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A Study on the Move Method of Calculating System Dependent on Acceleration using Android Communication Module and Sensor

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Abstract

As GPS technology has been developed with other mobile communications, GPS function is essentially loaded on mobile devices including smartphone and tablet PC. Thus, users can exchange information based on the current location of the GPS through the application service such as path-finding and current velocity. However, since it is difficult to identify accurate means of transportation of a user, there is limitation on providing high-quality service and information. For instance, it causes unnecessary data consumption that providing unnecessary traffic information to a user walking or riding city rails.

Keywords: *Android, GPS, Mobile-Network, Sensor, JSON*

1. Introduction

Recently, the smart device penetration surpassed the 30 million people in the country. In other words, six out of 10 people are using smart phones. Further, the smart phone penetration rate of twenties is 91.6%, which means most of them use smart phones.

Each of the smart devices has GPS(Global Positioning System) and they are released with the various sensors mounted.

Location-based applications with Android module such as GPS and acceleration sensors are used. Through them, services like public transportation information, navigation, map, camera, and etc. are provided [1,2].

However, applications based on location service are simply using the latitude and longitude and services by analyzing and processing the location for further information are insufficient.

The purpose of this paper is to process GPS, mobile networks and the location information utilizing a sensor and to design calculation systems of transferring methods that can provide a higher service to administrators and users. And also, by using the acceleration sensor based the latitude and longitude, it aims to calculate a movement method and public transportation currently using and offers a way for an administrator to provide quality service to the user, using this information.

Chapter 2 describes related researches. Designs of this system are shown in chapter 3. Implementation is described in chapter 4 and conclusions and future research is in Chapter 5.

2. Related Researches

2.1 Location Manager

In Android, in order to confirm the location, Location manager is provided as a system service[3]. It includes this class on the android location package to find out the location information and defines the needed class for use.

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Types of location providers are GPS_PROVIDER, NETWORK_PROVIDER, PASSIVE_PROVIDER and each provider calculates a location by using a GPS module, mobile, network, and other applications on a same device [4]. They can set a margin of error differently around the consumption of the battery [5].

2.2 Accelerometer

The accelerometer is a sensor that gravity information and a linear accelerator is calculated together. It can process each value of the coordinate of X, Y, Z by the array.

When the device is put on the ground, the value of the acceleration sensor is a +9.81. This value is the value obtained by subtracting the gravity value -9.81m / s ^ 2 in a linear acceleration value of 0m / s ^ 2 of the terminal. If the device is pushed in the direction of A, the acceleration value is A + 9.81m / s ^ 2, and this is understood as a vector form.

The X axis represents the horizontal axis of the screen pointing to the right and the Y axis does the vertical axis of the screen pointing to the top of the screen. When the Z-axis is placed on the ground to the top of the screen of the device, it refers to the sky..

2.3 Gyroscope Sensor

The axis of rotation of the sphere (Sphere) may have the characteristics to remain constant, the slope is calculated based on the rotating shaft. Gyro is a sensor for detecting a rotational angle of the object using the nature of keeping the movement. The vertical direction can be calculated from the slope for the angle.

And the formula(2.1) is about the level of acceleration of the accelerometer installed on the object and the angle of verticality.

$$a = g \times \cos\ \theta$$
$$\theta = \arccos\ \left(\frac{a}{g}\right) \qquad (2.1)$$

3 Gyro and the axis rotation speed are determined by the X, Y, Z-axis. The X-axis rotation angle is called a roll angle, the Y-axis rotation is a pitch angle and the Z-axis rotation is called yaw.

2.4 JSON(JavaScript Object Notation)

JSON is a lightweight data-interchange format. It is easy for people to read and write and also easy for the machine to analyze and generate data over the network.

There is no greater restriction on the type of material, and is suitable for representing the values of the variables of a program. This model is lighter than previously used XML(eXtensible Markup Language) for data exchange between being replaced by JSON.

In this paper, user's location data is sent as JSON type. When GCM(Google Cloud Message) push message is sent, the server operates JSON type information and sent it back [6].

3. Design

In this paper, by using GPS and a sensor built in a mobile device, a system for calculating a user's mobile method is designed and implemented.

This system uses the sensor data in the area of the Android kernel, and quantifies data on Android Activity using the JSON parsing passes data to the server, allows calculations and indicate on Map Activity. In this paper, user's location data is sent as JSON type.

When GCM(Google Cloud Messaging) push message is sent, the server operates JSON type information and sends it back [6]. The system configuration is shown in Figure 1.

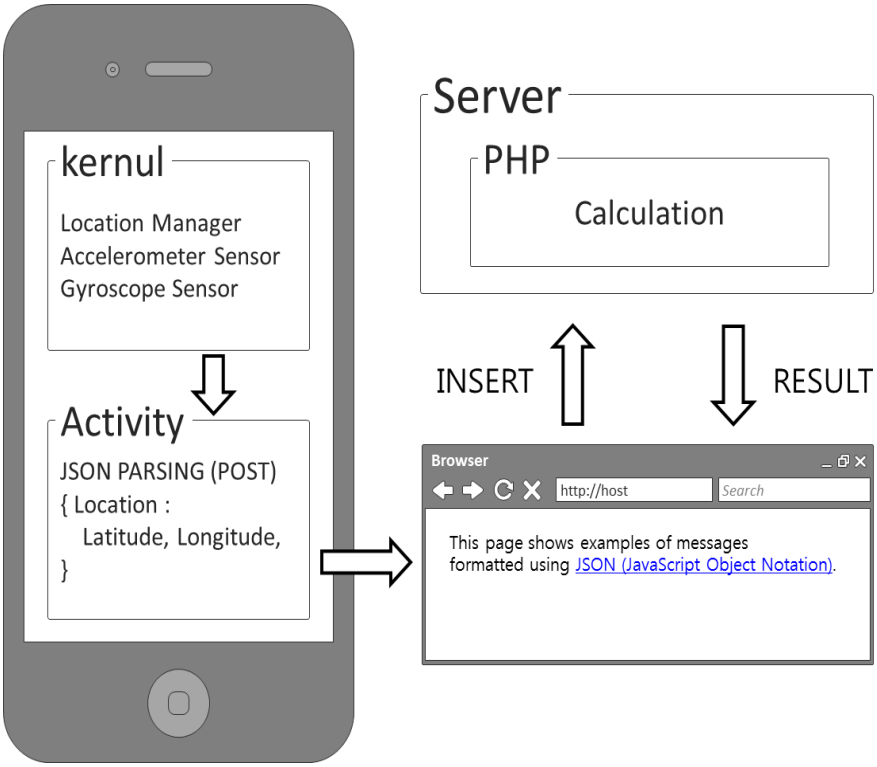

Figure 1. System Configuration

The current user's latitude and longitude are sent to the server, and re-measured latitude and longitude are received in real time, calculated and processed on the server.

The server receives the user's position and the transmission continues to move away, and measure the position, and continues to transmit the data output Android application for error correction showing a modification to the user range error.

Vector and the acceleration sensor, which can recognize only the form, by tracing the X, Y, Z, axis gyro sensor, detects the change in the rotation, so as to calculate the moving direction and the moving speed. The gyroscope sensor recognizes the curve, while the acceleration sensor does the change of the linear form. They complement each other, so the data of moving means is standardized. The data is calculated by foot, subway, train, bus and car, and each item defines the minimum and maximum speed for the move proportionately to speed increase/decrease and direction of the linear motion in a particular direction.

When the application is running on a device, the location information of latitude and longitude is stored as the number on the server in the form of JSON to MYSQL DATABASE, and resends the location information once every 2 minutes, and also utilizes distance calculation formula in the server.

First measured and re-measured error of the location value becomes recognized as a walk on the server side within 0 ~ 180m. At this time, even if it is not walking, it reduces the error received two minutes each new measured value.

In the case of the subway and train, because the direction of movement to move along the rail, the 500m ~ 1Km latitude to define the virtual invisible points and longitude of the marker along the rail and is stored on the server.

After the error of the radial diameter 200m (virtual markers around the user of the device, the virtual markers 200m) defines a moving means in subway and train.

In this case, since the distance between the user and the virtual markers should be calculated, it quantifies as numbers using a way to convert the distance of the latitude and longitude.

By multiplying each distance by the amount of angle difference between two latitudes, calculating the horizontal distance between points, multiplying the difference between the latitudes and the longitudes, and calculating the vertical distance between the two points, then it obtains the value of the square root on the latitude ^ and longitude ^ and calculates the distance between the user's location and the virtual marker.

The moving path for the first 3 times is similar to a bus, so it is recognized as a bus and or a car. But if it continues to pass the imaginary marker, this system recognizes a user's means of transportation as subway. Calculating a value corresponding to the moving direction of the rail by the virtual markers is shown in Figure 2.

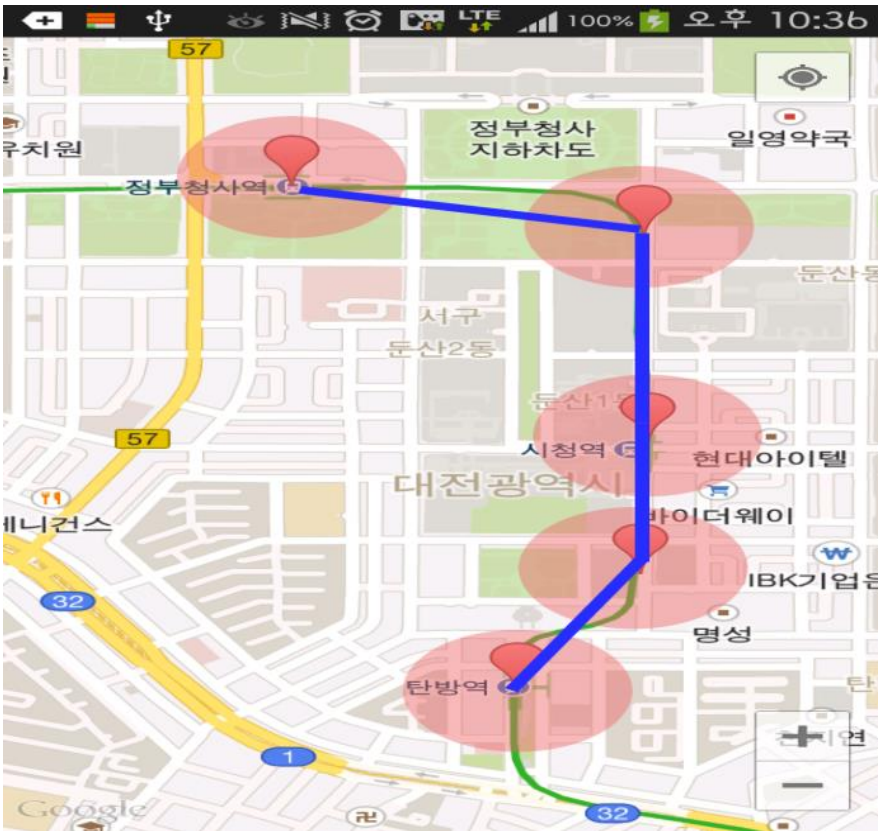

Figure 2. Definition of City Rail and Rail Car Using Virtual Markers

In addition, if the measured value by bus and car is within 180m ~ 4Km, it is defined as a bus or a car. On the other hand, if the value is more than that, it is defined as KTX(Korea Train Express) and a plane for high-speed transportation. The sequence diagram of the mobility measurement algorithm is shown in Figure 3.

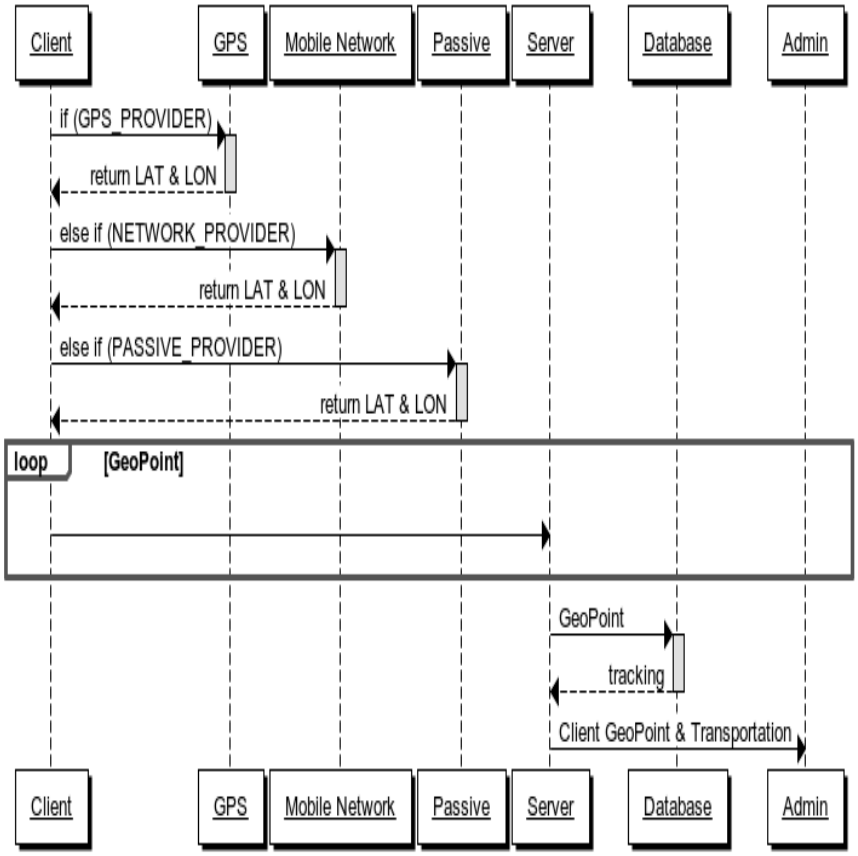

Figure 3. Sequence Diagram of Movement Means Identification System

4. System Implementation and Experiment

The system is built on the Android and 3 devices - 2 units of Galaxy S3 and a unit of Galaxy S4 - supporting mobile networks are used in this experiment.

Two people participated in the experiment; one conducted the user's application and the other did the administrator's application. It was performed once for each means of transportation: subway, car, and walking. Development environment for performing research in this paper are shown in Table 1.

Table 1. Development Environment

Division	Contents
Development Tool	Eclipse(android SDK), APM_SETUP
Development Language	Java, PHP
Development PC	windows7, Intel i7-2600, 8GB RAM
Development Smartphone	Android 4.3 Galaxy S4

If you choose to walk, there are 3 types of walking: fast work, slow walk, and jump. If you use a car, and the results are shown in Figure 5. If the experimenter ran at full speed, it was calculated that he or she used a bus or car. But the server re-measured location information 3 times every 2 minutes, and thus, the errors were reduced and calculated to foot movement normally. A case of a car was same as well.

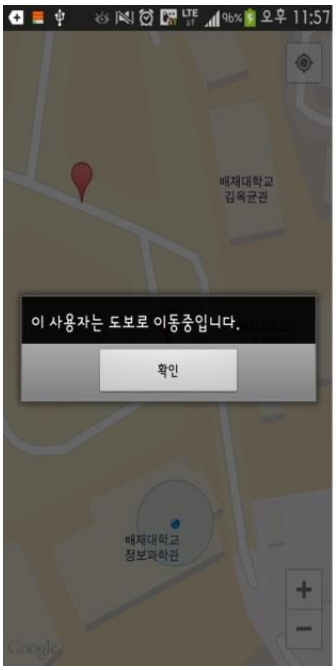

Figure 4. The Result when a User Walks

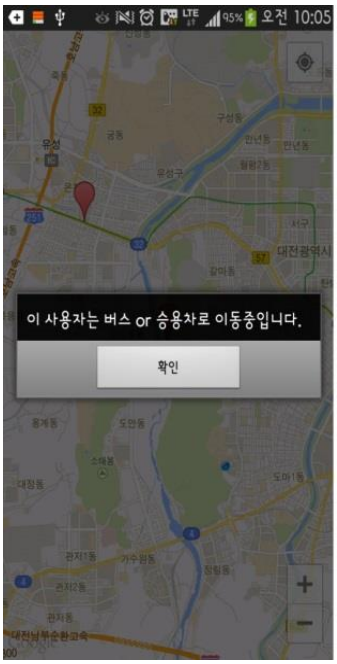

Figure 5. The Result when a User Uses Car

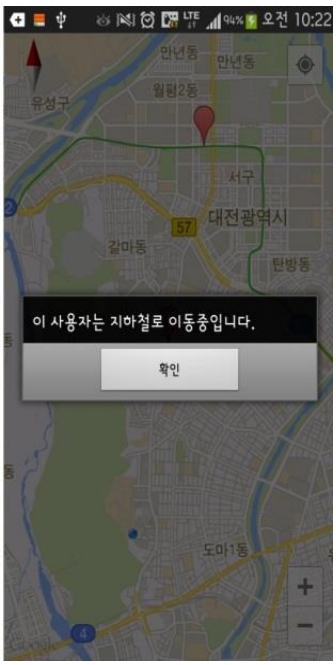

Figure 6. The Result when a User Uses City Rail

In the case of subway, when the application was used for the first time, it recognized a bus or a car. However, after modifying the error of the latitude and continuing to pass over the virtual marker, it recognized subway.

In case of not recognizing GPS on subway, it switched to mobile network as an alternative and calculated the location. If the current location is recalled when using mobile network, there is an error that the current location presented as a close station. But after re-adjusting data and processing it on the server, the method of movement is calculated in figure 6 by modifying the error range of a virtual marker.

Computing and creating 3rd party application server to the PHP documentation, the messages on means of transportation currently using can be sent to users as GCM JSON form with accuracy.

5. Conclusion

Using Android SDK(Software Development Kit), the mobile network (Long Term Evolution, LTE), and GPS, the system of calculating a user's means of transportation was implemented as proposed in this paper.

Location-based applications currently serving nowadays mostly provide the same information to all users, not considering each user's method of movement and means of transportation.

But rather, it is common that transportation service is provided while a user is walking or moving by train to train, it causes waste of data with unnecessary information.

In this paper, based on the proposed system, using the GCM functions of the server, the user's value of each means of transportation is transformed as BigData so that it can be utilized by a service providing high quality contents.

Not only movement patterns of users, but also behavior patterns of movement are analyzed, so it is expected that more precise service with high quality can be provided to users having smart devices.

It is considered to be utilized in the management system and the disaster information systems of a fire or an emergency.

Virtual markers and mobility patterns of this system will be used in the future and be utilized in the object internet control on users' behavior pattern analysis of IoT(Internet of Thing) which has recently become an issue.

References

[1] H. W. Kim, H. L. Lee and S. J. Choi, "An exploratory study on the determinants of mobile application purchase", The Journal of Society for e-Business Studies, vol. 16, no. 4, **(2011)**, pp. 173-195.
[2] D. Schuster, T. Springer and A. Schill, "Service-based development of mobile real-time collaboration applications for social networks", Pervasive Computing and Communications Workshops, vol. 8, **(2010)**, pp. 232-237.
[3] N. Friedman, D. Geiger and M. Goldszmidt, "Bayesian network classifiers", Machine learning, vol. 29, **(1997)**, pp. 131-163.
[4] Y.N H. Weng, F. S. Sun and J. D. Grigsby, "GeoTools: An android phone application in geology", Computers & Geosciences, vol. 44, **(2012)**, pp. 24-30.
[5] O. Z. Hong, S. M. Na, Z. X. Su and S. J. De, "Key techniques for mobile peer-to-peer networks", Journal of Software, vol. 19, no. 2, **(2008)**, pp. 404-418.
[6] Y. H. Kim, "Geometry-Based Sensor Selection for Large Wireless Sensor Networks", Journal of information and communication convergence engineering, vol. 12, no. 1, **(2014)**, pp. 8-13.
[7] R. Cohen and T. Wang, "Android Application Development Processes and Tool Chains for Intel® Architecture", Android Application Development for the Intel® Platform, A press, **(2014)**, pp. 47-84.
[8] M. L. Zheng, P. Z. Pei and X. Zou, "Research of Location Technology Based on Wireless Sensor Network", Advanced Materials Research, vol. 860 **(2014)**, pp. 2817-2824.
[9] A. R. Han, D. H. Bae and S. D. Cha, "An efficient approach to identify multiple and independent Move Method refactoring candidates", Information and Software Technology, vol. 59, **(2015)**, pp. 53-66.
[10] M. Jones, JSON Web Algorithms (JWA), **(2014)**.
[11] T. Bray, The JavaScript Object Notation (JSON) Data Interchange Format, **(2014)**.
[12] Z. H. Liu, B. Hammerschmidt and D. McMahon, "JSON data management: supporting schema-less development in RDBMS", Proceedings of the ACM SIGMOD international conference on Management of data, ACM, **(2014)**.
[13] A. Sharma, N. Francesco and D. C. Manolache, "User-aware cloud to device messaging systems and methods", **(2014)**.

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