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Research paper

Design of Falling Notification System using Falling Situation and Geofencing Service

TaeWoo Kwon[1], Jong-Yong Lee[2], Kye-DongJung[*3]

[1]*Department of Information System, KwangWoon University Graduate School of Smart Convergence, 20 KwangWoon-ro, Nowon-gu, Seoul 139-701, Korea*

[2]*Ingenium College of liberal arts, KwangWoon University, 20 KwangWoon-ro, Nowon-gu, Seoul 139-701, Korea*

[*3]*Ingenium College of liberal arts, KwangWoon University, 20 KwangWoon-ro, Nowon-gu, Seoul 139-701, Korea*

**Corresponding author E-mail: gdchung@kw.ac.kr*

Abstract

The existing falling notification system notifies only the occurrence of a falling and provides notification service. However, falling has different risk levels depending on the type and location of falling. Therefore, the falling notification system based on the falling situation is required. In this paper, we use accelerometer data of smartphone to recognize falling. In this system collects beacon and GPS sensor data to recognize falling location.This falling location data is used for geofencing service within a certain area when the falling occurs. The acceleration sensor data is converted into SVM(Signal Vector Magnitude) and used. When the falling occurs, it is converted not only into falling data, but also falling situation data using location information including pre-falling and post-falling data. However, when real-time processing of multiple data including sensor data, data overload, and connection speed delay problems arise. In this paper, we set up three layers of the system to minimize these problems.The three layers are composed of End Layer, Fog Layer, and Cloud Layer, respectively. Behavior data when no falling have occurred are stored in the temporary storage of the Fog Layer. If the falling does not occur for a certain period of time, the data stored in the temporary storage is deleted.When the falling occurs, the falling notification service is provided based on the falling situation. The notification service provides geofencing service in addition to SMS to the caregiver.

Keywords: *Geofence,Falling, Context-aware System, Notification System, Beacon, Smartphone*

1. Introduction

Recently, the development of information technology and sensor technology has been used to study the behavior recognition of human daily life using sensors[1-7].In addition, the number of smartphone-based behavior recognition research is on the increase as the number of sensors in the smartphone is increasing and the penetration rate is increasing[3,4].Behavior recognition mainly uses an acceleration sensor and recognizes the behavior according to the pattern[4,5].Behavior in this behavior recognition research is divided into dynamic behaviors such as "Walking", "Running", and "Falling" as well as static behaviors such as "Standing", "Sitting", and "Lying".Behavior recognition technologies are often recognized only for each behavior.Especially, in the case of "Falling", the risk varies based on the falling situation.Falling situations can be inferred as "falling location", "pre-falling behavior" and "post-falling behavior."

In this paper, we design the system that provides notification service according to the falling situation using geofencing service[8-10].In order to recognize falling situation, data of acceleration sensor and GPS sensor are collected from smartphone. In addition, Beacon's distance data is used to obtain a more accurate falling location.If high-risk fallings are recognized, we propose the system that provides notification services using the Geofencing API.

The composition of this paper is as follows.Section 2 describes the Geofencing Service and Behavior Recognition Technology.In Section 3, we describe the overview and flowchart of the system designed in this paper.Section 4 describes the scenarios of the system designed in this paper.Section 5 describes the conclusions and supplementations of the system designed in this paper.

2. Related Works

2.1. Geofence

Geofence is a combination of “Geo” with the meaning of “earth” and “soil”, and “Fence” meaning “fence”[8-10].A geofence is a technique for designating a virtual boundary and providing services to a user located within the boundary[8].To do this, we use LBS(Location-based Service) to identify the location and provide service if it is within the area[9].Geofences collects location information from the GPS sensor of a mobile phone or a wearable device and provides services specified by the provider.Geofence is mainly used in marketing and notification services.

2.2. Behavior Recognition Technology

Behavior recognition technologies are techniques that recognize ADL(Activities of Daily Living)[2-7].Most of the behavior recognition techniques use sensor to collect sensor data and process data to obtain behavior data.The technique of obtaining SVM (Signal Vector Magnitude) value from the acceleration sensor and recognizing it into behavior data according to the threshold of SVM value is mainly made up[2-5].Equation 1 is an equation for obtaining the SVM value using the acceleration sensor data.In addition, 1g shows the case where there is static state by dividing by the gravitational acceleration of 1g.

$$SVM(g) = \frac{\sqrt{(Acc_x)^2+(Acc_y)^2+(Acc_z)^2}}{9.8} \quad (1)$$

Behavior recognition technology is being studied in many areas. ADL in behavior recognition can be divided into static behavior and dynamic behavior. Static behavior is when the SVM value is 1G, and there are "Standing", "Sitting", "Lying". Dynamic behavior is when the SVM value is not 1G, and there are "Walking", "Running", "Falling". In particular, research has been conducted actively on methods of recognizing and recognizing the falling that is at high-risk of being injured in ADL.

3. Proposed System

3.1. System Architecture

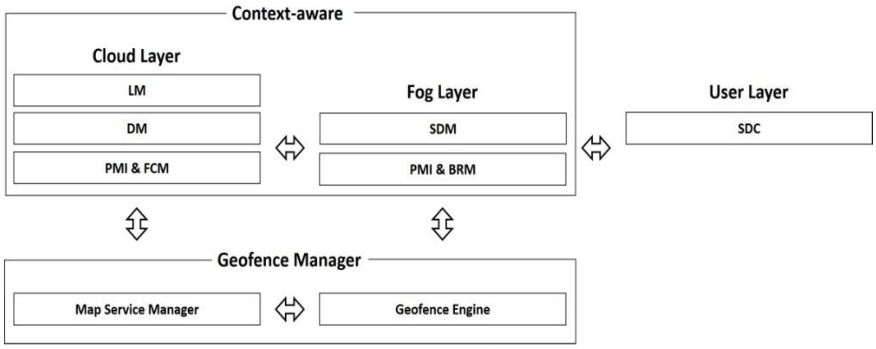

Figure 1: SystemArchitecture

Figure 1 shows the architecture of a system designed based on the previously studied Falling Context-aware system.It is collecting real-time sensor data, so we divide into three layers to reduce data throughput and server overload.Each layer is in User Layer, Fog Layer, and Cloud Layer.The User Layer SDC(Sensor Data Collection) collects and transmits the accelerometer and GPS sensor data of the smartphone.The Sensor Data Manager(SDM) of the Fog Layer manages sensor data and maps it to a metadata format.The Pedestrian Map Information and Behavior Recognition Manager(PMI & BRM) recognize behaviors from acceleration sensor data.In addition, it receives the distance information from the beacon and grasps to which crosswalk the user's behavior has taken place.These data are stored in Temporary Storage.If the falling occurs, data stored in Temporary Storage and behavior data after the falling are transmitted to the Cloud Layer.The DM(Data Manager) of the Cloud Layer manages behavior data, falling situation data, and metadata format.PMI &FCM(Pedestrian Map Information and Falling Context-aware Manager) infer falling situations.The falling situation is inferred based on falling location before and after falling.If high-risk falling, map where Geofence Manager falling in Map Service Manager.It also raises another Raspberry Pi geofencing event near the falling location.The Geofence Engine configures the zone and broadcasts a notification service to users who are located in or entering the zone.

3.2. Systemflow

3.2.1. Sensordatacollection

In the system designed in this paper, the user layer collects sensor data in real time and transmits it to the Fog layer.The sensor data is measured using the acceleration sensor and the GPS sensor built into the smartphone.The SDC collects acceleration and GPS sensor data and distance information from the beacon. And transmits the collected sensor data to the SDM of the Fog.To map the data, the Data Mapping Service requests the Meta-data format from the DM of the Cloud.Map data to format and store it in Temporary Storage.

3.2.2. Behaviorrecognitionanddatastoring

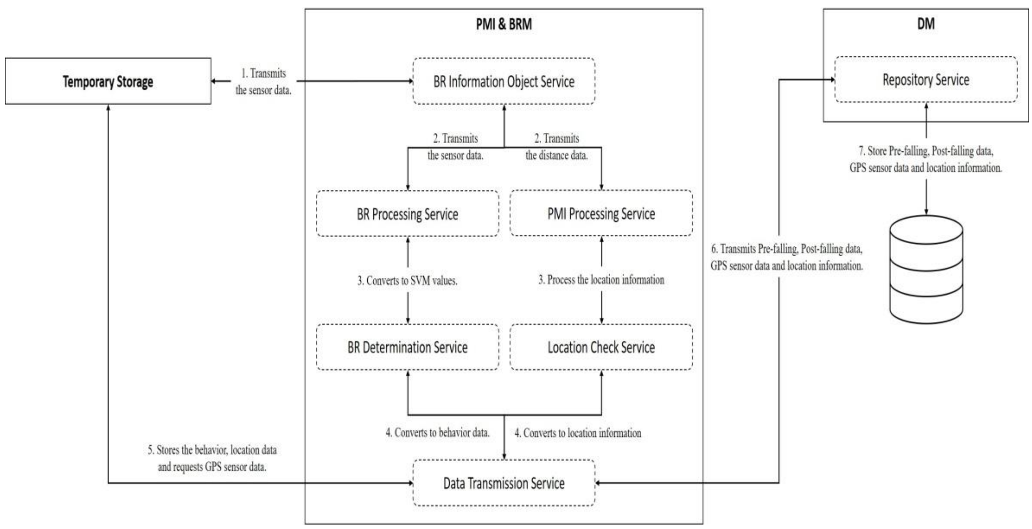

Figure 2: FlowchartI(BehaviorRecognitionandDataStoring**)**

Figure 2 depicts the process of storing data using DM when a behavior is recognized and a falling occurs.Transfers acceleration sensor, GPS sensor and distance data stored in Temporary Storage to PMI & BRM.The BR Information Object Service determines the processing method according to each data format.The BR Processing Service converts the acceleration sensor data to SVM and transmits it to the BR Determination Service.PMI Processing Service receives distance data and processes it as location information.BR Determination Service transforms it into behavior data according to the converted SVM value.The Location Check Service refers to the PMI and converts the user's location into location information.The converted data is stored in Temporary Storage again using Data Transmission Service.When the falling data occurs, the data transmission service transmits the pre-falling behavior data, GPS sensor data, falling data, and distance data stored in the temporary storage to the Repository Service in the DM of the server.The Repository Service stores the received data in the database of the Cloud.

3.2.3. Fallingcontext-Aware

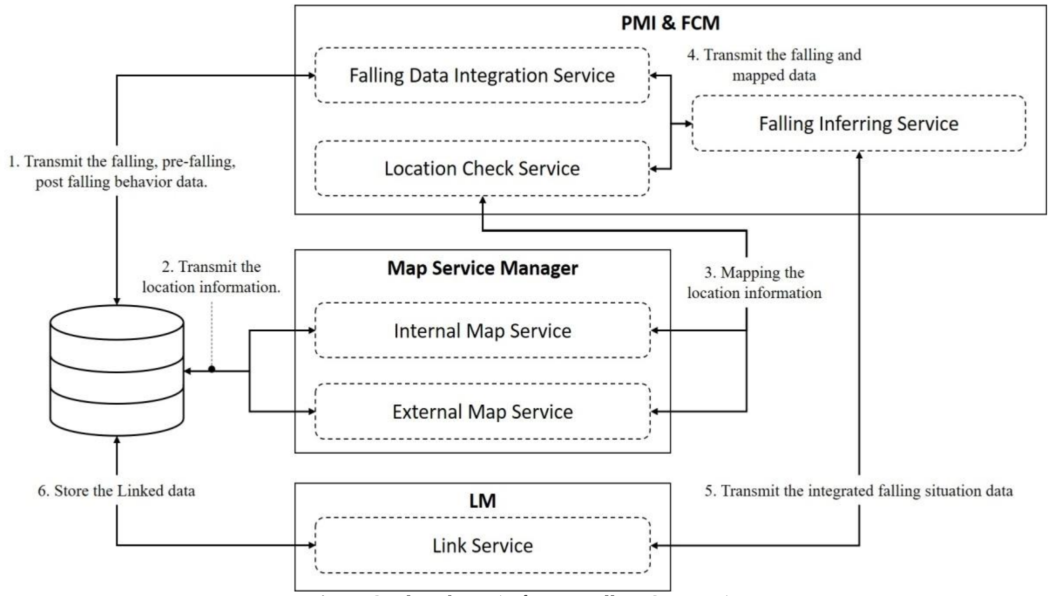

Figure 3: FlowchartII(Inferring Falling Situation**)**

Figure 3 shows the process of recognizing falling and storing them in the database.First, data of falling and pre-falling and post-falling are transmitted to Falling Data Integration Service and fall data are integrated.Then, the location information is sent to the Internal Map Service and the External Map Service to determine the location and send it to the Location Check Service.In Falling Inferring Service, falling situation is inferred based on pre-falling and post-falling situation and location information.The inferred data is stored in the database by the link service.

3.2.4. Geofencingareasetting

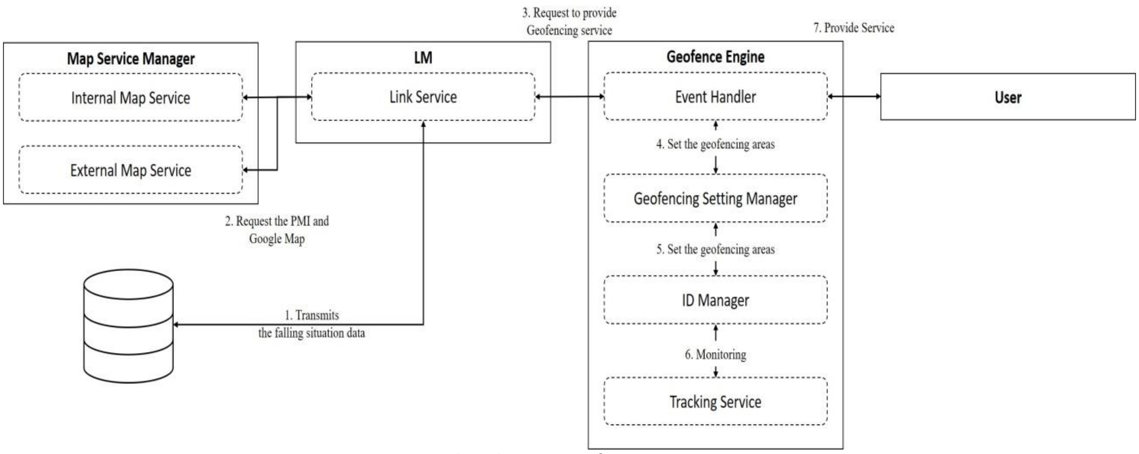

Figure 4: FlowchartIII(Geofencing Area Setting)

Figure 4 depicts the process of providing a geofencing service to a user.If the falling situation is a dangerous situation, the falling situation data is transmitted to the Link Service.From the Internal Map Service and the External Map Service, get information about where to set the geofencing area based on the location of the Raspberry Pi.When the event handler of the Geofence Engine receives the falling data, it sets the area with the Geofencing Setting Manager.The ID Manager creates and manages IDs in the configured geofencing area.The Tracking Service identifies users in the geofencing area and provides services to the user.

4. Example of Implement System

4.1. Systemscenario

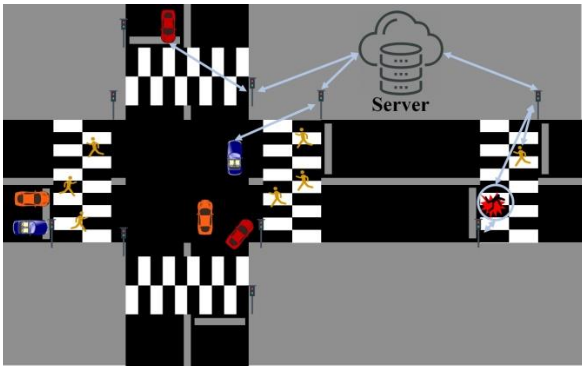

Figure 5: Example of Implement System

Figure 5 shows an example of implement of the falling situation notification service system using the geofencing service designed in this paper.The Raspberry Pi attached to the traffic light collects the sensor data of the smartphone and recognizes the behavior.In addition, the beacon is located at each corner of the pedestrian crossing to recognize where the user is located.The beacon calculates the distance using the RSSI.If a person falling on a pedestrian crossing, the Raspberry Pi transmits data for falling to the server.The server inferring falling situations, and provides notification when high-risk situations using geofencing manager.The server requests a geofencing service from a Raspberry Pi(traffic light) near the place where the falling occurred.When the Raspberry Pi receives a geofencing service request, it sets the zone and broadcasts it to the car in the zone.

5. Conclusion

In this paper, we propose the Falling Notification System using Falling Situation and Geofencing Service.In order to infer the falling situation, we use the accelerometer and GPS sensor data of the smartphone.In addition, the beacon RSSI distance measurement technique is used to grasp the falling location more precisely.If a falling is recognized, the server will check where it has fallen and request to provide the Raspberry Pi geofencing service near the falling location.In Raspberry Pi, the area is specified, and the notification message is broadcast to the user who is located in the area or entered.

The system designed in this paper provides a geofencing service based on the falling situation and user 's fall location.Also, since the error range of GPS sensor data is about 5m, beacon RSSI distance measurement technique is used to reduce the error range of the user location.Fuzzy Logic and Deep Learning will be introduced in order to improve the accuracy of perception of behavior and falling as a future research task.

References

[1] Lara OD, Labrador MA. A Survey on Human Activity Recognition using Wearable Sensors, IEEE Communications Surveys & Tutorials, Vol. 15, No. 3, pp. 1192-1209, March 2013.

[2] Kim JH, Kim IC. Design and Implementation of a Two-Phase Activity Recognition System Using Smartphone's Accelerometers, KIPS Transactions on Software and Data Engineering, Vol. 3, No. 2, pp. 87-92, 2014.

[3] Yang J. Toward Physical Activity Diary: Motion Recognition Using Simple Acceleration Features with Mobile Phones, in Proc. 1st International Workshop on Interactive Multimedia for Consumer Electronics, pp. 1-10, Oct.19-24, 2009.

[4] Lee DP, Lee JY, Jung KD. The design of the Fall detection algorithm using the smartphone accelerometer sensor, International Journal of Advanced Culture Technology(IJACT), Vol. 5, No. 2, pp. 54-62, June 2017.

[5] Kwon TW, Lee JY, Jung KD. Design of Cloud-based Context-aware System Based on Falling Type, International Journal of Internet, Broadcasting and Communication(IJIBC), Vol. 9, No. 4, pp. 44-50, November 2017.

[6] Kim SH,Choi IY, Han YK,Lee SY. Fall Context-aware for Emergency Notification Services based on the Fall Type, Korea Computer Congress(KCC), Vol.2015, No.6, pp. 2025-2027, June 2015.

[7] Jo KJ, Kim HD,Lee HJ, Sim CB,Chang JW. Development of Real Time Monitoring System based on Context-awareness for Wireless Sensor Networks, The Journal of the Korea Contents Association, Vol. 11, No. 4, pp. 101-111, 2011.

[8] EomYH,Choi YK, Cho SK, Jeon BK. A Time-Limited Three Dimensional Geofence using Timestamp, International Journal of Applied Engineering Research,Vol. 10 No.90, 2015.

[9] Jeon BK. 3D Geofence Framework Design for the Internetof Things", 2014 Summer International Academic Conference, Religion and Infotech of the Northeast Asian Nomadic People, pp 149-157, 2014.

[10] Jeon BK, R,Kim YC. A system for detecting the stray of objects within user-defined region using location-based services, International Journal of Software Engineering and Its Applications 7.5 (2013): 355-362.

[11] Eom YH. A Three-Dimensional Geofence System with Context-Awareness [thesis]. KwangWoon(KW): KwangWoon University; 2016. 112p.A Three-Dimensional Geofence System with Context-Awareness