Laser Pointer Map Interaction

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Abstract

The use of computers to improve the study of non-IT courses is in Slovakia a very little widespread. One of the reasons is the absence of software applications in this field. Purpose of our project is to improve this situation by creating a prototype of laser pointer recognition system for geography lessons at high schools. It is based on tracking the position of laser point on information table (blind map of Slovakia in our case) using an ordinary webcam. Processing the webcam input we get the exact position on the map and the name of the nearest known city is played as a sound from our sound records. This is a new way of interactive teaching and examining. We tested it in between a wide range of users from pupils to adults and all of them consider this as useful and helpful. Our software is easy to use since a 6 year old child managed it. Our idea of pointing can be simply used in all other subjects e.g. biology or history, wherever pointing the right place is needed. It is not limited only for high schools, can be used at primary schools and at universities as well.

1. Introduction

Teachers often do not use computers for teaching lessons such as geography. This was probably caused by the lack of the suitable easy to learn and use applications for the support of the education. We took this as a challenge and we decided to create such an application applying our knowledge from area of the human computer interaction. Our main idea was to create an application, which would use at first a laser pointer instead of finger pointing (on map) and at second a webcam to recognize the red laser point on the map. After recognition the nearest geographical object from the map can be calculate. This system can be used for learning as well as for examining. As you can see, it requires inexpensive accessories such as a laser pointer, an ordinary webcam and a map, therefore it is very easy to use this application.

Before detailed description of key characteristics of our application, we need to mention the user’s interaction with it to make the following chapters more understandable: After installation, running the program and setting the system for map position (see Fig. 1), user can pinpoint by laser one of dots on the map and wait for computer acceptation sound. This sound means that the computer recognized a red dot on the map. Then computer tells the name of the place (if you have the map of cities, it tells the name of the nearest city user was pointing at). This process can be repeated as many times as user wants. User can choose a testing module as well, which randomly chooses n places and wants him/her to show right dot (place/city) on the map in defined time interval. It is the way how to test knowledge.

The most of projects based on laser pointer recognition deal with its using with projector during presentation [1][2][3]. We have chosen another way, which wasn’t implemented till today. As we already mentioned, our project is suitable particularly for education. Needed hardware is common or cheap, so every school or student can afford it.

2. Laser pointer as input device

We have used and modified existing algorithms for the exact recognition of the laser spot, calibration of the map coordinates and their transformation.

2.1. Laser spot detection

In every kind of similar application it is necessary to determine the accurate location of the laser spot. The searching algorithm without optimization can lead to big delays that are unwanted in all types of interaction. We considered only the red component of each frame image. We have discovered that although the LASER point is red, its center pixels are usually captured as white (due to surface reflection and camera saturation). At the beginning is created the average of every pixel from 3 continuous frames to reduce the noise. This average frame is compared with every new captured frame which are captured every 100 ms. By the comparison we are searching for a pixel with the biggest difference and with the intensity above the exact threshold. In the neighborhood of this spot are similar intensive pixels. From these pixels is counted their average position which represents the searched coordinates of the laser spot. If such coordinates are in range of 5 pixels in 4 continuous frames it is considered as input spot.

2.2. Map calibration

Map calibration is needed in order to reflect webcam coordinate system on database data. The layout of the system is briefly sketched in Fig. 1. On the base of the
calibration 8 coefficients are acquired. These coefficients are needed to transform webcam coordinates \( x, y \) into map coordinates \( u, v \).

Using the coefficients, the coordinates \( u, v \) are calculated by the simple conversion equations. These transformed coordinates are used directly for getting the object from the database. The output is the nearest object from the database that’s coordinates are the closest to the coordinates \( u, v \).

Fig. 1. Layout of the map, camera, PC and user

3. Usage of the program

We have made GUI which guides the user in the course of calibration and gives the opportunity to run educational and testing module. It is very simple and optimized so the user do not have to keep in touch with computer during teaching or testing module.

3.1. Testing module

In this part the program allows the user to choose the time limit of the answers to the questions and the number of questions. The questions are asked by the voice what gives the user the possibility not to be in direct contact with PC. At the end of the test results and efficiency are given to the user on the PC screen.

3.2. Figure captions

This module is designed to quick teaching of the user. After pointing at any point on the map the voice from the computer announces the name of the chosen place.

3.3. Test of the usability

Our program has been tested by several independent schoolmates from our university. We found that the usage is simply, natural and highly enjoyable. The recognition of red spot has been noticeably delayed in high capture resolution. With lowering the resolution we got acceptable results. For our surprise we found out that the usability has not been decreased by the resolution as low as 320x240 pixels. We have not recognized any defects and therefore we think that this solution could be applied in real usage.

4. Conclusion

We have developed practical system for education of one part of the geography. We think that our project (generally using computers), which is not very common form of education system in our society can be more effective in the way how to keep an attention of students and make them learn new things easier. It can be adjust to be used with any kind of map-based course. The following development can be aimed to make an application for creation of a database. Further, the development could lead to adjust the calibration for the usage with any kind of map. The calibration should be based on the coordinates of the database objects. In the future it would be possible to upgrade the program in the way that the computer would point at the place on the map similar technique to the [4] and the user would be required to say what is pointed at. However this requires voice recognition and additional peripherals.

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5. References


