Journal of Ubiquitous Computing and Communication Technologies (ISSN: 2582-337X)
www.irojournals.com/jucct/

Child Safety Monitoring and Notification Gadget in Smart Town/City using IoT

Vasantha Kumar S.[1], Chandhini S.[2], Kowshika S.[3], Monisha Priya K.[4], Silambarasan A.[5], Vasanthi M.[6]

[1,2,3,4]UG Students, Department of ECE, Knowledge Institute of Technology, Salem, Tamilnadu, India.

[5,6]Assistant Professor, Department of ECE, Knowledge Institute of Technology, Salem, Tamilnadu, India

E-mail: [1]svasanthakumar333@gmail.com, [2]chandhiniece@gmail.com, [3]kowshisankar15@gmail.com, [4]monishamalathi2@gmail.com, [5]simbhuece@gmail.com, [6]vasanthiece@gmail.com

Abstract

This study suggests a brand-new child safety device for smart cities that uses the Internet-of-Things (IoT) to give parents real-time monitoring and alerts about the child. With the use of a variety of sensors, including a temperature sensor to monitor ambient conditions, a touch sensor to detect simple presses or contact on the device's surface, a heartbeat sensor to measure fundamental health, and GPS for location tracking, this device is able to collect vital data about the child's well-being. Parents can view their child's data remotely. The microcontroller unit processes the data and sends it to a specified server. To notify parents of possible risks, such as exceeding a set temperature threshold, detecting a fall, or the child wandering beyond approved safe zones, a notification system is put in place. The device can also have a buzzer installed for instant local alerts in an emergency. Using the user-friendly Firebase software, parents can track their child's whereabouts continuously with the device's GPS module. This all-inclusive strategy improves child safety within the smart city infrastructure by giving parents peace of mind and enabling prompt action when needed. This device aligns with the expanding trend of smart city development, which uses technology to enhance the safety and well-being of its residents. Through its smooth integration with current

DOI: https://doi.org/10.36548/jucct.2024.2.009
Received: 02.05.2024, received in revised form: 24.05.2024, accepted: 08.06.2024, published: 20.06.2024

IoT networks and infrastructure, this solution provides a useful and efficient way to protect kids in cities.

Keywords: Child monitoring system, IoT (Internet of Things), Real-time tracking, Special need children, Smart solution, Smartphone application, Security monitoring, Safety device, GPS tracking.

1. Introduction

India is a multicultural nation with a substantial child population, so it is imperative to safeguard their welfare. In 2021, more than 77,000 children vanished in India, marking a sharp increase from the previous year. With the growing concern in today's society about the safety of young children in crowded environments, this wearable device was created. In several of these cases, there was a close relationship between child labor and human trafficking.

The notion of a smart city evokes visions of technological innovations that augment productivity and elevate the standard of living for its inhabitants. But even with all of the new technology and infrastructure, one vital issue still comes first: children's safety. Ensuring children's well-being becomes a priority as cities become more urbanized and as they become more independent in navigating their surroundings. Using Internet-of-Things (IoT) technology, this project offers a fresh approach: a child safety monitoring and alerting device made especially for smart cities. This cutting-edge tool attempts to close the mental gap between a parent's need for peace of mind and their child's growing independence.

Since child safety is of utmost importance, the research focuses on enhancing safety measures to protect children using the Internet of Things (IoT) and sensors. The developed user interface allows parents to track their children’s in real-time location through the GPS module, utilizing the intuitive Firebase platform.

This comprehensive approach enhances child safety in smart city settings, offering parents peace of mind and enabling swift responses to potential risks. By integrating seamlessly with existing IoT networks and infrastructure, this solution effectively contributes

to the protection of children in urban environments, aligning with the broader trend of smart city development aimed at improving resident safety and well-being.

2. Related Works

Parents can monitor their child's school arrival and departure times using this device. In case of an emergency, pressing the alarm button triggers a message to nearby hospitals and police stations [1]. The Internet of Things (IoT) system integrates physical sensors and actuators with the internet, maintaining continuous connectivity [2]. Smartphones are increasingly utilized for environmental sensing. This proposed study utilizes the UNO microcontroller board, based on the ATmega328P, which includes a GSM shield enabling GSM network functionalities [4] such as sending and receiving SMS messages, making calls, and connecting to the internet. Similarly, wireless sensor networks [5] monitor weather conditions, flood barriers, tides, and other environmental factors.

This study describes a design and implementation approach for a GPRS (General Packet Radio Service) [6] network-based embedded Linux remote video monitoring system. Once connected to the terminal, the monitoring center receives and displays image data. Utilizing this system on a Windows machine is simpler. After JPEG compression, image data can be sent to the monitoring center in three to six seconds. Most wearables on the market today use Bluetooth and Wi-Fi to inform parents about their child's whereabouts and activities. [7]. However, Bluetooth and Wi-Fi seem to be incredibly unreliable sources for information transfer. Consequently, SMS is meant to be the primary means for interaction between the parent's wearable device and the child's as it is less likely to malfunction than Wi-Fi or Bluetooth.

Smart cars, wearable technology, human implanted devices, home automation systems, lighting controls, and more are all included in the Internet-of-Things (IoT) [8]. The wearable device was inspired by the growing concern for young children's safety [9] in today's world, where there is a risk of them getting lost in busy, large areas. This research focuses on the important idea that people nearby can assist a lost child and ensure their safety until they are reunited with their parents. Obstacle sensors [10] that identify when a child enters a dangerous area or approaches a potentially harmful object will sound an alarm or send a notification to the caregiver through their mobile device. The Internet of Things is made up

of two main components: the server-side architecture that supports the devices and the devices themselves [11].

If a parent sends an SMS to the wearable gadget, the wearable's SOS light feature will be activated, allowing them to find their lost kid. The widely recognized SOS signal alerts everyone nearby that the child is in trouble and needs assistance. This project attaches a sensor to a child's belt to monitor the child's activity [15]. Parents receive notifications each time their child boards the bus from their homes, and they may use specially designed software to locate the youngster using GPS. The primary purpose of this system is to monitor children remotely. The wearable device also has a distress alert buzzer that can be activated by texting the wearable the term "BUZZ" via SMS [13]. The loud buzzer is audible from a great distance, and the child's precise coordinates can be sent to the parents via SMS, enabling them to find the child with extreme precision.

Other comparable wearables include the Sproutling, iSwingband, and Mimo, each of which has several shortcomings. The proposed wearable gadget, however, will communicate with the parent via SMS, ensuring a reliable communication channel. Through microcontroller reprogramming, the wearable can be further customized to meet specific needs. Examples of previous research in this field include the low-cost, lightweight Wristband Vital, which detects and reports dangerous environments for elderly and children in need of emergency care. The primary flaw of the vital bands [17] is that it uses Bluetooth connectivity to facilitate communication between parents and children. Because of this, there may be situations in which there is a significant distance between the two, making it impossible for Bluetooth to create a close relationship.

3. Proposed Design and Architecture

The architectural and design approaches used in the creation of the Child Safety wearable gadget is covered in this part. Figure.1 shows the proposed block diagram.

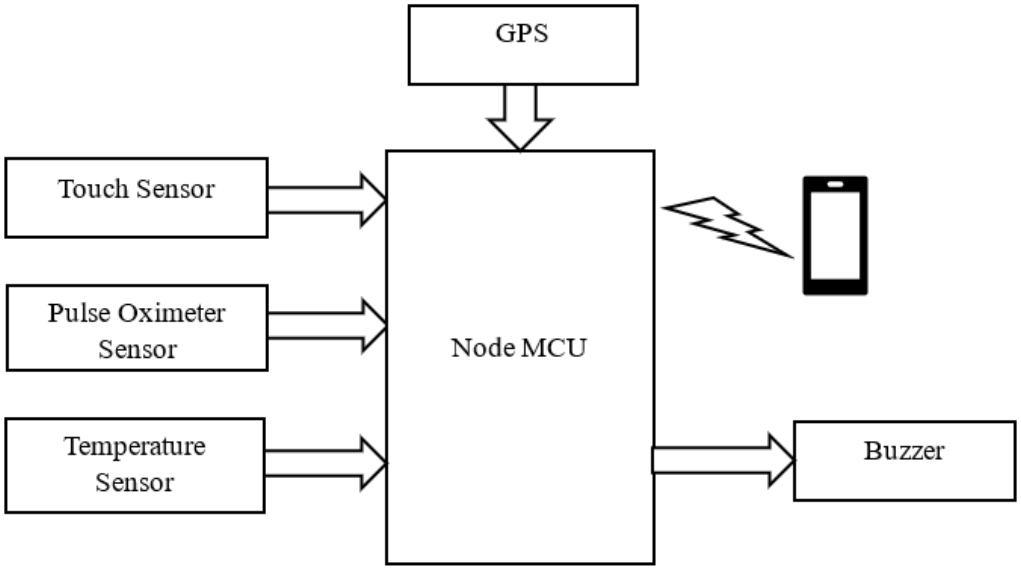

Figure 1. Block Diagram

3.1 Overview

This research proposes the development of a comprehensive child safety monitoring system using a NodeMCU Microcontroller and the Internet of Things (IoT). Designed to provide maximum peace of mind, this wearable gadget offers continuous surveillance and monitors vital signs. At the heart of the system is a Microcontroller that processes data from multiple sensors. The heart rate sensor monitors the child's health and can detect signs of stress or fatigue. Additionally, a GPS module enables real-time monitoring of the child's location, providing alerts through an intuitive IoT platform. Furthermore, a temperature sensor alerts parents to potentially hazardous conditions such as excessive heat. In situations where voice activation is impractical or risky, a touch sensor can silently request connection with a parent or guardian

Guardians can monitor the child's movements in real time using a user-friendly smartphone app or notifications, facilitated by the GPS module. Data visualization and remote monitoring are enabled through secure transmission via the Firebase cloud platform. In case of emergencies or predefined conditions such as high heart rate exceeding safe limits or elevated temperatures detected by sensors, an integrated Arduino alarm buzzer will activate. Simultaneously, the child's GPS location is transmitted via the cloud platform to notify specified contacts. Additionally, to alert parents of the need for protective measures, a supplementary touch sensor can be included to detect discreet alerts or presses, sending notifications via SMS or the app. Figure.2 shows the proposed wearable IoT device.

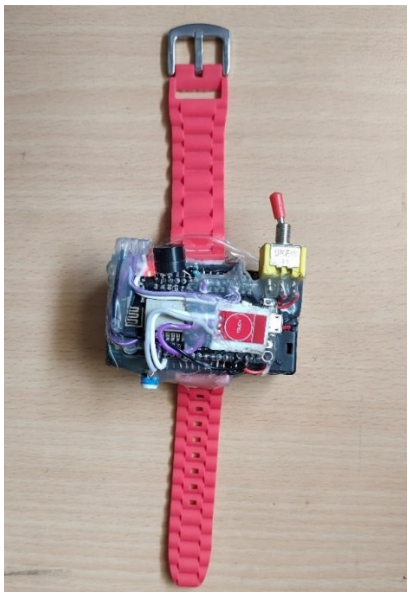

Figure 2. Proposed Wearable IoT Device

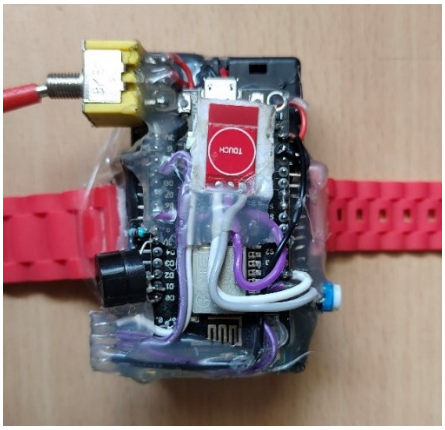

Figure 3. Front View of Wearable Device

The Google cloud computing system Firebase offers a reliable and efficient method of managing the gathered data. GPS coordinates and sensor readings are instantly saved to the Firebase database. Through a user-friendly smartphone app, parents can view this data and remotely monitor their child's vitals, location, or any environmental dangers. Firebase provides data visualisation tools that facilitate the identification of patterns and potential problems. This comprehensive monitoring solution promotes child safety and wellbeing, while giving parents and guardians a peace of mind. Figures 3, 4, and 5 show the front, back, and side views of the wearable watch, respectively.

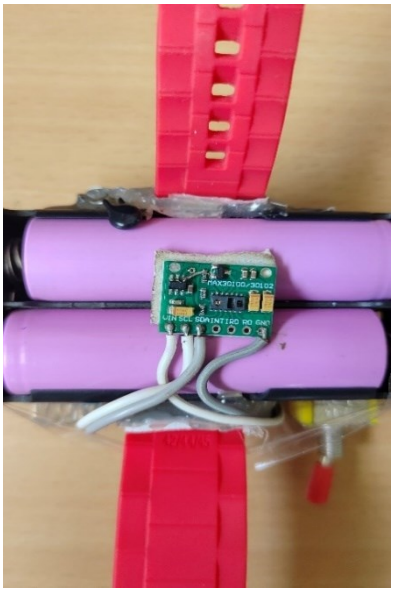

Figure 4. Back-view of Wearable Watch

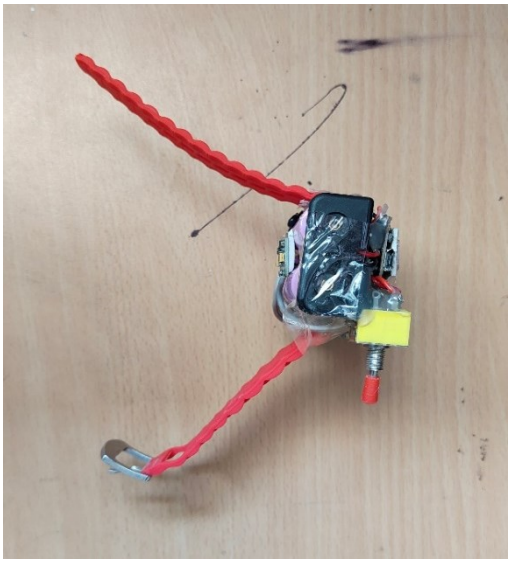

Figure 5. Side-view of Wearable Watch

3.2 Working Process

The gadget, resembling a tag, monitors the child's temperature, heartbeat, and current location, and is worn on the child's hand. For this purpose, a Python application has been developed, linking to the Microcontroller IDE via organization ID, device name, device ID, authentication key, and API token. Subsequently, the Microcontroller IoT application, created using MIT App Inventor 2, connects the Microcontroller IDE to Node-RED. The Microcontroller IDE dashboard displays real-time temperature and heart rate data. Additionally, the child can activate the Alarm Button in case of an emergency."

The parent monitors this data via the Child smartphone app. To access the program, the user must register with an email address and password, both submitted to the Firebase database. Upon registration, the user clicks the 'Verify' button to confirm the account. A verification link is emailed to the user's email address. Clicking this link redirects the user to a verified sign-in page, where they can log in using the Child application. After logging in, the user can view their child's location. Notifications are sent to the user's smartphone notification bar and through the Child app if the child leaves the geofence or activates the panic button. The Child app also allows the user to monitor their child's temperature and heart rate. Data such as location, heart rate, and temperature are stored in the Firebase DB for future reference. The proposed flowchart is shown in Figure.6. The Table.1 and 2 shows the hardware and the software requirements of the proposed.

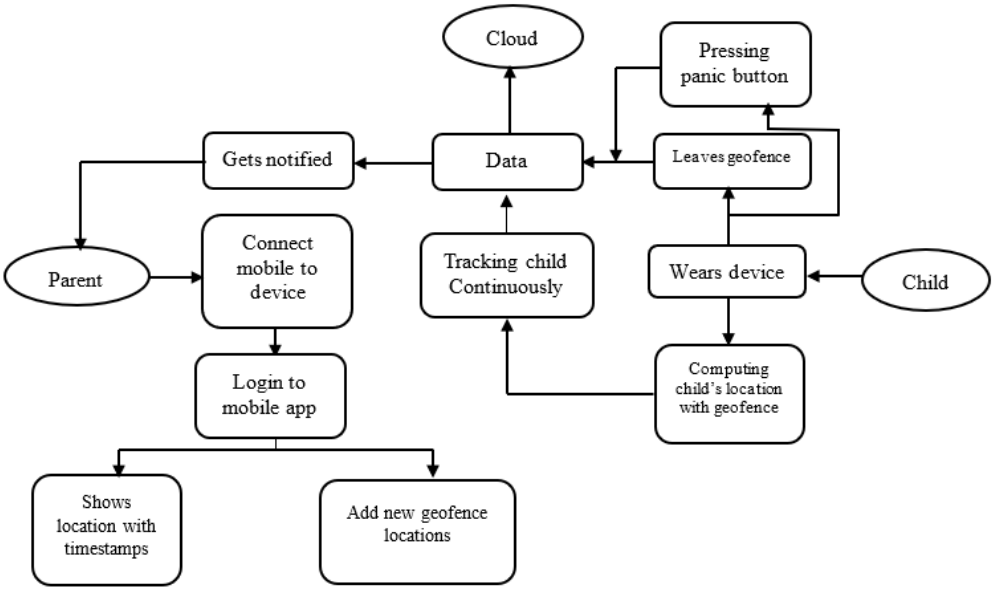

Figure 6. Flowchart

Table No 1. List of Hardware Components

S. No.	Hardware Components	Its Proposed Work
1	GPS Module	For tracking purposes, it gives the location of the child in real time.
2	Temperature Sensor	Monitors kid's body temperature and the surroundings to identify any potential threats to health.
3	Pulse Oximeter Sensor	Monitors kid's heart rate, which could be an indication of stress or fatigue.
4	Touch Sensor	It triggers a silent emergency protocol by performing a unique touch sequence. This could send alerts, discreetly activate a buzzer on the gadget, or initiate contact with emergency services.
5	Microcontroller	It gathers sensor data and manages functions, serving as the device's central processing unit.
6	Alarm Buzzer	When an emergency or other predetermined circumstance arises, an alarm sounds.

7	IOT Platform	This establishes an internet connection between the device and software, enabling data visualization, remote monitoring, and even potential smartphone app integration.

Table No 2. List of Software Used

S. No.	Software tools	Description
1	Arduino IDE	Code creating, compilation, and uploading facilities are available for the Arduino Uno board with this open-source software environment.
2	Language – Embedded C	The Arduino program code written in Embedded C will continuously read sensor data using appropriate libraries.
3	Application	The sensor data and warnings for a child can be kept on a specific path, and an app for smartphones (created with tools like Firebase) can be set up to listen for updates on that path.

4. Results and Discussion

The proposed wearable device is an advanced system integrating multiple platforms and technologies for child protection and monitoring. At the core of the system is the child's wearable gadget, functioning as a tag to monitor their location, temperature, and heartbeat. This data is seamlessly transferred to the Microcontroller IDE through a Python program, utilizing essential credentials including organization ID, device name, device ID, authentication key, and API token for connectivity. The Microcontroller IDE functions as the primary processing hub for processing temperature and heartbeat data, which is then presented on an dashboard through integration with Node-RED via Microcontroller IoT. The gadget also has an emergency Panic Button that sends alerts to the mobile notification bar and the Child app, making sure parents are informed in a timely manner when things go serious. The results of the Application developd are given in Figure 7-9.

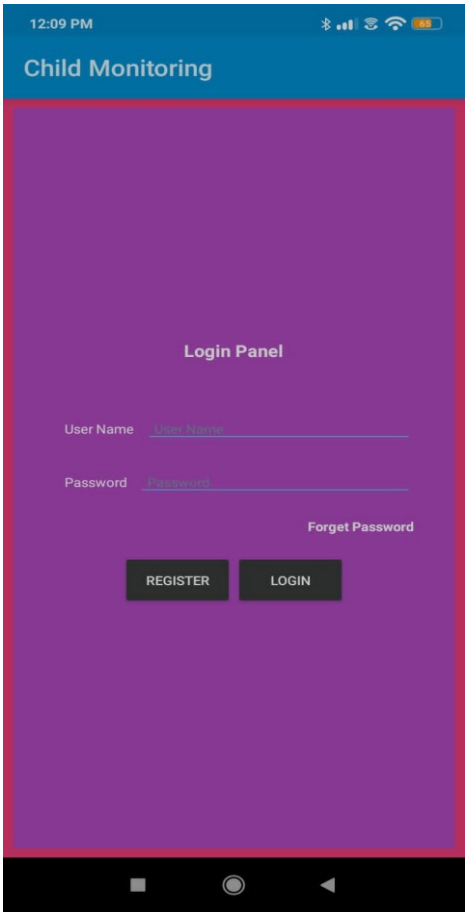

Figure 7. Login Page

The mobile app, was created with MIT App Inventor 2 to provide parent with an user friendly platform for keeping tabs on their child's wellbeing. Users are required to register using their email address and password; an account verification email will be sent to them for validation. After verification, parents may use the app to receive real-time data on their child, including location, heart rate, and temperature. This increases parental awareness and makes it possible to intervene quickly when needed.

Additionally, the app has geofencing features that alert parents if their child crosses the set area limit. Combined with vital sign tracking and emergency alarms, this real-time monitoring guarantees a complete safety net for kids. Additionally, Firebase DB securely stores all monitored data, making it easier for parents and caregivers to refer to and analyze it later.

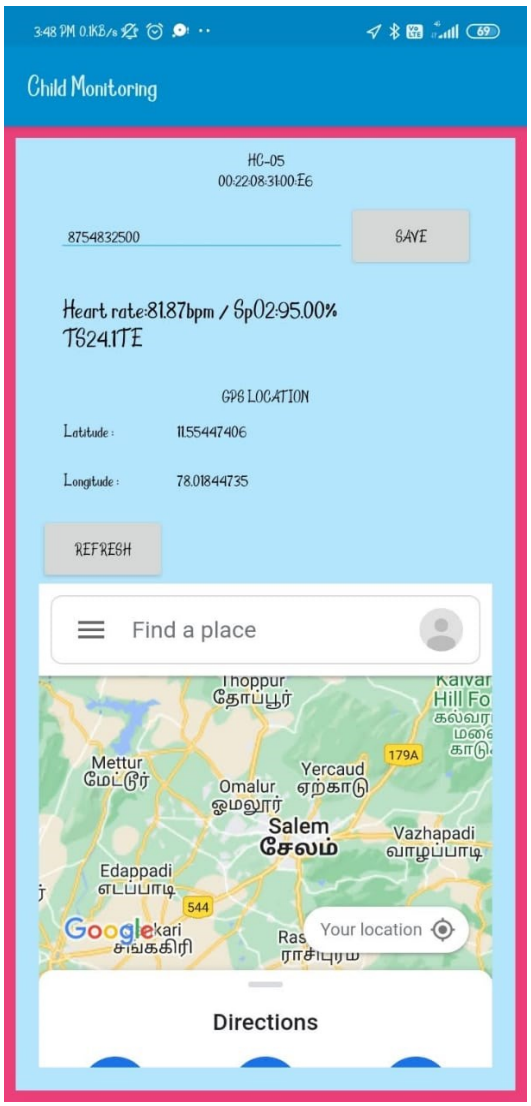

Figure 8. Child's Location is Displayed on the Dashboard

Figure 9. A Notification is Sent if the Child Press Panic

This research essentially demonstrates the technical capabilities of integrating hardware, cloud services, and mobile applications while also emphasizing how crucial it is to improving child safety and giving parents peace of mind by means of continuous monitoring and prompt response mechanisms.

5. Conclusion

IoT security continues to improve daily alongside advancements in technology. Our primary focus lies in child remote monitoring systems, which enable parents to fulfill their responsibilities and commitments in their professional lives. With this program, parents can effortlessly monitor their children in real-time while focusing on their careers, without the need for physical intervention. It's like having them right by their side. Child safety and protection devices are designed as intelligent Internet-of-Things devices. In addition to providing real-time updates on their child's temperature and heartbeat, they include a panic button that children can activate via a touch sensor to notify their parents in emergencies.

6. Future Scope

The future of IoT-enabled child safety monitoring and notification devices for smart towns and cities encompasses advancements in sensor technology, AI integration for predictive capabilities, real-time communication, smart infrastructure integration, enhanced data privacy and security measures, community engagement, customizable options, and seamless integration with other smart devices and services. These developments collectively enhance the safety of children's environments.

References

[1] Senthamilarasi, N., N. Divya Bharathi, D. Ezhilarasi, and R. B. Sangavi. "Child safety monitoring system based on IoT." In Journal of Physics: Conference Series, vol. 1362, no. 1, p. 012012. IOP Publishing, 2019.

[2] B. Dorsemaine, P. Gaulier, P. Wary, N. Kheir and P. Urien, "Internet of Things: A Definition and Taxonomy," Next Generation Mobile Applications, Services and Technologies, 2015 9th International Conference on, Cambridge, 2015, pp. 72- 77.

[3] Y. A. Badamasi, "The working principle of an Arduino" Electronics, Computer and Computation (ICECCO), 2014 11th International Conference on, Abuja, 2014, pp. 1-4.

[4] N. N. Prince, "Design and implementation of Microcontroller based short message service control system," Internet Technology and Secured Transactions (ICITST), 2013 8th International Conference for, London, 2013, pp. 494-499.

[5] F. A. Silva, "Industrial Wireless Sensor Networks: Applications, Protocols and Standards," in IEEE Industrial Electronics Magazine, vol. 8, no. 4, pp. 67-68, Dec. 2014.

[6] Heng, Lai Yi, and Intan Farahana Binti Kamsin. "IoT-based Child Security Monitoring System." In 3rd International Conference on Integrated Intelligent Computing Communication & Security (ICIIC 2021), pp. 467-472. Atlantis Press, 2021.

[7] P. Bhagwat, "Bluetooth: technology for short-range wireless apps," in IEEE Internet Computing, vol. 5, no. 3, pp. 96-103, May/Jun 2001.

[8] S. Nasrin and P. Radcliffe, "Novel protocol enables DIY home automation," Telecommunication Networks and Applications Conference (ATNAC), 2014 Australasian, Southbank, VIC, 2014, pp. 212-216.

[9] "WiFi and WiMAX - break through in wireless access technologies," Wireless, Mobile and Multimedia Networks, 2008. IET International Conference on, Beijing, 2008, pp. 141-145.

[10] Mayur Bhor, Nikhil Kadam, Dinesh Shinde, Pranoti Mane “Children Safety and School Bus Tracking Solution” ISSN (Online): 2347-2820, Volume -5, Issue-1, 2017.

[11] Jun Zheng, Simplot-Ryl, D., Bisdikian, C., Moufah, H.T., "The internet of things" in Communications Magazine, IEEE, vo1.49, No.11, pp.30-31, November 2011 doi: 10.1109/MCOM.2011.6069706

[12] Kok Sun Wong, Wei Lun Ng, Jin Hui Chong, Chee Kyun Ng, Aduwati Sali, Nor Kamariah Noordin “GPS Based Child Care System using RSSI Technique,” Proceedings of the 2009 IEEE, 9th Malaysia International Conference on Communications, 15 -17 December 2009, Kuala Lumpur Malaysia.

[13] Vibha Chandrala, Niveditha N, Neha B Reddy and Urmila N, “Child monitoring system using IoT,” International Journal of Advance Research, Ideas and Innovations in Technology. 5(3) 2019 . 416-419.

[14] Badgujar, Dipali, Neha Sawant, and Dnyaneshwar Kundande. "Smart and secure IoT based child monitoring system." Int Res J Eng Technol (IRJET) 6, no. 11 (2019) 387 -390.

[15] H. Moustafa, H. Kenn, K. Sayrafan, W. Scanlon and Y. Zhang, "Mobile wearable communications," in IEEE Wireless Communications, vol. 22, no. 1, pp.10-11, February 2015.

[16] Sadhana B, Navya A, Nidhishree, Vidhyashree, Vishwa “Child monitoring using GPS tracking system,” International Journal of Engineering Applied Sciences and Technology, 2022. Vol. 7, Issue 1, Pages 329-337.

[17] K. Braam, Tsung-Ching Huang, Chin-Hui Chen, E. Montgomery and R. Beausoleil, "Wristband Vital: A wearable multi-sensor microsystem for real-time assistance via low-power Bluetooth link," Internet of Things (WF-IoT), 2015 IEEE 2nd World Form on, Milan, 2015, pp.87-91. doi: 10.l109/WF-IoT.2015.7389032

[18] "Digital parenting: The best wearables and new smart baby monitors - The latest smart baby monitors and connected tech for your peace of mind,” Tech. Rep., 2015.

Author's biography

Silambarasan A. is an Assistant Professor in the Department of Electronics and Communication Engineering. He has an M.E., in VLSI Design and a B.E., in Electronics and Communication Engineering. His research interest is in Design and Testing related to VLSI and Networks. He has 2 years of teaching experience and has 2 Journal Publications.

Vasanthi.M is an Assistant Professor in the Department of Electronics and Communication Engineering. She has an M.E., in VLSI Design and a B.E., in Electronics and Communication Engineering. Her research interest is in Design and Testing related to VLSI and Communication. She has 8 years of teaching experience and has 6 International Journal Publications.