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DESIGN AND IMPLEMENTATION OF A GSM-BASED CHILD RESCUE SYSTEM FOR EARTHQUAKE EMERGENCIES USING RASPBERRY PI

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ABSTRACT
Nowadays many natural disasters are happening especially earthquake. Due to earthquake lots of buildings are collapsed, in that collapsed building many children are affected. There is no proper mechanism to track and rescue the children from the building. To address this issue, this paper proposes a GSM-based child rescue system that utilizes Raspberry Pi, sensors such as temperature, pH, and heart rate, as well as GPS and GSM. This system aims to save children from collapsed buildings by using data obtained from the sensors. Overall, the proposed system has the potential to significantly reduce the response time during rescue operations and increase the chances of rescuing children in critical situations and also successfully fulfills all the objectives toward safely rescuing the wounded child and take in to medical treatment. When compared to the conventional techniques, the proposed model offers satisfactory results in performing the rescue operation in an efficient manner within a short span of life and at a low cost.

Keywords: Children rescue, Earthquake, Raspberry pi, Monitoring, GPS and GSM

INTRODUCTION
In today's world, the concept of the "Internet of Things" (IoT) has become increasingly prevalent. IoT refers to a network of physical objects equipped with sensors, software, and other technologies that enable them to communicate and share data with other devices and systems using the internet.

In recent years, natural disasters have caused more damages, in that earthquakes have caused significant devastation and loss of life around the world. In particular, children are at high risk during such disasters due to their vulnerability and inability to protect themselves. The earthquake causes a higher death rate compared to the other disasters, as shown in chart 1. In response to this problem, there has been an increasing focus on developing innovative solutions to help rescue and protect children during disasters.

One such solution is an GSM-based children's rescue system that leverages the power of technology to locate and rescue children who are trapped in the rubble following an earthquake. The proposed system uses sensors, communication technologies, and data analytics to locate the position of children and send alerts to rescue teams, enabling them to respond quickly and efficiently.

The proposed method aims to explore the development and implementation of such a system, including the technology behind it, the challenges faced in designing and deploying it, and the potential impact it can have in saving lives during earthquakes. Additionally, it will examine the ethical considerations surrounding the use of such technology, including data privacy and security concerns. Overall, it seeks to provide a comprehensive overview of the GSM-based child rescue system and its potential to revolutionize disaster response efforts, particularly in earthquake-prone areas.

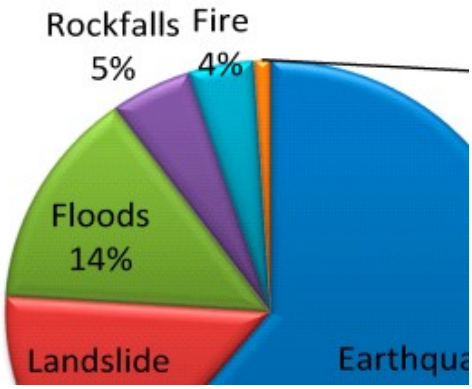

Chart 1: Circle graph for disaster affected the humans

EXISTING METHOD

An overview of recent studies on the monitoring and rescue system for children is given in the literature review that follows

In the initial stage, Wearable sensors like magnetometers, gyroscopes, and accelerometers can produce data in time series. Using machine learning or deep learning models, this data may be utilised to categorise different aspects of daily living. Human activity recognition is useful for applications in sports, education, child monitoring, ambient assisted living, and other fields

. The model was trained using a benchmark human activity recognition dataset from the WISDM lab for performance assessment and comparison[1].Drones were used to collect a new thermal imaging dataset utilising unmanned aerial vehicles (UAVs).

This dataset was then used to train survivor identification models using a variety of deep convolution neural networks including YOLOV3, YOLOV3 MobileNetV1, andYOLOV3 MobileNetV3[2]

.

The UAV was specifically designed for post-disaster rescue missions, and its mapping capabilities make it easier for rescue personnel to reach and begin operations in disaster-stricken areas[3].

Another wearable is incorporated into crowdsourced sensing networks created by smartphone users and includes mobile iBeacon and 3-axis accelerometer modules.. This device utilizes GPS to track location is equipped with sensors and indoor IOT technology to transmit data[4].

For flood monitoring, prediction, and emergency and rescue services during or after a flood occurrence, hierarchical coloured Petri nets (CP-Nets), which simulate and verify the Gaia multi-agent technique, are used[5].

The method necessitates manual activation of the panic button in emergency situations and utilizes Wi-Fi for data transmission, which may not be as dependable as GSM[6].

If the child arrives at school, the parent receives an immediate SMS to the mobile; it only tracks the child's location; and if any system fails, it fails to send SMS to the parent [7].

Using ZigBee, Bluetooth, WI-FI, and some wearable sensors to monitor the child's vital signs and send messages to parents [8].

Asthma affects 6.3 million children worldwide. To address this issue, a system has been proposed that inactively and unassertive monitors the surroundings of an asthma sufferer.The system uses a Foobot sensor to detect cooking and smoking as well as excessive levels of particulate matter, volatile organic compounds, and carbon dioxide during these activities[9].

A messaging system and a self-rescue system are the two parts of the smartphone communication system for disaster recovery. Communication amongst rescuers is made possible by the message system, which seamlessly mixes cellular networking, ad hoc networking, and opportunistic networking [10]. And the comparison tabulation of existing and proposed system is shown in the Table 1.\

S. NO	AUTHOR	HARDWARE	COMPONENTSUSED	APPLICATION
1	Atulahire2018	ArduinoUNO	GPS andGSM	Tracking children's locations
2	Sundarajan.VP. T 2018	ArduinoUNO MCU	GSM,GPRS, Crystal oscillator and Accelerometer sensor	Monitor children's responses to outages, anxiety, and dread.
3	J. Dong, K. Ota 2021	YOLOV3,	YOLOV3-MobileNet V1 and YOLOV3-MobileNet V3	UAV hadbeen designed for post-disaster rescue; mapping the areas would

				help rescuers
4	Proposed system	Raspberry pi pico	LM35, pH, Heart beat sensors, GPS and GSM	Health monitoring of children and rescue children from disaster

Table 1. Comparison of existing work and proposed system

PROPOSED SYSTEM

This paper proposes a GSM-based children's rescue system for earthquake emergencies, which aims to demonstrate its efficacy in terms of cost and simplicity while enabling the rescue of children in a short span of time. The proposed system involves three stages of operations: data acquisition, classification, and alert notification, as illustrated in Fig 1.

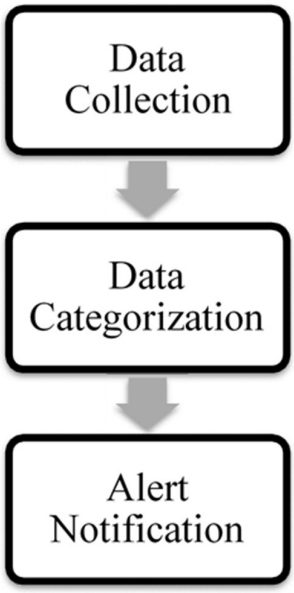

Fig.1 Simplest Block diagram of the proposed system

Data Collecting

The process of sampling signals that measure real physical circumstances and transforming the resulting samples to digital values is referred to as information acquisition. Typically, analog waveforms are converted to digital values for processing, as shown in Fig 2. The data collected from temperature, pH, and heartbeat sensors in analogue form and needs to be converted into a digital signal for processing at this stage.

Data Categorization

The classification process involves organizing data into relevant categories, making it more efficient to use for protect, easier to locate and retrieve. This stage involves classifying data based on children's values for temperature, pH, and heart rate

Alert Notification

Machine-to-person communication is crucial when time is of the essence, especially when an alert is a notification of an important message. In the final stage, Inputs are sensed from the child's body using sensors. The input data is compared to the expected range of values; if the data exceeds the expected range, an alarm signal is sent

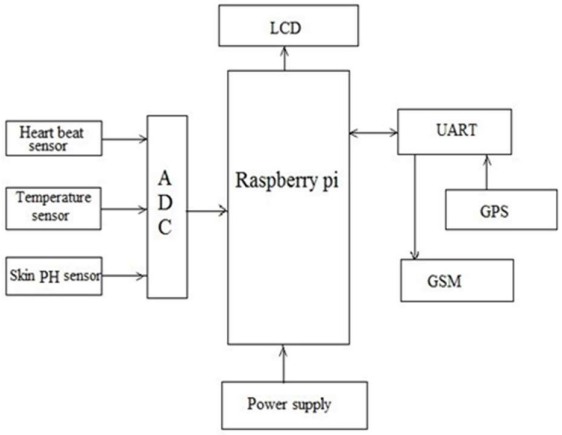

Fig.2 Signal Conversion

The detailed block diagram of the proposed system for the GSM-based children's rescue system for earthquake emergencies is shown in Fig 3.

The temperature, heart rate, and pH sensors are connected to the ADC pins on the Raspberry Pi. In an ADC pin, it would convert the analog input, like a sine wave, into digital outcomes, like 0's and 1's. The temperature sensor has three terminals: a positive, a data pin, and a negative. The positive and negative pins are used for the power supply and ground, and the data pin is contact with the children's body for sensing the temperature. That pin acts as an input pin, providing input data to the controller.

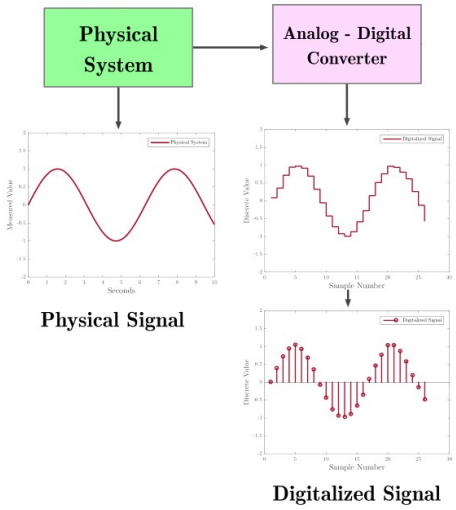

Fig.3 Block Diagram of the proposed system

The heart beat sensor includes an infrared transmitter and receiver. The transmitter sends an infrared signal through the body, calculating the count of heartbeats. The receiver receives the signal and stores the count. The received data is an input. That input analog signal is connected to ADC pin and converted into digital signal.

A pH-sensitive system's electric potential
is compared to the potential of a stable reference system to operate the pH sensor. A pH-sensitive glass bulb that changes voltage proportionately to the concentration of hydrogen ions makes up the sensor mechanism. A sensor electrode measures the glass bulb's voltage, and it should be connected to the 27th ADC pin for accurate data acquisition.

And for serial communication to transfer data or location from the GPS, The device is connected to the UART (Universal Asynchronous Receiver and Transmitter) which is comprised of two types: UART Receiver and UART Transmitter. The UART receiver pin is connected to GPS to receive the exact location. Meanwhile, the UART transmitter pin is used to transmit data to a mobile device through GSM. The UART receiver would receive the location frequently through GPS. And the UART transmitter would transmit the received data to the user's mobile phone through GSM.

GSM is used to send information to parents and rescue teams' mobile phones as a message notification.GSM stands for "Global System for Mobile Communication" and is a popular digital mobile network among users of mobile phones. The three most popular digital wireless telephony technologies are TDMA, GSM, and Code Division Multiple Access. It integrates different Time Division Multiple Access (TDMA) capabilities (CDMA). Data is digitalized and compressed by GSM before being sent together with two other streams of user data, each in its own time slot, along a channel. Either the 900 MHz or 1800 MHz frequency bands are used for operation.

This code is written in Python and appears to be part of a larger program that uses a GPS module to send temperature, pH, and heart rate alerts to two phone numbers. Here's a step-by-step breakdown of the code

Check if temperature reading (T) is greater than 40
If yes, check if the alert has already been sent to the first phone number .If x is 0 (meaning an alert has not been sent yet), send an AT command to the GPS module to initiate sending the SMS message to the first phone number. The message will contain the latitude and longitude values along with the temperature reading, preceded by the "Temperature Alert:" text. After sending the first message, wait for 5 seconds and then send the same message to the second phone number. Set x to 1 to indicate that an alert has been sent. If T is less than or equal to 40, set x to 0.

Check if pH reading (P) is greater than 07

If yes, check if the alert has already been sent to the second phone number If x is 0 (meaning an alert has not been sent yet), send an AT command to the GPS moduleto initiate sending the SMS message to the first phone number. The message will contain the latitude and longitude values along with the "PH Alert:" text. After sending the first message, wait for 5 seconds and then send the same message to the second phone number. Set x to 1 to indicate that an alert has been sent. If P is less than or equal to 07, set x to 0.

Check if heart rate reading (H) is greater than 70

If yes, check if the alert has already been sent to the second phone number. If x is 0 (meaning an alert has not been sent yet), send an AT command to the GPS module to initiate sending the SMS message to the first phone number. The message will contain the latitude and longitude values along with the "HB Alert:" text and the heart rate reading. After sending the first message, wait for 5 seconds and then send the same message to the second phone number. Set x to 1 to indicate that an alert has been sent. If H is less than or equal to 74, set x to 0, then the child is either dead if it was stuck in an earthquake or normal in a safe condition is shown in Fig. 4.

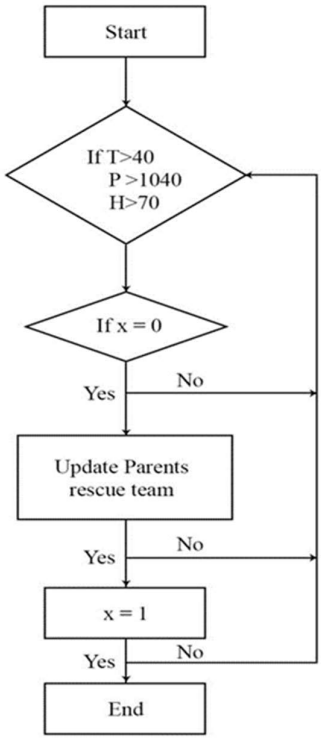

Fig.4 Flow chart for the proposed system Algorithm

RESULT ANALYSIS

The result for the children's rescue system has been shown below and explained with various scenarios. The output has been obtained for the high temperature, pH, and heartbeat range of the children, as shown in the figure below. The temperature, pH, and heart beat sensors are connected to the ADC pin in the Raspberry Pi Pico; the prototype of the proposed system is shown in Fig 5.

Time is displayed on the x-axis and temperature is plotted on the y-axis.The temperature can be measured in degrees Celsius or Fahrenheit. The graph can show how the temperature changes over time, whether it is increasing, decreasing or fluctuating. A sudden spike or drop in temperature is due to the earthquake, the temperature is decreased, if the children under collapsed building for long time and it indicates a problem and send a alert notification to the parent and rescue team is shown in Fig 6.

Time is displayed on the x-axis and pH is plotted on the y-axis.A pH of 7 indicates neutrality, while a pH scale of 0 to 14 indicates acidity, alkalinity, and neutrality, respectively. The pH level of the children is initially normal and the body get dehydration due to the decrease of water content in children body. Due to this, the children skin pH level is base. And send a alert notification to the parent and rescue team is shown in Fig 7

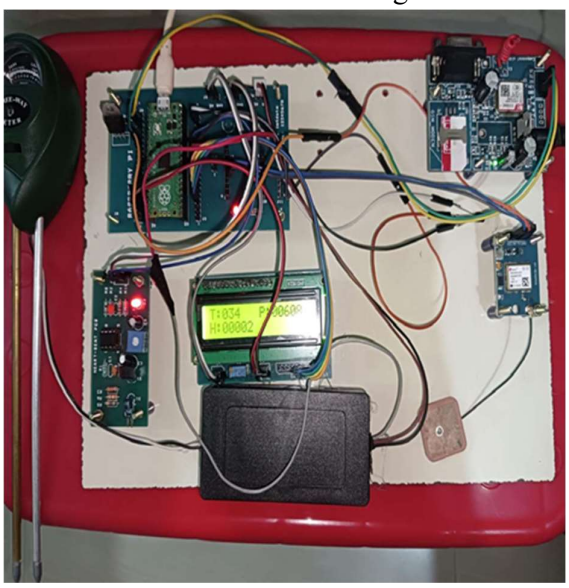

Fig.5 Hardware prototype of the proposed system

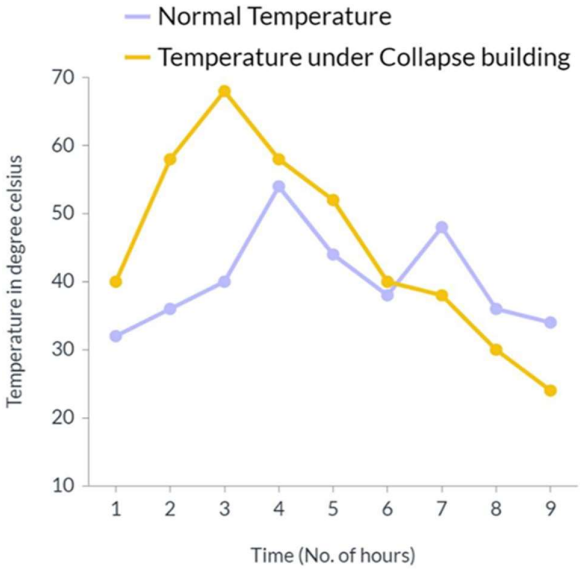

Fig.6 Graph analysis for temperature

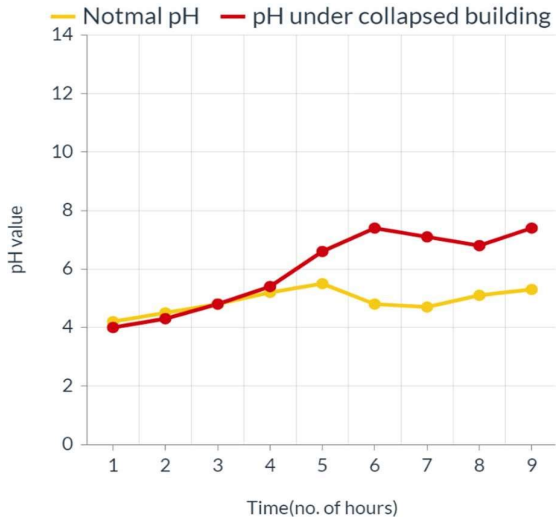

Fig.7 Graph analysis for pH

Time is displayed on the x-axis and heart rate is plotted on the y-axis. The heart rate is usually measured in beats per minute. The graph can show how the heart rate changes over time, whether it is increasing, decreasing or fluctuating. A sudden change in heart rate can indicate a change in the health due to earthquake and pulse is decreased because under collapsed building the oxygen level is low, so the children heart beat rate is reduced is shown in Fig 8.

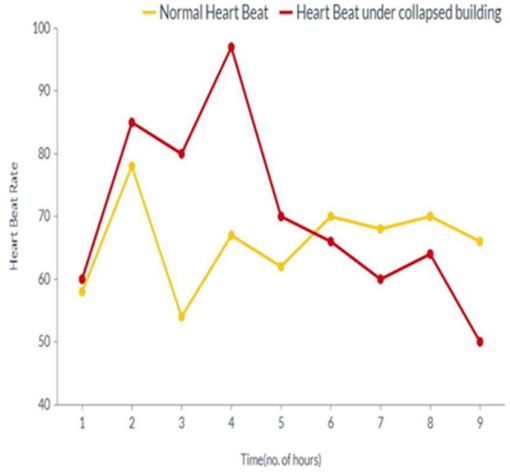

Fig.8 Graph analysis for heart beat rate

The proposed work was tested in diffirent scenarios to validate its effectiveness in detecting abnormal values.

of temperature, pH, and heart rate. The system was found to be accurate and reliable in detecting and alerting the parent's and rescue team in case of medical emergencies through mobile with the help of GSM, as shown in Fig 9 and Fig 10.

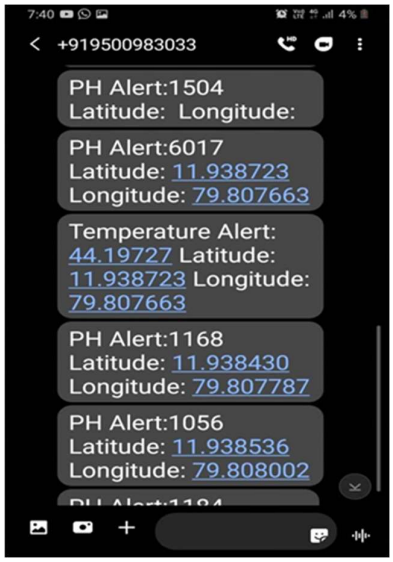

Fig 9 Alert notifications for Parent's

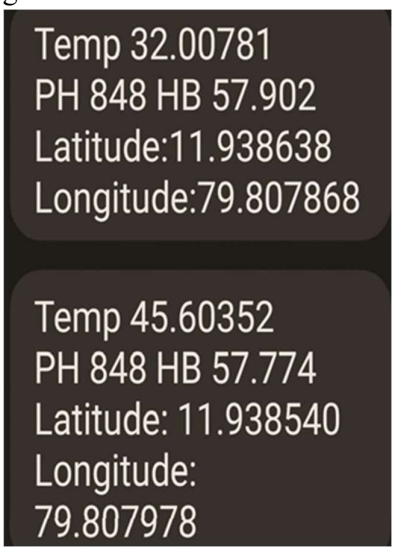

Fig 10 Alert notifications for Rescue team

CONCLUSION

Overall, the proposed system using the Raspberry Pi Pico, along with temperature, pH, and heartbeat sensors, GPS, and GSM modules, offers many advantages over the existing systems. It provides real-time tracking, accurate location data, low cost, ease of deployment, and a user-friendly interface. It also has the potential for scalability and can be extended to include other sensors for monitoring additional aspects of a child's physical state. In the future, it will also be applicable for rescue systems in industries like the chemical industry and atomic and nuclear power plants to prevent the workers from deficiency syndrome by adding more sensors to the system to monitor other human health parameters such as blood pressure, oxygen saturation, and respiratory rate. This can provide a more comprehensive picture of the health status and also add more communication modules to the system, such as Wi-Fi or Bluetooth, to ensure uninterrupted communication between the system and the parent or guardian. This can help in situations where the GSM network is not available.

REFERNCES

[1] H. A. Imran, "Khail-Net: A Shallow Convolutional Neural Network for Recognizing Sports Activities Using Wearable Inertial Sensors," in IEEE Sensors Letters, vol. 6, no. 9, pp. 1-4, Sept. 2022, Art no. 7003104, doi: 10.1109/LSENS.2022.3197396.

[2] J. Dong, K. Ota and M. Dong, "UAV-Based Real-Time Survivor Detection System in Post- Disaster Search and Rescue Operations," in IEEE Journal on Miniaturization for Air and Space Systems, vol. 2, no. 4, pp. 209-219, Dec. 2021, doi: 10.1109/JMASS.2021.3083659.

[3] L. -W. Chen, T. -P. Chen, H. -M. Chen and M. -F. Tsai, "Crowdsourced Children Monitoring and Finding With Holding Up Detection Based on Internet-of-Things Technologies," in IEEE Sensors Journal, vol. 19, no. 24, pp. 12407-12417, 15 Dec.15, 2019, doi: 10.1109/JSEN.2019.2938324.

[4] M. Aljehani and M. Inoue, "Performance Evaluation of Multi-UAV System in Post-Disaster Application: Validated by HITL Simulator," in IEEE Access, vol. 7, pp. 64386-64400, 2019, doi: 10.1109/ACCESS.2019.2917070.

[5] N. Akhtar et al., "Hierarchical Coloured Petri-Net Based Multi-Agent System for Flood Monitoring, Prediction, and Rescue (FMPR)," in IEEE Access, vol. 7, pp. 180544-180557, 2019, doi: 10.1109/ACCESS.2019.2958258.

[6] Awodeyi, Afolabi & Moses, Obomighie & Opeyemi, Makinde & A., Ben-Obaje & Abayomi-Zannu, Temidayo. Design and Construction of a Panic Button Alarm System for Security Emergencies. International Journal of Engineering and Techniques, 4(3):649-652, 2018

[7] Al-Mazloum, A., E. Omer, and M. F. A. Abdullah. "GPS and SMS based child tracking system using smart phone." International Journal of Electrical, Computer, Energetic, Electronic and Communication Engineering 7.2 (2018): 238-241.

[8] Dias D, Paulo Silva Cunha J. Wearable Health Devices-Vital Sign Monitoring, Systems and Technologies. Sensors (Basel). 2018 Jul 25;18(8):2414. doi: 10.3390/s18082414. PMID: 30044415; PMCID: PMC6111409.

[9] U. Jaimini, T. Banerjee, W. Romine, K. Thirunarayan, A. Sheth and M. Kalra, "Investigation of an Indoor Air Quality Sensor for Asthma Management in Children," in IEEE Sensors Letters, vol. 1, no. 2, pp. 1-4, April 2017, Art no. 6000204, doi: 10.1109/LSENS.2017.2691677.

[10] Z. Lu, G. Cao and T. La Porta, "TeamPhone: Networking SmartPhones for Disaster Recovery," in IEEE Transactions on Mobile Computing, vol. 16, no. 12, pp. 3554- 3567, 1 Dec. 2017, doi: 10.1109/TMC.2017.2695452.

[11] A. Kumar, V. Kumar, and R. Kumar, "Raspberry Pi: A Low-Cost Platform for Building Robotics and Control Applications," IEEE Potentials, vol. 34, no. 6, pp. 21-25, Nov. 2015

[12] T. F. Ribeiro, E. M. de Aguiar, A. J. Tavares, and J. C. da Silva, "A Low-Cost IoT Platform Based on Raspberry Pi for Environmental Monitoring," Journal of Sensors, vol. 2018, Article ID 9731781, 11 pages, Oct. 2018.

[13] B. Ramasamy, M. V. S. S. Giridhar, and S. S. Iyer, "Design of a Home Automation System Using Raspberry Pi," IEEE Transactions on Consumer Electronics, vol. 61, no. 2, pp. 201- 208, May 2015.

[14] M. T. Hossain, M. Hasan, M. A. Hoque, and M. R. Uddin, "Raspberry Pi Based Intelligent Surveillance Monitoring System," International Journal of Computer Applications, vol. 107, no. 6, pp. 15-21, Dec. 2014.
[15] S. S. Kanhere, R. Jurdak, and P. Gauravaram, "IoT Security and Privacy: Challenges and Opportunities," Computer, vol. 49, no. 11, pp. 56-61, Nov. 2016.
[16] S. Bandyopadhyay and J. Sen, "Internet of Things: Applications and Challenges in Technology and Standardization," Wireless Personal Communications, vol. 58, no. 1, pp. 49-69, May 2011.
[17] Pradeep, J., Harikrishnan, M., Vijayakumar, K. (2022). Automatic Railway Detection and Tracking Inspecting System. In: Saraswat, M., Roy, S., Chowdhury, C., Gandomi, A.H. (eds) Proceedings of International Conference on Data Science and Applications . Lecture Notes in Networks and Systems, vol 288. Springer, Singapore.
https://doi.org/10.1007/978-981-16- 5120-5_24.
[18] D Prabakar, J Pradeep, Arul G Elango and N Lakshmy. Article: Performance Analysis of Wireless Mesh Network in Hospital Environment. IJCA Special Issue on International Conference on Electronics, Communication and Information systems ICECI(1):28-33, November 2012