Hindawi Publishing Corporation
Advances in Electronics
Volume 2015, Article ID 140762, 8 pages
http://dx.doi.org/10.1155/2015/140762

Research Article

Design and Implementation of Android Based Wearable Smart Locator Band for People with Autism, Dementia, and Alzheimer

Isha Goel[1] and Dilip Kumar[2]

[1] *Department of Academic and Consultancy Services Division, C-DAC, Mohali 160071, India*
[2] *SLIET, Longowal, Sangrur 148106, India*

Correspondence should be addressed to Isha Goel; er.ishagoel@yahoo.com

Received 7 August 2014; Revised 1 December 2014; Accepted 9 December 2014

Academic Editor: Gianluca Traversi

A wearable smart locator band is an electronic device which can be worn on the wrist of the children to monitor and keep an eye on them. As the number of mishaps with children is increasing, it is a must to keep them safe. This also helps reducing crime rates. The research study proposed the development of a wearable smart locator band that helps keeping track of kids. The developed device includes an AVR microcontroller (ATmega8515), global positioning system (GPS), global system for mobile (GSM), and switching unit and the monitoring unit includes Android mobile device in parent's hand with web based Android application as well as location indicated on a Google Map. This development is very useful for senior people and individuals suffering from memory diseases. This device, hence, behaves as a communication interface between wearer and caregiver.

1. Introduction

Safety concern is a major issue these days. Incidents of kidnapping, child abuse, lost persons, and misbehaviour with children, adults, and aged people are increasing day by day. The wearable smart locator helps to maintain an eye on our beloved ones [1]. It has been found that 30 million individuals in the world are suffering from autism (nervous breakdown), dementia (short term and long term memory loss), and Alzheimer (loss of brain function). Then, wearing this device helps locating these diseased individuals in emergency conditions by pressing emergency buttons. It will set off an automatic location beacon of the wearer through message and will ring the emergency contacts [2, 3].

Even this device includes a virtual radius which can be set around a destination by which a notification will be sent to a caregiver's number whenever their wearer enters into or leaves it and an LED glows as an indication in the device [4, 5]. This device is a continuous monitoring embedded application of wearer's location, whether still or moving, and reports the status of that location to caregiver's mobile. The caregiver can even talk to the wearer with a two-way calling facility, including audio channel in GSM with microphone and speaker which help in calling.

It is worn by wearer all the time and does not require the person to operate this device in any way except in case of emergency. This focuses on better security and safety of persons by improving the feasibility and reliability of available locating devices which face obstacles in communication and adapting or cognitive performance as well as emphasizing the relative merits and limitations of existing technologies. To boot, it seeks to gain an enhanced understanding of the complex realities related to the carrying out of locating technology.

2. Literature Survey

In the past years, various tracking/monitoring systems had been designed and these systems are generally implemented in the form of children or vehicle tracking systems.

Mammone in 2005 caves in a method for nearby people in a crisis situation with rapid soliciting. This invention allows a parent to alert other people who are present in a fixed radius

[3]. In 2007, Kennedy designed an alert notification which is text messaging based on the Amber Alert system which helped in child kidnapping [4].

In the year 2005 King and Yancey had given an attack warning for vehicle and location scheme. Emergency vehicles will get to a destination by travelling quickly and safely and are indicated along the map with an icon with different visual characteristics with respect to the position of the vehicle [5].

Then Curran et al. proposed a method in 2012 for defining the devices entering into a 2D geographic zone area with a user alert [6]. Pankaj and Bhatia in the year 2013 also have given their thought to implement GPS/GSM based vehicle tracking system and track the vehicle on Google Map and also provide the shortest route to reach vehicle easily in minimal time [7].

As these tracking systems are utilized for tracking children or vehicles, this sort of technique is likewise employed for people who are suffering from diseases like autism, dementia, and Alzheimer and elderly individuals.

3. Device Architecture

3.1. Description of Transmission Unit (Figure 1)

3.1.1. AVR (ATmega8515). The ATmega8515 belongs to AVR (enhanced RISC architecture) family which is a low power (7.5 mW), high performance device as it works at crystal frequency of 4 MHz and executes powerful instructions in a single clock cycle (it achieves throughputs approaching 1MIPS per MHz) and In-System Self-Programmable Flash 8-bit microcontroller. It has 512-byte SRAM and 512-byte EEPROM internal memories. It is as well recognized as the centre of this system. It mostly works as an interface between a GPS receiver and GSM module. It has a feature of three power saving modes: idle, power-down, and standby. This microcontroller initiates and sends the wearer's information, message, and voice calling details to mobile phone through the GSM chip.

3.1.2. GPS Technology. The GPS is based on a global navigation satellite system to determine speed, position, direction, and time. It utilizes a constellation of 24/32 active satellites in Earth orbit that transmit an accurate microwave signal and enable GPS receiver. A GPS receiver needs at least three or four satellites to calculate the distance as shown in Figure 2 and figure out its two dimensions, that is, latitude and longitude, or three dimensions, that is, latitude, longitude, and altitude positions [8, 9].

3.1.3. GSM Technology. The GSM modem which acts as a mobile phone accepts any GSM network operator SIM card with its own unique phone number. This SIM900A GSM modem can communicate and develop embedded application of SMS based remote control, for example, to send/receive SMS and make/receive voice calls [10].

It can also be used for data logging application which connects to internet with GPRS mode. It is dual band 850/1900 MHz which makes it a flexible plug and makes it suitable for long distance data transmission. Its international roaming capability is an advantage, with improved battery life and data up to 9600 bps baud rate.

3.2. Monitoring Unit. The monitoring unit illustrated in Figure 3 includes an Android GSM mobile with an internet plan and a web based Android application supporting it. The GSM mobile will receive an SMS which includes the automatic location beacon of the wearer (longitude and latitude) and another SMS which includes the virtual radius entering and leaving information [11, 12].

By opening that SMS it will directly connect to the Android application within a second and open the Google Map with a pointer pointing towards the coordinates which is the exact current location of the wearer.

4. Hardware Description

This hardware design is used to locate the wearer and help him in case of need with the help of pushbuttons S1, S2, S3, and S4 that even has two-way calling facility by using GPS and GSM which are serially interfaced with ATmega8515 controller for continuous monitoring and message sending from the device.

4.1. Switching Unit. As shown in Figure 4, it consists of four switches which are used by device, that is, smart locator band for calling and sending SMS. Four different operations are performed by each switch as follows:

S1: for calling the two emergency numbers one after the other,

S2: for disconnecting the call,

S3: for answering the incoming call,

S4: for sending SMS of location to both emergency numbers.

4.2. GPS Module. Figure 5 illustrates GPS module which works on 3.3 V supply. It continuously senses the current position of the wearer and sends it automatically to the microcontroller. GPS parameter and specifications are shown in Table 1.

4.3. GSM Module. In Figure 6 GSM module is used for communication, that is, two-way calling that includes dialling, receiving call with the help of microphone and speaker, and sending SMS which contains the current location of the wearer and virtual radius entering and leaving information. GSM parameter and specifications are shown in Table 2.

4.4. Battery. When using a combination of GPS with GSM technology, approximately 100 mAh is required. Taking these factors into consideration the rechargeable batteries with the capacity of 7.2 V and 2200 mAh or 4.2 V and 1900 mAh (three in the series) among which one can be used. On an average it can provide a backup of 22 hours a day and it can last up to 2-3 days depending on usage.

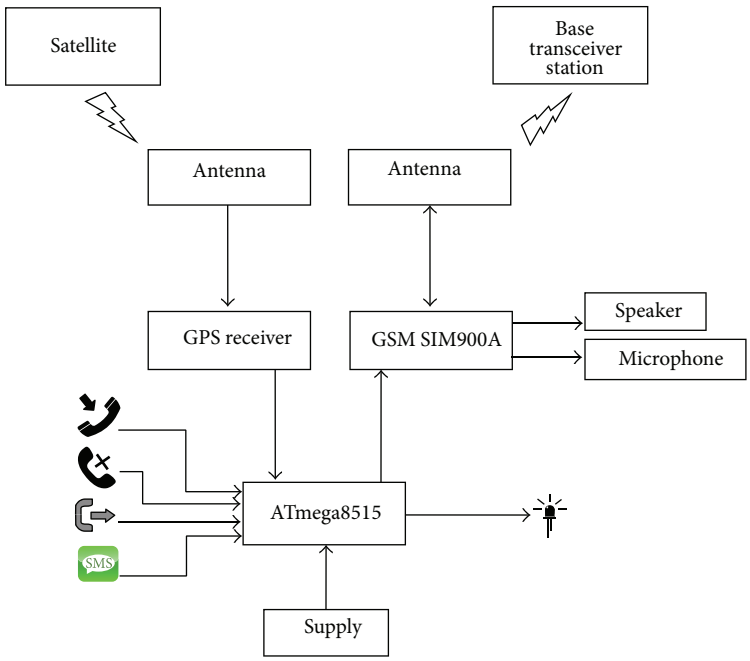

Figure 1: Architecture of transmitting unit.

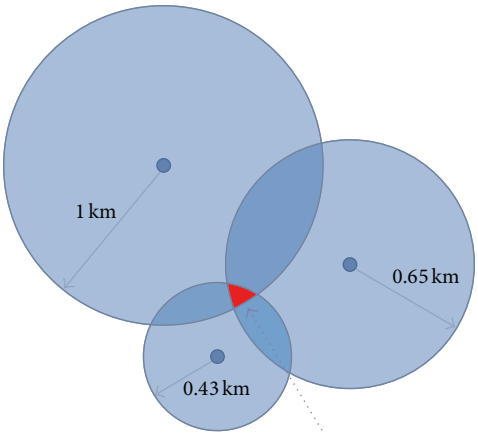

Figure 2: GPS signal working.

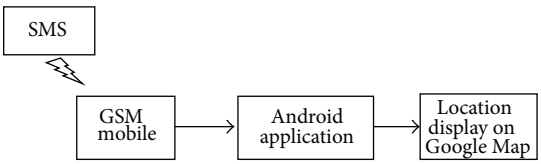

Figure 3: Monitoring unit architecture.

Figure 4: Prototype model of device.

Figure 5: GPS module.

Figure 6: GSM module.

5. Software Description

5.1. MicroC Pro for AVR. This software is primarily utilized to activate AVR (ATmega8515) microcontroller according to the input received by it. "Embedded C" code is written using this programming tool. In this project, coding is written for GPS, GSM, and switching unit which is interfaced with

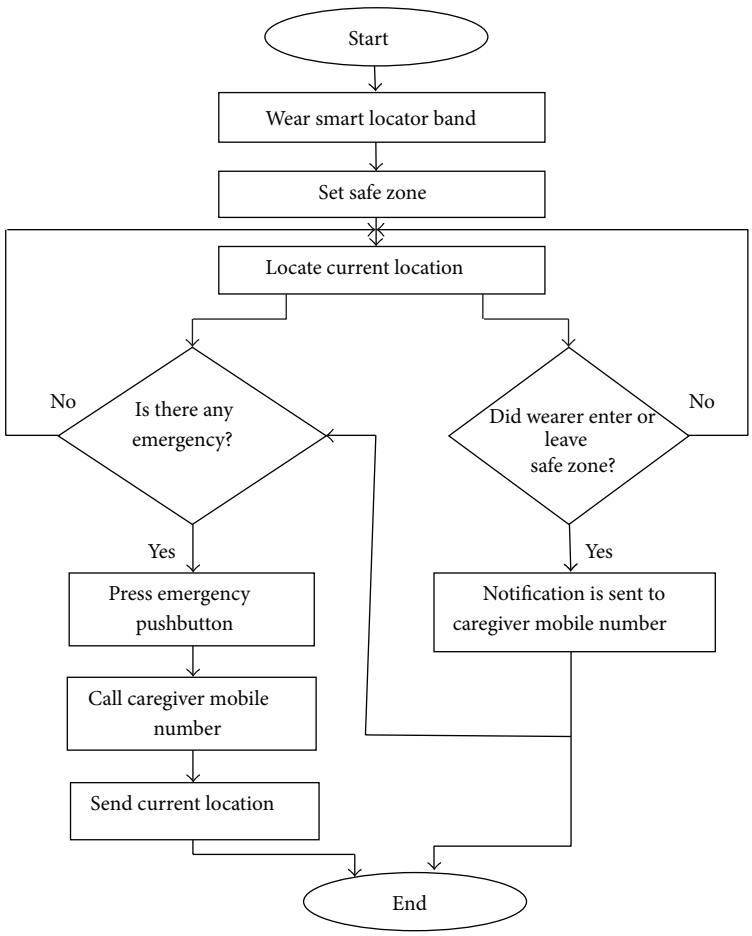

Figure 7: Flowchart of the device.

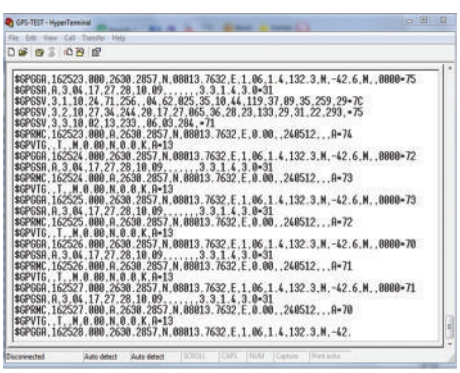

Figure 8: GPS output.

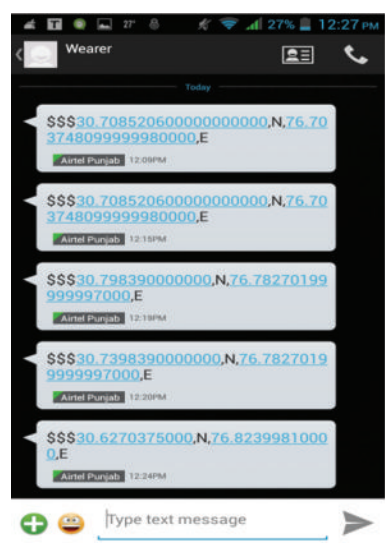

Figure 9: SMS received on smartphone.

AVR microcontroller at the transmitter end. As per the code embedded in the controller, the interfaced modules generate appropriate output at the receiving terminal.

5.2. ECLIPSE (LUNA 4.2). Application in Android mobile device is created using ECLIPSE software. It is elastic and provides compatibility to create novel applications in Android mobile devices. The Java language is preferred as the basic platform for application creation. In this project, an application named "SMS Receiver" is created using ECLIPSE which enables the caregiver at receiving end to visually see

Figure 10: Pointer in GMAP.

the place on Google Map corresponding to the position of the wearer at the transmitting end [12, 13].

5.3. Design Methodology. Figure 7 describes the flowchart/design methodology steps as follows.

(i) The wearer will wear the smart locator band.

(ii) Then, a safe zone is defined or set by the caregiver for safety of wearer.

(iii) The device will continuously monitor the latest location of the wearer, generate an SMS alert, and give birth to the possibility of two conditions:

(a) whether the wearer enters or leaves the secure zone;

(b) whether there is an emergency situation or not.

(iv) When the wearer crosses the safe zone, then SMS notification will be sent; otherwise it will not be sent.

(v) When an emergency situation is noticed then wearer presses emergency button S1 for calling and S4 for sending location via SMS.

6. Result and Discussion

6.1. GPS Output. As shown in Figure 8 the controller filters and selects the incoming one packet, that is, $GPRMC from continuous six packets of GPS data, and extracts the current location of the wearer by forwarding only the latitude and longitude values to GSM.

It has been found that the shadowing and multipath effect due to tall buildings in urban canyons or even indoors like public malls cause difficulty in detecting the position of the wearer. To overcome this problem an alternative approach is evaluated which uses the internal memory, that is, SRAM of the Atmega8515 microcontroller, to keep the code data and EEPROM is used to save last valid position data (up to 20 values) in the device itself. Therefore, when the GPS gives the invalid location of the wearer in the process of continuous position sensation, then the last saved location in EEPROM is automatically sent by the device on the caregiver side so that approximate location of the wearer can be identified.

Table 1: GPS parameter and specifications.

GPS module	Chipset	SKYLAB SKG13C
	Receiver type	22 tracking/66 acquisition channels
	Sensitivity	Ultrahigh, −165 dBm
	Protocol type	NMEA-0813
	Operating temperature range	−40 to +85°C
	Power consumption	Lower, 45 mA @ 3.3 V
	Operating voltage	Typical 3.0 V to 4.2 V
	Command statements	$GPGSA, $GPGLL, $GPGGA, $GPGSV, $GPZDA, $GPVTG, $GPRMC
	Dimensions	15 × 13 × 2.7 mm

Table 2: GSM parameter and specification.

GSM module	Frequency band	850/1900 MHz dual band
	Baud rate	9600 bps
	Transmission power	2 W @ 850 MHz 1 W @ 1900 MHz
	Power supply	3.2 to 4.8 V.
	Operating temperature	Restricted operation: −40 to −30°C and +80 to +85°C Normal operation: −30 to +80°C Storage temperature: −45 to +90°C
	Dimensions	24 × 24 × 3 mm

6.2. SMS Receiver Application Installed on Android Phone. The Android application which is web based named as "SMS Receiver" represents the complete output of the device created in caregiver's Android mobile, which is opened directly when received SMS is opened with the working Internet pack. This application then points towards the exact location on Google Map retrieved by the latest Lat., Long. values sent by GSM modem [14, 15].

Characteristics of SMS receiver application are as follows.

(i) It is activated on special message received by the device with $$$ unique starting keyword.

(ii) It will extract the location from the message.

(iii) It displays current location of the wearer.

(iv) SMS receiver uses Internet connection and automatically searches the location on Google Map and points to it with a cursor.

(v) It is easy to understand and is user friendly.

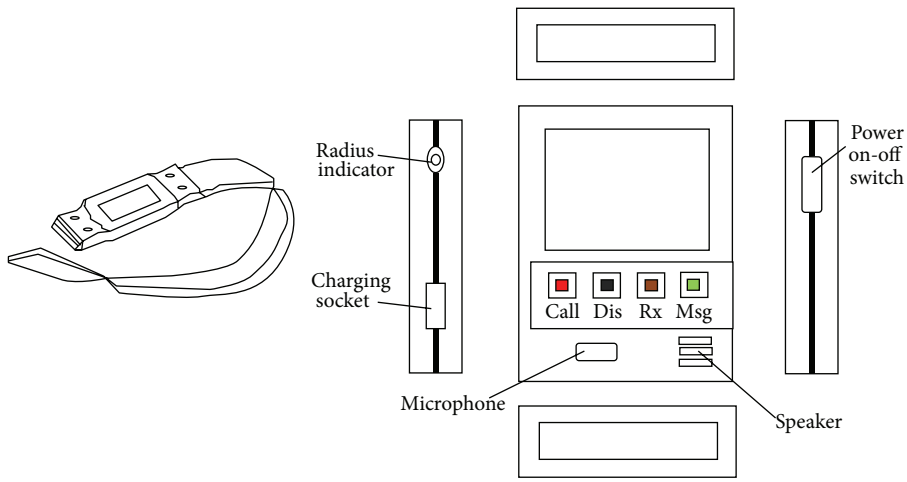

Figure 11: 3D view of smart locator wrist band.

Table 3: Testing of developed prototype on different subjects at different locations.

Subjects with diseases	Location coordinates	Coordinates on Google	Name of the location	Error (in meter)
1	30.7021052, 76.850094	30.7021049, 76.80091	Industrial area phase-1 Chandigarh (India)	2
2	30.71447700, 76.7148930	30.71447800, 76.7148927	Phase-5 Mohali (India)	0
3	30.719425700, 76.781259600	30.719325700, 76.781259600	Sector-20 Chandigarh (India)	7
4	30.739833900, 76.783207999	30.739833900, 76.782707999	Sector-17 Chandigarh (India)	3
5	30.708171000, 76.718559000	30.708191000, 76.718559000	Phase-3B-2 Mohali (India)	2
6	30.681173000, 76.746737800	30.681073000, 76.746637800	Phase-11 Mohali (India)	13
7	30.707679600, 76.747769780	30.707669600, 76.747669780	Sector-44 Chandigarh (India)	5
8	30.707679600, 76.752279400	30.707669600, 76.752179400	Sector-45 Chandigarh (India)	8
9	30.70544444, 76.709112222	30.70541350, 76.709119999	Sector-71 Chandigarh (India)	3
10	30.712486500, 76.73656500	30.712487300, 76.73659800	Sector-52 Chandigarh (India)	3

6.3. Received SMS Containing Latitude-Longitude on Smartphone. When switch S4 is pressed by the wearer, GPS module of the system senses the position of the wearer with longitude-latitude and this value is sent by using the GSM module to the caregiver's mobile. Figure 9 shows that the message is received on caregiver's smartphone.

6.4. Location Indication with Pointer on GMAP. Figure 10 shows that when SMS is received, the SMS receiver application directly opens and the longitude-latitude values received in SMS are located by the pointer which are showing the current location (position) of the wearer whenever there is an emergency message on caregiver's Android smartphone, that is, at receiving end, and the output of GMAP is obtained with the help of Android application [16].

6.5. Testing of Device on Different Subjects. The complete prototype developed was tested on different subjects at different locations. When subject (suffering from autism or dementia or Alzheimer) enters or leaves the zone defined or call is done or received by the GSM modem it sends the coordinates received by the GPS module to user in SMS (short message services) form. So, the accuracy of device is nearly perfect. Table 3 describes the testing of the prototype.

6.6. Ergonomic Study of Wrist Shape. For designing the wrist band for wearer the following ergonomic design steps need to be followed.

(1) The size of the wrist strap must be equal to the circumference of the wrist of the wearer and is calculated by taking measurements of different subjects (at least 10), and an average value is calculated which can be adjusted according to wearers need.

(2) The device placed on the wrist is in rectangular shape and its dimensions need not be greater than wrist of the wearer.

(3) Four different colour switches are placed on the top of the device for call, disconnect, receive, and message.

(4) A microphone and a speaker are also available on the front panel for the wearer communication.

(5) A radius indicator, on-off switch, and the charging socket are provided on the sides of the device.

Table 4: Comparison of work with existing devices.

Parameters/devices	Amber Alert GPS	Pocket finder	Spark nano	Live view GPS	E zoom	Zoom bak	Itrack 2.0	5 Star	Mei track	Itrack GPS tracker	Smart locator band
Volume (inches^3)	2.8 × 1.5 × 0.8	2.25 × 1.62 × 0.62	2.66 × 1.57 × 0.83	3.5 × 2.09 × 0.75	2.76 × 1.73 × 0.85	2.87 × 1.69 × 0.82	2.2 × 1.4 × 0.4	2.9 × 1.7 × 0.7	2.29 × 1.5 × 0.7	3 × 2 × 0.5	3 × 3 × 1
Weight (grams)	61.5	40	100	113	85.0	70.8	297.7	51.0	65.2	48.2	70
Battery life (hours)	40	50	336	96	72	72	1440	96	24	144	72
Battery (rechargeable)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Water (resistant/proof) protection	Res	Proof	Res	Res	Proof	Res	Res	Res	Proof	Res	Proof
Panic button	Y	N	Y	N	Y	N	Y	Y	Y	Y	Y
Two-way calling	Y	N	N	N	N	N	Y	Y	Y	N	Y
Zone alert	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
Text notification	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
Emergency contacts	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Tracking history	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
Web based user interface	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Android application	Y	Y	N	Y	Y	Y	N	Y	Y	N	Y
Status indication	Y	Y	Y	Y	Y	N	N	N	N	N	Y
Device price (Rupees)	7620	7920	9110	12130	6100	4880	12190	3050	5490	7870	2900
Activation charges (Rupees)	1220	Free	Free	1220	1830	920	—	2140	—	—	Free
Monthly price (Rupees)	920	790	1830	2440	1220	1220	—	920	—	—	Free
Contract length (yearly/monthly)	Y	M	M	M	Y	Y	—	M	—	—	Life time

Figure 11 represents the proposed ergonomic design of a smart locator band including the front, back, and side views of the device. All the above-mentioned ergonomic design steps are considered while designing this band. This designed band is adjustable in size and it can be locked so the wearer who may not agree to wear it, he himself cannot remove it easily.

6.7. Comparison with the Existing Devices. A comparison work is also made between the existing devices and the developed prototype system. This is performed on the basis of different required parameters as described in Table 4.

The indigenous developed prototype can overcome the several limitations of imported commercial devices; that is, some device manufacturer charges extra monthly rental for using their online application services to access the GPS location, there is some activation charges to activate the device, with a less license validity period for using their device (for one month or a few months not for a lifetime). Even the existing devices do not include a panic button (that can be used in case of emergency), some of these devices are water resistant but not waterproof and they do not include two-way calling facility in the device for the wearer to stay in contact with the caregiver in case of need.

The novelty of this device is that it overcomes all the limitations of the existing commercial devices with an additional low cost product developed. After all, the developed device main advantage is that for accessing a location in existing devices the caregivers will have to open the application and access the wearer location themselves, but in this device an Android based application is also developed, which automatically opens the location of the wearer on Google Map within the fraction of seconds when it receives the message containing latitude and longitude and the caregivers have no need to open it manually like in other existing devices.

7. Conclusion and Future Scope

Operational and testing results of prototype system indicate that the system worked efficiently. If this device is fabricated into a wrist band, no one would be able to evaluate whether it is a safety locator band or a wrist band/watch.

This work is of low cost, very effective, and productive. But there is always room for improvement. This merchandise has been designed as a prototype and requires further developments for using it in assorted applications. This system can be further expended in developing a Windows application which can support windows phone and the wearer device must be small and unobtrusive in the form of compact watch and it should not label people.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

References

[1] C. Yamagata, J. F. Coppola, M. Kowtko, and S. Joyce, "Mobile app development and usability research to help dementia and Alzheimer patients," in *Proceedings of the 9th Annual Conference on Long Island Systems, Applications and Technology (LISAT '13)*, pp. 1–6, Farmingdale, NY, USA, May 2013.

[2] M. Randolph-Gips, "Autism: a systems biology disease," in *Proceedings of the 1st IEEE International Conference on Healthcare Informatics, Imaging and Systems Biology (HISB '11)*, pp. 359–366, San Jose, Calif, USA, July 2011.

[3] R. Mammone, "Child locator apparatus and method," U.S. Patent Application 10/689,216, 2003.

[4] P. J. Kennedy, "Mobile phone Amber alert notification system and method," U.S. Patent No. 7,228,121, 2007.

[5] B. King and D. A. Yancey, "GPS-based vehicle warning and location system and method," U.S. Patent No. 6,895,332, May 2005.

[6] D. Curran, J. Demmel, and R. A. Fanshier, "Geo-fence with minimal false alarms," U.S. Patent no. 8,125,332, February 2012.

[7] V. Pankaj and J. S. Bhatia, "Design and development of GPS-GSM based tracking system with Google map based monitoring," *International Journal of Computer Science, Engineering and Applications*, vol. 3, no. 3, 2013.

[8] P. Wang, Z. Zhao, C. Xu, Z. Wu, and Y. Luo, "Design and implementation of the Low-Power Tracking System based on GPS-GPRS Module," in *Proceedings of the 5th IEEE Conference on Industrial Electronics and Applications (ICIEA '10)*, pp. 207–210, June 2010.

[9] M. Kunal, S. Mandeep, and J. Neelu, "Real time vehicle tracking system using GSM and GPS technology—an anti-theft tracking System," *International Journal of Electronics and Computer Science Engineering*, vol. 1, no. 3, 2012.

[10] M. A. Al-Khedher, "Hybrid GPS-GSM localization of automobile tracking system," *International Journal of Computer Science and Information Technology*, vol. 3, no. 6, pp. 75–85, 2011.

[11] P. B. Fleischer, A. Y. Nelson, R. A. Sowah, and A. Bremang, "Design and development of GPS/GSM based vehicle tracking and alert system for commercial inter-city buses," in *Proceedings of the IEEE 4th International Conference on Adaptive Science and Technology (ICAST '12)*, pp. 1–6, IEEE, October 2012.

[12] J.-H. Liu, J. Chen, Y.-L. Wu, and P.-L. Wang, "AASMP-Android Application Server for Mobile Platforms," in *Proceedings of the IEEE 16th International Conference on Computational Science and Engineering (CSE '13)*, pp. 643–650, 2013.

[13] J. Saranya and J. Selvakumar, "Implementation of children tracking system on android mobile terminals," in *Proceedings of the International Conference on Communications and Signal Processing (ICCSP '13)*, pp. 961–965, April 2013.

[14] N. Chadil, A. Russameesawang, and P. Keeratiwintakorn, "Real-time tracking management system using GPS, GPRS and Google Earth," in *Proceedings of the 5th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON '08)*, vol. 1, pp. 393–396, Krabi, Thailand, May 2008.

[15] Y. A. N. G. Mei, "Application design and implementation of GPS-GPRS location system vehicle terminals," *Telecommunication Engineering*, vol. 3, article 024, 2004.

[16] L. Rui, Z. Minjian, L. Wenhu, and H. Tao, "Designed and implementation of the positioning and tracking system based on GSM SMS module," *Journal of Electronic Measurement and Instrument*, no. z1, pp. 283–286, 2008.