Journal of Engineering and Applied Sciences 13 (5): 1078-1082, 2018
ISSN: 1816-949X

Target Location Alerts System Using IoT

[1]Ki-Young Lee, [1]Kyu-Ho Kim, [2]Jeong-Jin Kang, [3]Sung-Jai Choi,
[4]Gyoo-Seok Choi, [5]Yun-Sik Lim and [6]Gye-Kuk Kim
[1]Department of Medical IT, Eulji University, 13135 Seongnam, Korea
[2]Department of Information and Communication, Dong Seoul University,
13117 Seongnam, Korea
[3]Departmentof Electronic Engineering, Gachon University, 13120 Seongnam, Korea
[4]Department of Computer Science, Chungwoon University, 22100 Incheon, Korea
[5]Department of Electrical Engineering, Yeoju Institute of Technology, 12652 Yeoju, Korea
[6]Department of Information and Communication Engineering,
Gangneung-Wonju National University, 26403 Wonju, Korea

Abstract: With the development of smartphone and communications technologies, markets and IoT technologies combining objects and the internet have rapidly developed. The development of IoT technologies and communications technologies has made it possible to establish ubiquitous environments in which IT devices can be operated in all places during all times. The goal of this study is in the provision of accurate locations of a subject using IoT technologies. Using HM-10 and ESP 8266 Arduino modules, Bluetooth Beacons, ultrasonic sensors and Piezo buzzers, a system that displays the location of a subject easily understandable by users and provides notifications of subject locations was designed and realized.

Key words: Internet of things, Beacon, Arduino, smart phone, communications technologies, IoT

INTRODUCTION

According to statistics from Ericsson there will be an estimated 6.1 billion smartphone users in the world in 2020 (Anonymous, 1996). Considering such increasing numbers of smartphone users, it is expected that the number of users exposed to smartphone-based IoT technologies will also increase. It is also predicted that the IoT industry will witness immense growth. When the IoT industry, undergoing growth today becomes well established, numerous users of its products will emerge. Once the number of its users increases, IoT services will also establish a degree of price stability while becoming increasingly accessible which in turn will result in an environment where people will easily have access to IoT services in their daily lives. The greatest disadvantage of IoT systems associated with cost burdens and the problem of difficulty of access by general users will increasingly become lessened with the passing of time and the expansion of the IoT market.

The target location alerts system using an Arduino module proposed in this study makes use of a relatively low cost Arduino and applies GPS modules, Bluetooth Beacons, Bluetooth communications modules, WiFi communications modules that connect with the Arduino to provide convenience to users by making it possible to find the location of a subject in any place and at any times using an application. The range of subjects considered in this instance includes children, Alzheimer's patients, precious valuables or a variety of other things (Anonymous, 2012, 2015).

Literature review

IoT (Internet of Things): The dictionary definition of IoT is "a spatial network of things where intelligent relationships such as sensing, networking and information processing are formed by mutual cooperation between three distributed environmental elements which are humans, things and service without an explicit human intervention" (Nam, 2014; Jeong-Hwan, 2015; Yang and Koo, 2015). The key technologies required to realize IoT include a sensor technology to collect information in behalf of the five senses of humans, a network infrastructure technology to establish the IoT network and an IoT service interface technology to save, process and convert information.

Arduino: Arduinos are tools to create digital devices applying a variety of interactive objects used to control and detect the physical world and also refer to its

Corresponding Author: Kyu-Ho Kim, Department of Medical IT, Eulji University, 553 Sanseong-daero, Sujeong-gu, Seongnam, Korea

microcontroller board-based open source computing platform and software development environment. A variety of boards to suit various needs exist and a development tool as well as a library regarding several functions are provided. Although, Arduinos have similar physical computing functions as other micro-controller platforms, the Arduino simplifies the work needed to be undertaken during the development of micro-controllers. Compared to other microcontrollers, Arduinos are advantaged in that they have low price points and can be developed using Windows, Mac and Linux operating systems. It also entails a simple and clear programming environment is open source and is easy to use by first-time users.

MATERIALS AND METHODS

Bluetooth Beacon: Bluetooth Beacon presents the HM-10 which is capable of being used as a Bluetooth Beacon based on the Bluetooth 4.0 (BLE) protocol. The module has high accuracy to the extent of being able to make distinctions in units of 5~10 cm. The modules also consumes low levels of power and is thus appropriate for application in IoT systems that always connect to devices. The price range of each unit is in the 20,000 won range and is also small in size which makes it possible for application as a basic unit used to establish IoT infrastructures. The Beacon is also advantaged in that it makes it possible to locate items in indoor environments which was impossible using GPS technology (Lim *et al*., 2009).

GPS (Global Positioning System) module: The navigation equation used to determine the location of a moving object through GPS technology makes use of a geocentric fixed coordinate system. If the distance of an object to a GPS satellite is known, the location of an object falls within the surface of a sphere having the GPS satellite at its center and the distance to the GPS satellite as its radius (Kim and Kang, 2015).

RESULTS AND DISCUSSION

Target location alerts system using Arduino

System design: This study makes use of Arduino boards to develop a subject location notification system that applies Bluetooth Beacons to ascertain distances to a subject, wireless communication (Bluetooth WiFi) to link a subject to an application and a GPS module to acquire the latitude and longitude of a subject. Using the subject location notification system, a system capable of locating a subject on a map and presenting the approximate distance to a subject in a smartphone was proposed. The system design drawings regarding the above were presented in Fig. 1.

The design specifications include a GPS function used to acquire longitudes and latitudes an Arduino module used to provide a distance measurement function to a subject. As for a communications module there is an application module that links to WiFi, Bluetooth and Arduino and displays information regarding the location of the subject. The application control module provides displays on a map based on the longitude and latitudes

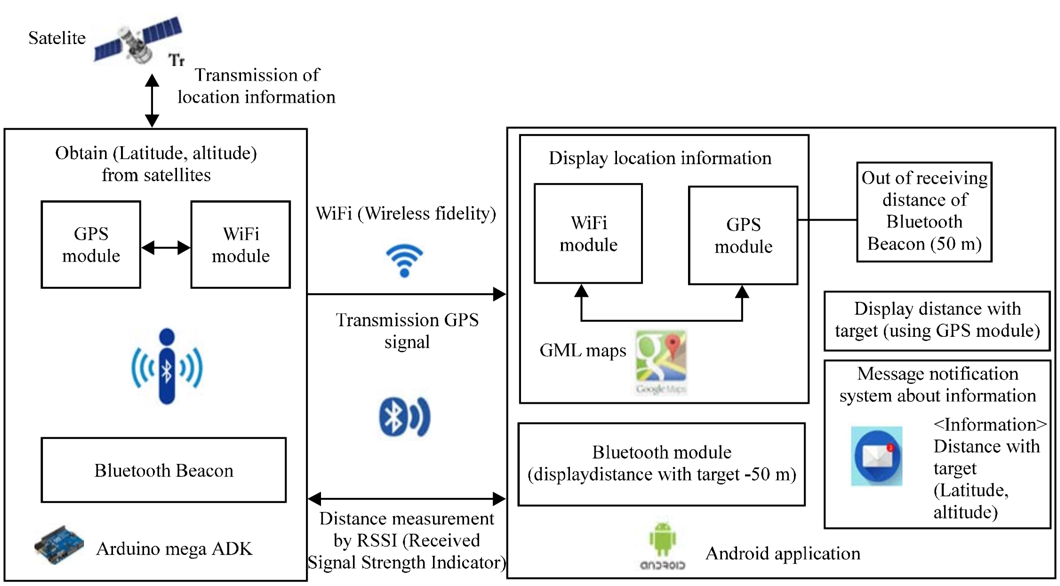

Fig. 1: System architecture

obtained from the Arduino GPS module and also controls the notification function of the LEDs and Piezo buzzers using Bluetooth communication. The location of subjects can be determined more easily through the above. The GPS module is composed of a GPS sensor (GY-NEO6MV2) used to assess the longitude and latitude of a subject and a WiFi communications module that relays longitude and latitude information to an Android device. The distance assessment module is a module that uses RSSI, the signal strength of the Bluetooth Beacon to assess the distance between a subject and an Android device. The application message module entails the function of providing location information to user's family or friends over regular time intervals according to the needs of the user.

System implementation: The system of this study was developed on Microsoft Windows 10, 64 bit. The Android minimum required SDK was set to API 14: Android 4.0 (Ice Cream Sandwich) and the target SDK was set to API 18: Android 4.4.2 (Kit Kat). The algorithm used to control the LED and SOUND of the subject using serial communication through the Bluetooth communications module. The application control module enables the controlling of LED or sound by sending a bifurcated number through an IF function when clicking the toggle button. The toggle button of the application is as follows (Fig. 2).

In the case of the android application beacon distance assessing algorithm. After using Beacon ID and major/minor code to parse the Beacon used to assess distance, the set ranging listener method of the beacon manager library was used to convert the distance to the subject in meter value for display.

Distance measurement algorithm:

```
Shortening
beacon Manager.set Ranging Listener ((region, list)->{
if(!list.isEmpty()){
Beacon Beacon = (Beacon) list.get(0)
Log.d (“Beacon”, “Nearest places”
+Beacon.get Rssi())
tvid.set Text (Double.parse Double (String. format (“%.2f”, get Distence
(Beacon. get Rssi(), -59)))+“m”)
if (get Distence (nearest Beacon.get Rssi (),-59) <= (double) 0.5){
if (turnon)
sendData(“1”)}
})
Shortening
private double get Distance (int rssi, int txPower){
return Math.pow(10d, ((double) txPower-rssi)/(10*2))}
```

Implementation results: The system was operated using an Intel Core (TM) i5-6200U CPU and Android 4.4.2 (Kit Kat) and the results of running the system were presented in Fig. 3-5. Figure 4 presents the main window of the application and the status of the Arduino when pressing the LED toggle button.

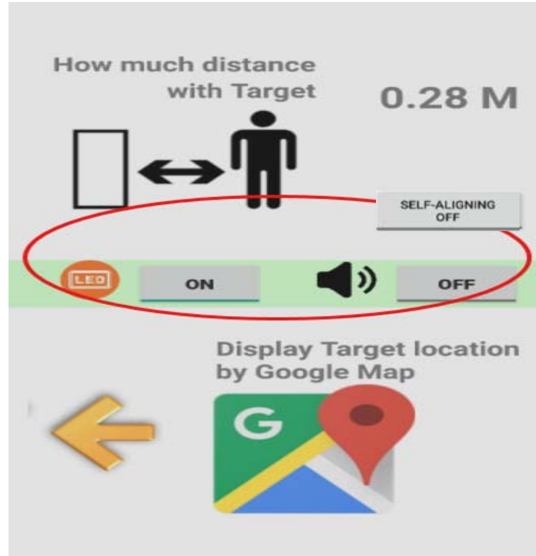

Fig. 2: LED/piezo control toggle button

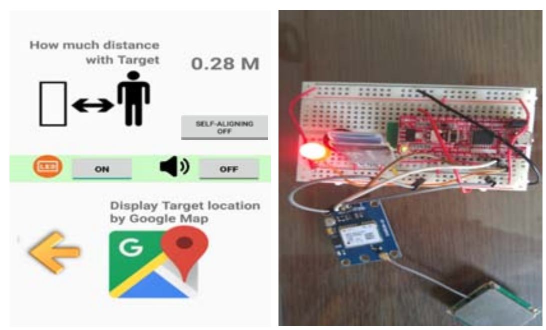

Fig. 3: System implementation results 1

Figure 5 presents the meter value regarding the distance between the subject and user identified by using Tx Power and RSSI, the signal strength of the Bluetooth Beacon (HM-10) in the top right corner of the application.

Figure 6 presents the location of the subject with a blue marker on an Android map using the parsed data (longitude, latitude) which are the GPS sensor and information values of the GPS module.

Performance evaluation: The performance assessment of the automatic inventory management system were presented in Fig. 7 and 8. The performance assessment environment entailed a degree-of-accuracy assessment of the GPS sensor and the accuracy of the beacon distance

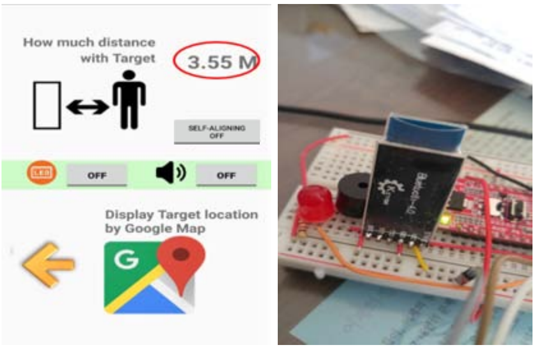

Fig. 4: System implementation results 2

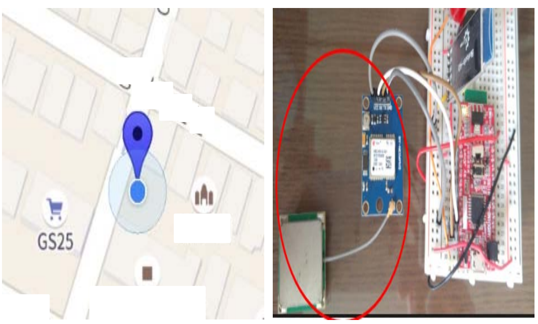

Fig. 5: System implementation results 3

measurements. The results shown in Fig. 7 presents the difference between the measured value of the application module and the actual distance value. The average values found for 50 trials of each distance were presented. Figure 7 indicates the results that due to the measuring of distances using RSSI Beacon signal strengths, it was possible to take relatively accurate distance measurements at close distances to the subject while errors of more than 3~5 m were presented in the distance measurements of subjects beyond 10 m distances.

Figure 6 and 7 presented a limitation of the system in which the measurement of distances between the subject and application user using RSSI signal strengths was appropriate to only within 10 m distances. To resolve this limitation, the researcher of this study applied the longitude and latitude values obtained through parsing from the Arduino GPS module (GY-NEO6MV2) and Android GPS function and displayed the location of the subject using a marker on an Android map fragment and also displayed the location of the users with a marker to enable users to gain an intuitive understanding of the relative positions. Figure 7 shows indicates each of the distances between the subject and Android (20, 30 m) on the map fragment. Figure 8 present the location values in cases of a distance of 20 m from a reference point based

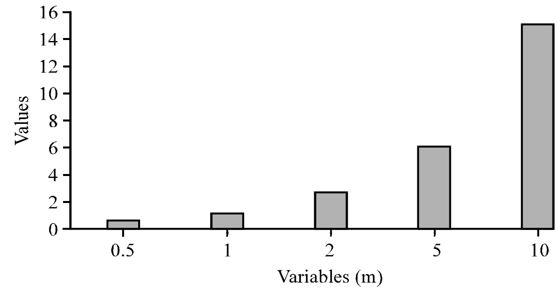

Fig. 6: Target Location Alerts System (TLAS) evaluation result 1

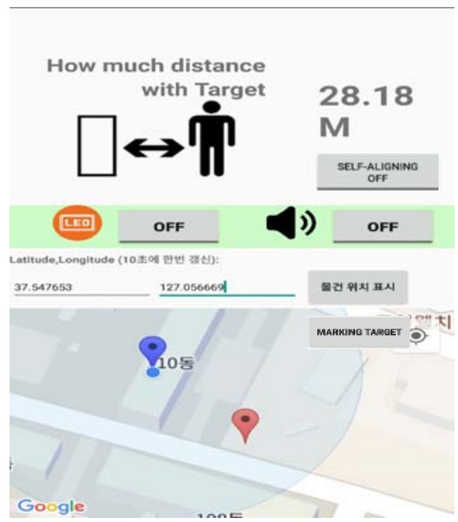

Fig. 7: TLAS evaluation result 2

Fig. 8: TLAS evaluation result 3

on longitudinal and latitudinal coordinates (37.547730, 127.056460) of the Android device, respectively. An examination of the meter value at the top right corner of the application indicates an error of 8.18 m.

However, the distance error between the actual location of the subject (37.547649, 127.056681) and the marker location (37.547653, 127.056669) regarding the GPS module-based marker on the map fragment was found to be 1.53 m. Using the same method, the location value of a subject at a distance of 30 m was presented in Fig. 8. Distance measurements through RSSI indicated a distance measurement of 50.12 m or an error of 20.12 m and was thus considered to be unreliable. In this case as well, the distance error between the actual location of the subject (37.547608, 127.056749) and the marker location on the map fragment (37.547625, 127.056774) was found to be 2.85 m, indicating relatively greater accuracy. The limitations of distance measurements using RSSI were found to be capable of being overcome by presenting the location of subjects using the display of markers based on GPS.

CONCLUSION

This study realized a subject location notification system using LED lights, a Piezo buzzer, Bluetooth Beacons, GPS sensors, WiFi communications modules, Bluetooth communications modules and Arduino boards. Using Arduinos and Bluetooth Beacons, a subject location notification system was proposed in which the system was designed and realized to make it easy to locate children or valuable items. It was found that it would be easy to find an object by applying the system to valuables or subjects that can be easily lost. Although, currently, distances of this system are measured using Bluetooth Beacons, a means of supplementing the limitations of Beacon distance measurements is planned for further study.

REFERENCES

Anonymous, 1996. [Report of missing children]. Statistics Korea, Korea. (In Korean) http://www.index.go.kr/potal/main/EachDtlPageDetail.do?idx_cd=1610.

Anonymous, 2012. [Dementia elderly over 65 years steeply surging]. Naver, Seongnam, South Korea. (In Korean) http://m.news.naver. com/read.nhn?mode=LSD&mid=sec&sid1=102&oid=021&aid=0002100620.

Anonymous, 2015. Ericsson mobility report: On the pulse of the networked society. Ericsson, Stockholm, Sweden. https: //www. ericsson.com/assets/local/mobility-report/ documents/2015/ericsson-mobility-report-june-2015.pdf.

Jeong-Hwan, K., 2015. Design and implementation of Bluetooth 4.0-based indoor location-based service system. Master's Thesis, Kangwon National University, Chuncheon, South Korea.

Kim, J. and N. Kang, 2015. Secure configuration scheme of pre-shared key for lightweight devices in internet of things. J. Inst. Internet Broadcast. Commun., 15: 1-6.

Lim, S.I., S.B. Nam and H.J. Lim, 2009. Design of the crane position control system using GPS and USN. J. Korea Acad. Ind. cooperation Soc., 10: 1520-1525.

Nam, K.H., 2014. A study on the office management service platform based on M2M/IoT. J. Korea Inst. Electron. Commun. Sci., 9: 1405-1414.

Yang, K.S. and K.W. Koo, 2015. A study for the design of a mobile medical care system M-LIMS. Intl. J. Internet Broadcast. Commun., 7: 84-89.