program that automatically made 3D buildings out of Master map. The buildings had only basic shapes but it would be enough to make a reliable estimation of their influence. Theoretically it is also possible to write a program that does that same out of photogrametry maps. Then the height of buildings would be based on a length of shade given by them at the time of making photography. To sum up two most basic and most obvious problems could be resolved [1].

Unfortunately at the same time some other problems emerge. First of them is plant life. During making the Gorlice animation the author had a physical

knowledge of the existence and high of trees at the towns square. Trees high bushes could have a great influence on visibility of GPS satellites. Unfortunately no such knowledge is usually given on maps. The only way of resolving that problem that the author sees is using photogrametry maps for this purpose. Unfortunately plant life changes dynamically. The trees grow, die, they get cut down and replanted. What is more influence of the seasons can be major factor. Getting new information of this sort in right periods of time would be extremely difficult.

What is more the Gorlice animation proved that the slope of the area (even if the slop is seemingly insignificant) can be the leading valuable in checking the possibility of survey. Author was unable to find and works that would automates 3D imagining of such element. Due to strong and at some point surprising influence of this agent finding solution for this problem would be crucial.

4. Findings

The *Visualization of GPS survey on a Town Square in Gorlice* animation showed that it is possible to use 3D imagining for predicting the best place and time to make GPS survey on urbanized are. Due to growing use of GPS techniques assessments like that are becoming more and more important. The additional advantage of this sort of project would be that not only the user could get the coordinates of a best place for placing the receivers but also had a good view of have the situation is going to look. This in turn would be useful in detail planning. For now making an automatic version of this project that would be working at the whole are of Poland and would be reliable is difficult. Fortunately the rapid connection between survey programming and 3D imaging might prove that systems like that would be in use in a few years.

References

[1] Góral W., Szewczyk J.: *Zastosowanie technologii GPS w precyzyjnych pomiarach deformacji.* Uczelniane Wydawnictwa Naukowo-Dydaktyczne AGH, Kraków 2004.

[2] http://www.kngk.agh.edu.pl/.