PROPOSE THE 3D AND TEMPORAL GIS FOR DETECTING MOVING OBJECTS WITH RASBERRY PI MOVING CLIENT BASE IN URBAN. STUDY CASE IN HOCHIMINH CITY, VIETNAM

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ABSTRACT

In this paper, the 3D and temporal system for detecting moving objects with Raspberry Pi moving client base in urban will proposed in which using HoChiMinh city data. By sending current location, moving direction and speed on road as well as raw processed collected picturtes in series of time to server, the mobile part, which employed by integrated GPS-GIS-Camera modules on Raspberry Pi based, will provide these data while moving. Such temporal GIS data will be calculated and compared with generated flat vector images from lidar 3D cloud points by serverside part for detecting moving objects. These vector images is the data reflecting the mainly skeleton of location landscapes. The set of statistical-algebra methods will be employed to detecting the ego-motion of camera on mobile part and other moving objects.

1. INTRODUCTION

Raspberry Pi devices are commonly used for many applications. Integrated hardwares and flexibly supportted softwares taking Raspberry Pi into potential GIS application deploying environment. Street cleaning, traffic policing and supporting vehicles operation in bad weather conditions, ect… are in the class of considered programs. The Raspberry Pi supports many programming language, such as Python, C/C++, Java, Perl, Ruby, BBC Basic,… OpenCV, an library of programming functions mainly aimed at real-time computer vision, …

Following are the researching titles involve:

- Reseach on capturing and processing image from the attached camera.
- Reseach on receiving and locating from GPS signal.
- Research on connecting and communicating messages with server.
- Reseach on querying spatial by vector and speed .
- Reseach on projecting map data into image.
- Reseach on analysing movement in images and alerting.

However, the most difficult problem in deploying the Raspberry Pi system is the speed of the device which CPU corresponding to 300 MHz Pentium II computers in 1997-1999 and GPU corresponding to Xbox in 2001 year, nearly 1 billion pixels/second. By April 2014, Raspberry Pi computational module is launched. But the speed of calculation is still a big problem.

2. THEORITICAL PROCESSES

2.1 Basic on object regconition from images

Computer vision is the research field for object regconition from images. The main problems are recognition, image restoration, motion estimation, and scene reconstruction, as Nguyen Xuan Vinh (2008).

To analyse the motion in the images from moving object with single camera, the motion detection process is performed in two steps (Boyoon Jung, 2004). The first step is analyzing the effects made while camera moving, called ego-motion compensation of camera images. Two consecutive recorded images will be calculated the frame differencing. And after that, the moving object detection will be applied to find out the motion of features by tracking algorithms. In theory, two continous images will be transformed into one projection and compared together. The comparative methods are usually based on two tasks. The first is the extraction of objects in each image and object access trail between the two images. Lucas-Kanade method is applied to "trace" the set of objects. Then, the calculation of "image changes due to camera motion" (ego-motion) is performed by two processes: a model transformation and the second is the optimal model. With model transformation, affine or methods such as bilinear or virtual projection (pseudo-perspective) are used depending on the application as well as the actual change. This is related to the velocity and direction of motion of the camera changes the image of the object is recognized under the influence of collective transformations such as translation, rotation, shearing and scaling… In addition, depending on the velocity of the moving image recording devices that image acquisition can not change according to the linear transformation, by nature is a change in the projection. In fact, the receiver when the receiver motion picture will be affected by various sources of "noise" (noise source) such as: light, quality camera (camera distortion), the shape of simple objects often and change. All above varied transform as well as the lack of depth information of features let the creating compensation images more difficult and less precise. In reality, the images taken from 2D camera will not show up all objects, especially the invisible objects but they may flash in the next images. So, the computating for compensated image will be complex.

As Boyoon Jung (2004), the below bilinear model (1) is employed to translated one image to the other. The cost-to-minimizing function is use least square optimization technique with N recognized objects as (2):

$$\begin{bmatrix} f_x^t \\ f_y^t \end{bmatrix} = \begin{bmatrix} a_0 f_x^{t-1} + a_1 f_y^{t-1} + a_2 + a_3 f_x^{t-1} f_y^{t-1} \\ a_4 f_x^{t-1} + a_5 f_y^{t-1} + a_6 + a_7 f_x^{t-1} f_y^{t-1} \end{bmatrix} \quad (1)$$

System optimization squared minima of N objects to determine the optimal:

$$J = \frac{1}{2}\sum_{i=1}^{N}(f_i^t - T_{t-1}^t(f_i^{t-1}))^2 \quad (2)$$

With the identification of a moving object, the basic process consists of three steps: object detection, classification and tracking the object. The detection of objects can be handled through methods: characteristics, based on the pattern or movement. Meanwhile, follow trail who require information about the location, size and shape of the object. Currently the algorithm according to the markings used include: camshift, optical flow detection coutour. Each method has different advantages and disadvantages in practice.

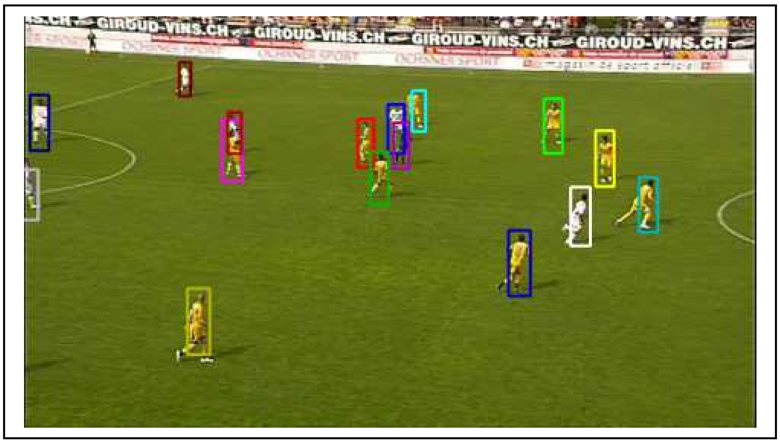

Figure 1. Moving object detection, as Quy-Tram (2014).

2.2 Projective

An object in space modeling laminar point on the map corresponds to a location. Meanwhile, in the GIS software, the set of points will be shown on the map view as a picture in 2D. In fact, every object that will be the nature of the position and altitude, which means they have geographic coordinates. Then, we can use the method of projective to convert the spatial position orthogonal aerial view down into the horizontal position corresponding image.

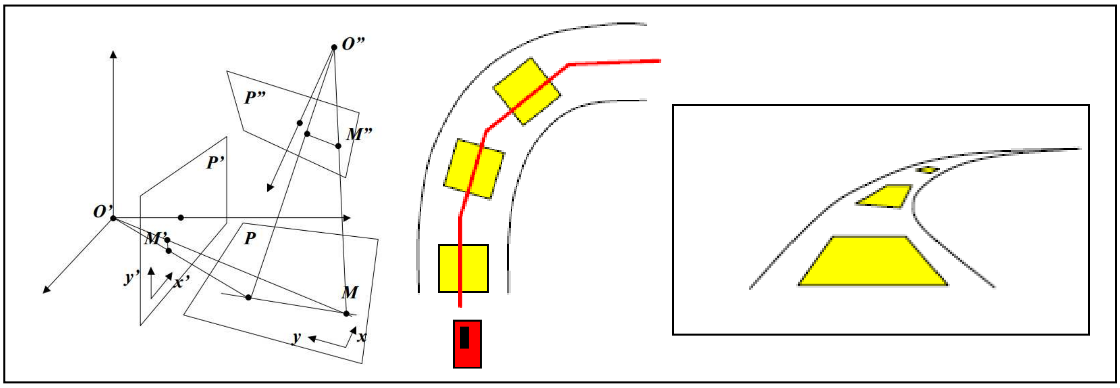

Figure 2. One projective model in the spatial, moving object on the road and the projective of the road (Source: internet documents)

The mathematics for objects transformation in the next image:

$$x' = \frac{x'_1}{x'_3} = \frac{h_{11}x + h_{12}y + h_{13}}{h_{31}x + h_{32}y + h_{33}} = \frac{h'_{11}x + h'_{12}y + h'_{13}}{h'_{31}x + h'_{32}y + 1} \quad (3)$$

$$y' = \frac{x'_2}{x'_3} = \frac{h_{21}x + h_{22}y + h_{23}}{h_{31}x + h_{32}y + h_{33}} = \frac{h'_{21}x + h'_{22}y + h'_{23}}{h'_{31}x + h'_{32}y + 1} \quad (4)$$

In 3D, to do geometry projective, points are defined in to 4-element vectors and one infinite point located at (0,0,0,1). Above setting let the projective model below:

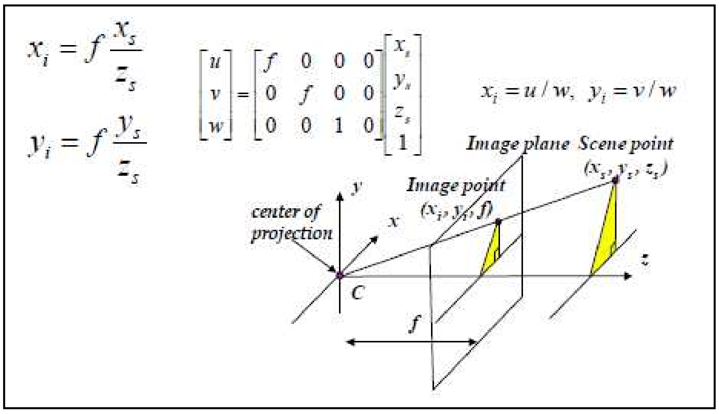

Figure 3. Calculation of objects by 3D projective (source: Internet document).

2.3 The role of spatial in object regconizition problem

The mobile object positioning system would help to know the relative position on the field. From the current location information, the system will support all of the data for the mobile system to identify the object in the image collection. It have two important parameters:

- Parameters for the position will support calculations to determine the direction of data required for mobile systems.
- Velocity parameters will support calculate the level of detail of data and preparation of the data in the future.

When server receives the position, it will calculate the dataset needed to send a mobile device. In particular, the position appears in the image will be projected to the mobile device identification. With the migration of the transport system in the city or municipality, the data layer need to define static objects can be listed including:

- Road layer.
- Pavement layer.
- Parcel and construction layers.
- Tree, vegetation layers.
- Utilities layers (such as signs, pole, mail boxes, fire hydrants…)
- Elevation (lidar) layer.

These layers include data on the probability of static objects are shown on the big picture. In particular, the class lidar elevation data will support high describe objects to the system all the work of calculating projective imaging objects for Raspberry Pi device.

Accordingly, depending on the height of each static objects on the road, and depending on conditions, the static object would appear probable or obscured by the mobile object. For example, the object in sidewalk lower elevation will be susceptible to the mobile objects such as cars obscure, or busy times there will be more mobile objects obscured static objects on the street,... In addition, for systems with high speed, the exchange between the host system and mobile system through the set point and the system will support all calculations projective.

3. INTEGRATED SYSTEM: RASPBERRY PI, GPS, CAMERAS

Raspberry Pi device integrated with GPS and camera for getting spatial location and image on the field. Besides the problem of processing speed on Raspberry Pi device, a numorous issues need to be addressed for using device.

3.1 The accurating factor of spatial data

The instantaneous spatial data have an error in precise location information, mainly from GPS signal and camera.

3.1.1 *GPS error*

Low cost GPS device have large errors. The GPS location errors will affect on two main issues, namely: the problem of the motion vector of the object and object location.

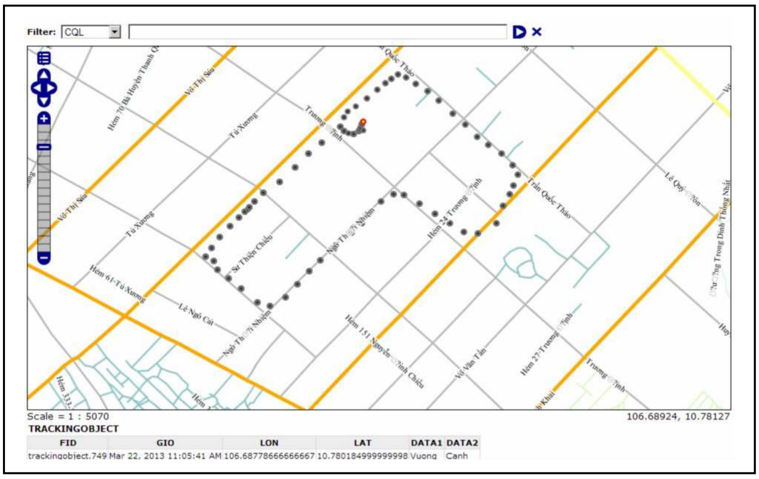

Figure 4. Spatial point by one moving low-cost GPS in Ho Chi Minh city.

3.1.2 *Image error*

Shook images will make errors. In addition, image capturing will affect by environment such as: the lighting, the moving objects close to the camera, the transient errors.

3.2 Integrated softwares into the Raspberry Pi device

Software installed on the Raspberry Pi device including: operating systems, image processing software packages, hardware drivers for the integrated (gps, camera, usb 3G). On the operating system, device manufacturers Raspberry Pi has proposed the OS to the device. Accordingly, the operating systems supported include: noobs, Raspbian, Pidora, OpenELEC, RaspBMC, RISC OS, Arch ... and Android OS. Then, we will install the system identifies OpenCV image processing packages. OpenCV is image processing software packages commonly used to study the system of image processing, computer vision, 3D... And we install two packages and gpsd gpsd-clients to receive data from a GPS device. In addition, we downloaded the package python-gps to perform GPS device control commands with Python.

3.3 Integrated hardwares into the Raspberry Pi device

Hardware integrated into the Raspberry Pi device are camera, GPS, and we can use the usb hub to serve the integrated 3G usb communication with the server. In the experiments, the authors use the camera to connect usb port, usb port GPS connection. In case of using Raspberry B+, the usb hub is not required because the device has 4 usb ports.

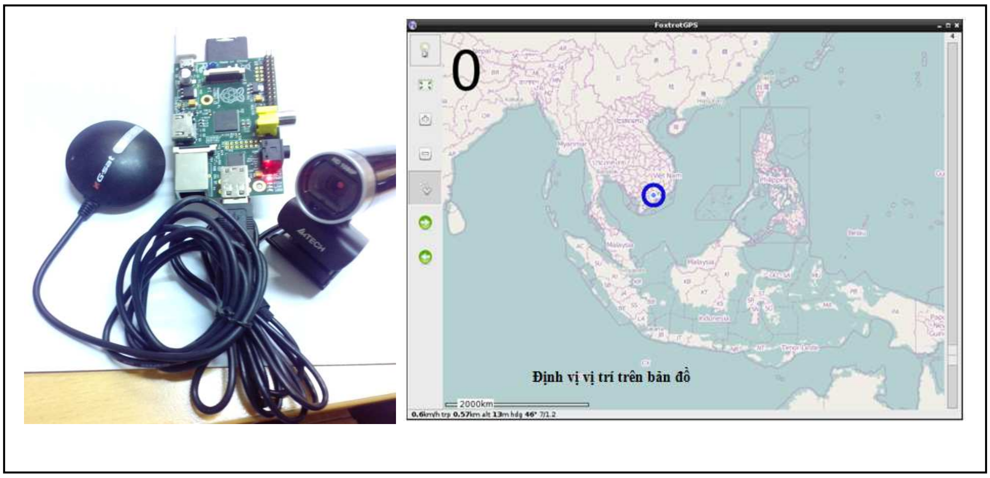

Figure 5. Integrated softwares and hardware on Raspberry Pi device.

4. CONCLUSION

The object recognition mobile devices with Raspberry Pi is an application inneed in practice. However, to build a system, we need to have systems and methods to increase speed and the precision. In this paper, we propose to use the spatial data (including space objects, height) from the position and direction of movement to cater for the static object recognition in images. Meanwhile, the real object, the determination will be simplified by methods such as filtration edit photos. From there, we can develop applications in traffic alerts,... In conclusion, applied research Raspberry Pi device is integrated research methods such as algebra, geometry and statistics with the aid of a spatial database of GIS to contribute to streamline processing in conditions of limited computing power of the device.

5. REFERENCES

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