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DESIGN AND IMPLEMENTATION OF A GSM-INTEGRATED FIRE AWARENESS SYSTEM USING MQ-2 AND ARDUINO

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Abstract: *This paper discusses the design and development of trapped awareness that is based on 'Global System for Mobile communications (GSM)' signal from the phone message. The microcontroller that connects with smoke detector are placed in device and respond when a trapped awareness perceives smoke. The trapped awareness is a device which senses the smoke and if smoke is detected it beep loudly. When smoke signal gets detected from microcontroller it sends signal through 'Tx Rx transmitter' to GSM signal receiver. The microcontroller connect with the smoke detector, GSM system and alarm system. The device achieved this by being able to receive signals from outside the building thus indicating what necessary action to be taken place in the area where the device is installed as a fire hazard indicator. The trapped awareness which detect the smoke, usually used as appliances at buildings. The experimental setup finally proves that the device is functioning well.*

Keywords: *Global System for Mobile communications (GSM),Smoke Detector, Arduino, MQ-2, Fire Alarm System*

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Introduction

With the enhancement of the economy, there is an increase in the number of buildings and infrastructure in Malaysia. Each structure poses its own unique fire risks. The rampant fire accidents result in the unfortunate demise of numerous innocents, while inflicting great destruction to properties. The requirement of fire safety is among the many considerations that developers take into account for any architecture or infrastructure. Every household needs to own a smoke detector because it is an essential device. A smoke detector is defined as a device that automatically raises the alarm if it perceives there is a fire hazard in the vicinity in which it has been placed. In an automatic alert system, the sound pre-programmed for detection is uniquely tailored to alert the occupants of the building. Should there be a possible risk of a fire or smoke occurrence, a notification would be dispatched to the guards' mobile phones through GSM and SMS. The mobile SMS recipient's number is pre-stored in the microcontroller of the device the guards are using.

Additionally, a siren will emit a high-pitched sound, signalling the possibility of fire danger. An information monitor mounted in the guards' workstation demonstrates the current status of the fire while sirens blaring at different locations indicating the fire zone are activated. In 2011, Bluetooth technology was enhanced with new security features. Adding passcode-protected access control systems was one of the major advancements which prevented unauthorised access to the system. Bluetooth's operational range, however, still remains a limitation and is only 10 to 100 metres (Tosi, 2017). Interference and attenuation in more advanced settings such as industrial areas may further restrict this range within additional considerations concerning signal propagation (Szyc,2022). This system interfaces with laptops and smartphones through Bluetooth, allowing a GUI server application to process data with the smartphone and the main control board after the connection is established (Amoran, 2021).

As outlined in their 2021 study, Rakib et al. designed a home appliance and security system control unit based on GSM technology. It enabled user interaction through both voice calls and mobile applications. Their study contributes to understanding GPRS technology by showcasing GPRS home systems that can be remotely accessed, thus increasing security and convenience in systems installed in areas with unreliable internet services (Rakib,2021). The construction of an SMS controlled for display notice board which uses GSM technology in conjunction with the PIC16F88 microcontroller and its automating control features, is the main focus of the work of (Basarkod,2021). Through this solution, students, teachers, and staff are informed precisely and in time, and the updates sent via SMS over GSM automation are shown on the LCD which ensures that all users remain informed and educational institutions operate efficiently. This advancement allows for more autonomous control and modular expansion of smart home systems since dynamic control is implemented at the module level for power transfer (Wang, 2022).

Problem Statement

Historically, fires were very dangerous to many buildings as there were no technological systems to notify people of a fire. Fire notifications on a global scale were also non-existent. People did not have the time needed to put out a fire, let alone save lives (Milington, 2022). The blaze alone had the potential to destroy infrastructure which would impede government function, along with being a significant danger to citizens who could not take proactive measures to tackle fire control because of the absence of immediate flame detection technology. The lack of technology made this problem worse. Without smoke detectors, the chances of surviving become very challenging. A household is much more secure if smoke detectors are in place, so modern research verifies that self-preservation in a household fire scenario is

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feasible (Nadipalli, 2025). Fire incidents remain one of the major threats to the safety of lives and property, especially in buildings and infrastructure that are rapidly developing in Malaysia. Although various safety technologies have been introduced, existing fire alarm systems still face several limitations. Most of these systems rely on manual activation or short-range technologies such as Bluetooth, which have limited coverage and are ineffective during emergency situations. The absence of a smoke detection system capable of real-time communication with security personnel causes delays in delivering alerts, thereby increasing the risk of accidents and damage. This system should be equipped with sensitive smoke and gas detection sensors as well as the ability to send information directly to users' mobile phones via GSM networks.

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Therefore, the objective of this project is to help users within an area detect fire threats with a specific device. Such a device will solve many of the issues outlined in this study, including: This system has a design and development that includes the configuration and the programming of a 'microcontroller (MC)' system to be interfaced with a GSM. This system triggers an alert when a fire or smoke is detected, with an accompanying message being sent to the mobile phone of the security personnel. Despite the advancements highlighted in these studies, there remains a significant gap in the application of GSM technology for critical safety systems, particularly in fire detection and awareness. While previous works have focused on home automation, security, and information dissemination, the integration of GSM technology into fire awareness systems has not been extensively explored. Existing fire alarm systems often rely on localized alerts, such as sirens or lights, which are ineffective in notifying individuals who are not present at the location of the incident. This limitation can result in delayed responses, increased risks to human life, and greater property damage. Furthermore, the lack of a real-time, remote notification mechanism hinders the ability to promptly alert emergency services or stakeholders. Therefore, there is a pressing need for a GSM-integrated fire awareness system that can provide instant alerts via SMS, ensuring timely evacuation and response. This paper discusses the design and development of a fire awareness system that provides real-time alerts for trapped individuals using 'Global System for Mobile communications (GSM)' signals via phone messages

Literature review

In former times, people were very proficient in spotting fires. A normally healthy person can perceive signs of a fire such as excessive heat, flame, combustion smoke, and even the smell of burning material. This is the reason most fire alarm systems are built around one or more manual fire alarm call activation units where one has to pull a lever or switch to set off an alarm to alert others and they can and often do see the fire (Alonistioti, 2023).To minimise the risks associated with fire incidents, an effective smoke detection system is simply indispensable. This system is important because it has the potential to monitor smoke which may lead to fires that can cause major damage economically, environmentally, and in terms of human life (Chitram, 2024). A home automation system for security and safety was developed in 2007 around a PIC controller and DTMF technology. To enhance security, a PIN-check algorithm was introduced (Shawon, 2022). DTMF controllers were also used by Nigam (2024) for the automation of several relays and the control of voltage-controlled open circuits for improved photovoltaic cell efficiency. One of the shortcomings of the method proposed was the excessive background noise that DTMF signal transmission was subjected.In year 2020, Albataineh et al. (2020) proposed a different approach to smart home electricity control through cloud computing. The web permits control, sending and receiving of commands and signals, virtually, to any power-connected device from any possible geographical location. The control arrangement comprises

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a web server acting as a controller, a website, and an electric switching hardware interface with software that supervises its control.

A bit later, Yuneela and Sharma (2022) implemented the same system with a web-based interface. These researchers developed modular portable smart sensors to design a complete real-time monitoring system for household appliances and home environmental parameters with wireless sensors and actuators interfaces and a 'web-based interface'.The advantages of the system include the reliability of the developed algorithms, good modularity, low power consumption, and low overall cost of the system. For the purpose of enabling communication with the server through the 'Raspberry Pi' board and other home gadgets an interfacing board was designed for communication with the associated web server and the Android application that controls the window shutters (Abd-Elrahim, 2021).

This paper studies the current technique of Trapped Awareness employing a GSM signal in both its software and hardware components. The software for the framework is contained in a mobile phone while its hardware is based on an Arduino Uno (R3) board. The circuit was designed to operate with a 5V DC voltage supply, allowing continuous operation of the sensor and the GSM circuit. Messages warning of potential danger are automatically sent as text messages to the user's mobile phones and the Arduino retrieves and processes the information via the GSM module. The Arduino equipped with an 'LED' display shows the message "Initializing modem" while in system 'Status OK' condition. The MQ-2 gas sensor will automatically set off an alarm when any gas increase is detected during a gas leakage. The gas MQ-2 sensor then starts sending the information to the Arduino. The functions of the Arduino systems permit the board to send commands to the various components that need to be activated to execute specific tasks. Moreover, it confirms that the GSM module is fitted with an Arduino so that the gas sensor MQ-2 can detect the building's harmful gaseous and smoke pollutants. The guard's mobile phone receives the automated warning message, "ASAP DIKESAN MOHON TINDAKAN SEGERA."

Methodology

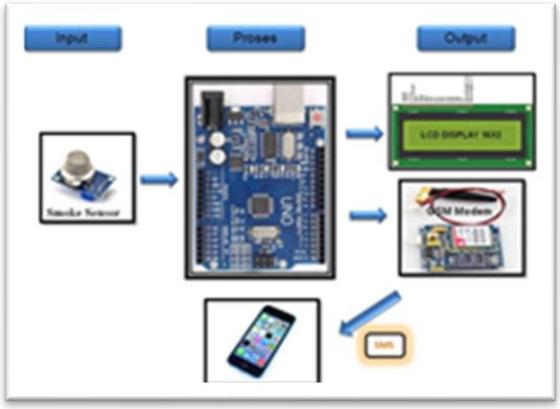

Figure 1: Scope of Work Diagram

This project is concerned with the identification of smoke, sending warning SMS to the guard and simultaneously turning the siren on. The power supply comes with two main column output voltages including the 12V which is with the GSM shield and the 5V provided by the Arduino. According to the block diagram above, the 'MQ' series serves as analogue smoke detectors. These types of sensors are quite sensitive to smoke and other flammable gases. In the case of fire or smoke, gas or combustible vapours will be set as inputs to the Arduino. The

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interconnections of the four system blocks with the Arduino enable each other to function. Signals from the Arduino will go to the GSM which will activate the mobile phone to send the message "ASAP DIKESAN MOHON TINDAKAN SEGERA" through SMS. While the module is receiving the information that the device's status is STAND-BY, the Arduino changes the information to be displayed on the LCD. The GSM Module operates with the SIM Card (Subscriber Identity Module). The SIM provides portability to the user. That is, any phone connected to the link of the Arduino can call from anywhere using a certain number. If the SIM card is placed in another GSM mobile phone, that person will receive messages which will be termed notifications.

Through two-way SMS interaction, the user has the capability to remotely start and stop the system. The mobile phone user can send SMS messages to the security sensors and receive feedback from the smoke sensors about the state of the area. With this feature, the security system can operate automatically and allows communication with the mobile user to inform him/her whenever smoke is detected in the surrounding area. Through this communication, the system can disable the alarm if smoke is detected. This helps to send messages in a cost-effective, effortless, and accurate manner. Integrated security systems will greatly benefit from mobile phones with SMS functionality. The information from the security systems will be sent in the form of SMS and will be received on the user's mobile phone (Ismail et al., 2016). Because of the SIM card's personal mobility feature, the customer is able to use all services subscribed to regardless of region, location, and even the terminal device in use. With the SIM card installed on different models of GSM mobile phones, the user with the SIM can now make and receive calls, and access other subscribed services on those phones.

Hardware Design

The part that the components have to be set up is the hardware configuration. The description of the subsystem integrates four modules which include a smoke sensor module, an alarm system module, a GSM module, and an LCD module. To complete this project, the required components are an 'Arduino Uno board', ' MQ-2 gas sensor', ' LCD', and an 'alarm system.'

Figure 2: LCD Initializing

The 'MQ-2 Gas Sensor' can easily be connected to the 'Arduino board' with the aid of jumper wires. Extreme caution has to be taken with coding declarations pertaining to the pin number connection. Additionally, an LCD screen needs to be connected to the Arduino used as a waiting 'ready' status indicator. The use of the LCD is described in Figure 2 and Figure 3. The Arduino and smoke sensor were programmed in C language together.

Volume: 8 Issues: 26 [March, 2025] pp. 189 - 199]
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Figure 3: Status of System

Next we integrate the 'GSM module' with the 'Arduino system.' The 'TX' and 'RX' terminals of the 'GSM module' should be connected to the 'TX' and 'RX' terminals of the Arduino correspondingly. Also, all the pins must be connected correctly so that the entire system functions efficiently.

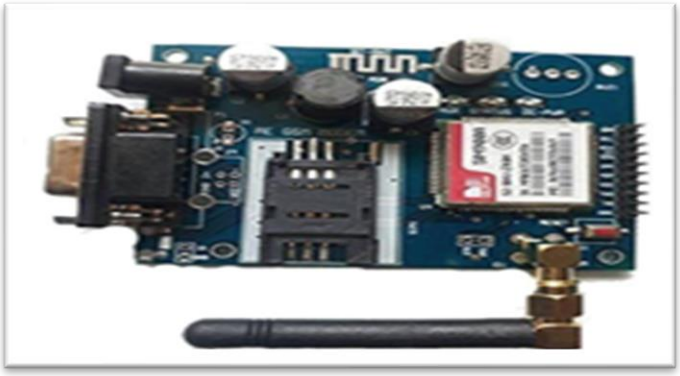

Figure 4: GSM module

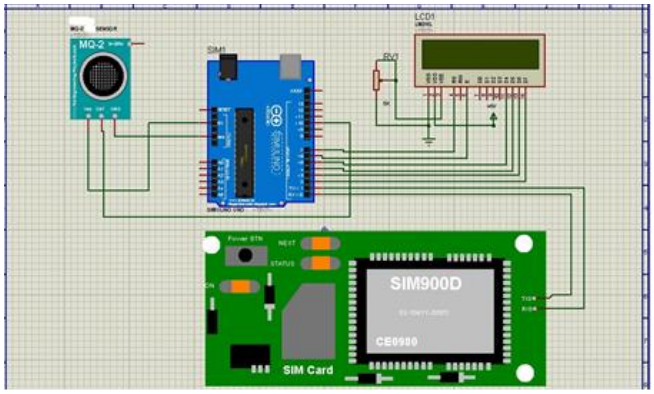

Figure 5: Hardware connection

As illustrated in the diagram, smoke is detected by the smoke sensor and information is relayed to the 'Arduino' via MQ2. The 'Arduino' is set to send information through the peripherals if smoke is detected. Subsequently, the user on the other end has to turn the GSM module on for the information from the Arduino to be accessed. Subsequently, the information will be sent and the user will receive an alert through SMS.

Volume: 8 Issues: 26 [March, 2025] pp. 189 - 199]
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Software Design

To design begin with begin software design phase. For ease of development, it is recommended to utilise a process flow chart. The first order of business is for the customers to download the software onto Arduino which serves as the programming tool. Figure 7 shows the flowchart of the method. The project is carried out using C programming and Arduino Uno Software. The initialization involved establishing key objectives and creating low-level constructs such as delay routines. The higher-level architecture that has been developed for a specific approach aims to send SMS notifications – SMS alerts are described as interpreting sensor data which transmits the temperature reading as a value with a decimal point as the temperature is sent in Celsius, the number of SMS alerts to be sent, and 'AT commands' with the text to be sent are populated with the required messages that are sent to the GSM module.

There are three fundamental steps (Gorgues, 2024) necessary to develop an Arduino programme:
i. Variables Declaration
ii. Initialization, in which written in the setup ( ) function
iii. Control Code, in which written in the loop ( ) function

Every 'sketch' can be saved in a file with an extension '.ino.' All actions including error checking, opening a sketch, and saving a sketch can also be done via the appropriate buttons on the toolbar or the tools menu. Under the sketchbook directory, the sketch which is most preferred and is the body of work is kept. The tools menu has to be opened by the programmer for selecting the board and checking other connections, such as ensuring the serial port to the board is connected. After that, that action can be completed by clicking the upload button or using the tools menu. The next procedure to be followed will be the Bootloader, which is going to begin to initiate the loading to the Microcontroller.

Figure 6: Arduino programming

In order to set off the trigger for the GSM Signal Trapped Awareness System, first it must refer to the LCD display intending to confirm whether it is in a ready state or not. When the Smoke Sensor Unit identifies the fire, the relevant mobile phone will be sent an SMS notification stating "ASAP DIKESAN MOHON TINDAKAN SEGERA" while simultaneously any alert systems located in the near vicinity will be activated.

Volume: 8 Issues: 26 [March, 2025] pp. 189 - 199]
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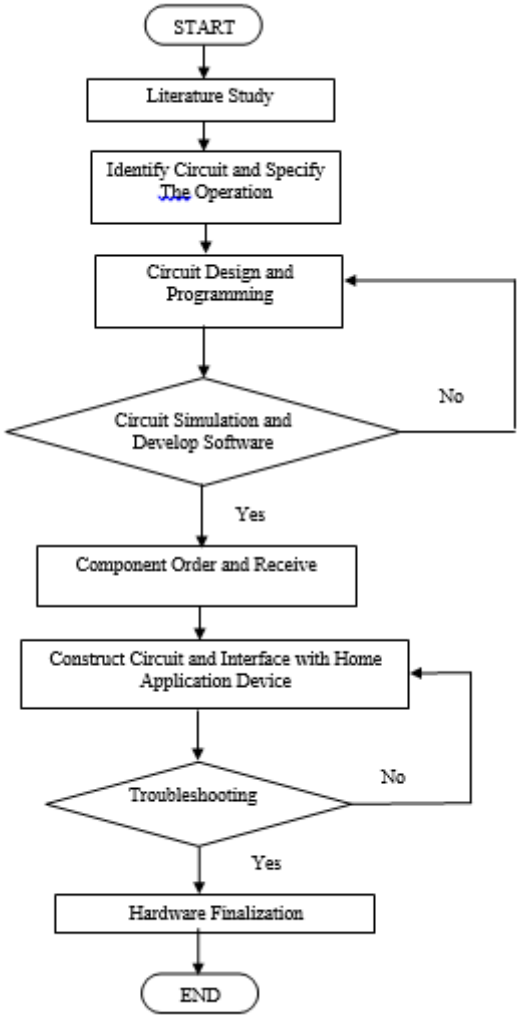

Figure 7 :Flow chart of The Method Process

Results and Findings

This approach to testing seeks to identify errors in the system as well as evaluate its efficiency. As an example to test A trapped of Awareness system involves integrating all modules, including a smoke sensor, GSM module, LCD, and Alarm application module, into one unit integration. This type of testing checks if indeed the systems accomplish all the functionality and activities that they are supposed to accomplish. The other part includes reviewing the source code along with the programme modules, and confirming that every subblock meets the requisite criteria. The system under test will achieve all the expected outcomes without any unhandled exceptions. The results of the test case in Table 1 were all implemented by the developer of the system. This thorough approach to testing, guarantees the full operation and seamless interaction of all components in the system. Similarly, system dependability needs to be validated through evaluating responsiveness to system environmental disturbing factors like smoke concentration and strength of the signal as external influences. Any issues found during the evaluation are fixed to improve the overall system dependability. Fulfilling all of these specified test case criteria demonstrates that the system is functional and will significantly enhance fire detection and response activities in the vicinity of the protected structures.

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Table 1. Summary of the Results for Unit Testing

No	Module	Test Condition	Expected Result	Experiment Result
1	Smoke Sensor module (MQ2)	Test the detection of smoke.	Smoke found within a range of 5 metres.	Pass
2	GSM	Sender and Receiver connection	SMS can be sent to the receiver's mobile phone.	Pass
3	'LCD'Display	Test the connection between Arduino and LCD display in Initializing modem	Display Smoke leakage monitoring System	Pass
4	Alarm	Test the alarm sound	Alarm able to triggered when system activated.	Pass

Conclusion

An Awareness system has been designed which for the purposes of this paper will be referred to as 'trap of awareness' system. This system is able to efficiently detect a fire in its early stages by integrating other safety measures into its operations. From the GSM channels accessible within the phone system, the system was able to remotely locate the appliances. Adding 'Internet of Things (IoT)' device functionalities to the system would greatly increase its monitoring, detection, and control capabilities for the appliances. With this integration, the system is able to communicate with other connected devices which can be monitored in real-time even when the user is not in the vicinity. Moreover, the system can be set to engage safety functions like switching off electrical devices or enabling sprinkler systems, thus increasing the ability to control and reduce fire risks.

Volume: 8 Issues: 26 [March, 2025] pp. 189 - 199]
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Reference

Abd-Elrahim, A. M., Abu-Assal, A., Abu-Algasim Mohammad, A. A., Al-Imam, A. M., Al-Hussein, A. A., & Muhi-Aldeen, M. M. (2021). Design and implementation of Raspberry Pi based cell phone. Proceedings of the 2020 International Conference on Computer, Control, Electrical, and Electronics Engineering (ICCCEEE), 35-40. IEEE. https://doi.org/10.1109/ICCCEEE49695.2021.9429601

Albataineh, H., Nijim, M., & Bollampall, D. (2020). The design of a novel smart home control system using smart grid based on edge and cloud computing. Proceedings of the 2020 IEEE 8th International Conference on Smart Energy Grid Engineering (SEGE), 70-77. IEEE. https://doi.org/10.1109/SEGE49949.2020.9181961

Alonistioti, N., Tsichrintzi, E. A., Chrysafiadi, K., & Alepis, E. (2023). Requirements for fuzzy logic in personalisation of fire emergency alerts. In Proceedings of the 2023 14th International Conference on Information, Intelligence, Systems & Applications (IISA) (pp. [page numbers]). IEEE. https://doi.org/10.1109/IISA59645.2023.10345861

Amoran, A. E., Oluwole, A. S., Fagorola, E. O., & Diarah, R. S. (2021). Home automated system using Bluetooth and an android application. Scientific African, 13, e00711. https://doi.org/10.1016/j.sciaf.2021.e00711

Basarkod, P. I., Reddy, P. A., Reddy, P. S. K., Reddy, N. R. P., & Reddy, P. A. (2021). GSM based SMS driven automatic display notice board. Turkish Journal of Computer and Mathematics Education, 12(11), 6919–6924.

Chitram, S., Kumar, S., & Thenmalar, S. (2024). Enhancing fire and smoke detection using deep learning techniques. Eng. Proc., 62(1), 7. https://doi.org/10.3390/engproc2024062007

Gorgues, Albert Llobera. Control Process: Development of an Arduino-Based Simulation and Interface System for NOVIA University of Applied Sciences. Bachelor's thesis, NOVIA University of Applied Sciences, 2024.

Ismail, W. H. W., Husny, H. R. M., & Abdullah, N. Y. (2016, January). Smoke detection alert system via mobile application. In *Proceedings of the 10th international conference on ubiquitous information management and communication* (pp. 1-6).

Kumar, A. S., Gobinath, D., Vijayakarthik, P., Dhanasekaran, S., Nithiyanandam, N., & Jeyalakshmi, V. (2022). An effective gas and oil leakage detection system over industrial environment using Internet of Things assistance. In 2022 3rd International Conference on Electronics and Sustainable Communication Systems (ICESC), Coimbatore, India. IEEE. https://doi.org/10.1109/ICESC54411.2022.9885290

Millington, J. D. A., Perkins, O., & Smith, C. (2022). Human fire use and management: A global database of anthropogenic fire impacts for modelling. Fire, 5(4), 87. https://doi.org/10.3390/fire5040087

Nadipalli, L. (2025). *Improving home security through user centered device positioning* (Master's thesis). Florida Institute of Technology. https://repository.fit.edu/etd/1538

Nigam, S., Pandey, V., Singh, N., & Srivastava, A. (2024). Designing of home automation based DTMF using GSM. Proceedings of the 2024 International Conference on Signal Processing and Advance Research in Computing (SPARC), 70-77. IEEE. https://doi.org/10.1109/SPARC61891.2024.10828955

Rakib, M. A., Rahman, M. M., Rana, M. S., Islam, M. S., & Abbas, F. I. (2021). GSM based home safety and security system. Engineering, 6(6), 2580. https://doi.org/10.24018/ejeng.2021.6.6.2580

Shawon, M. S. H., Das, C., Ahammed, M. T., Biswas, G., Mia, M. S., & Eva, E. A. (2022). Voice controlled smart home automation system using Bluetooth technology. In *Proceedings of the 2021 4th International Conference on Recent Trends in Computer*

Volume: 8 Issues: 26 [March, 2025] pp. 189 - 199]
Jurnal Penyelidikan Sains Sosial (JOSSR)
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DOI: 10.55573/JOSSR.082620

Science and Technology (ICRTCST) (pp. 1-5). IEEE. https://doi.org/10.1109/ICRTCST54752.2022.9781967

Szyc, K., Nikodem, M., & Zdunek, M. (2022). Bluetooth low energy indoor localization for large industrial areas and limited infrastructure. *Ad Hoc Networks, 134*, 103024. https://doi.org/10.1016/j.adhoc.2022.103024

Tosi, J., Taffoni, F., Santacatterina, M., Sannino, R., & Formica, D. (2017). Performance evaluation of Bluetooth Low Energy: A systematic review. Sensors, 17(12), 2898. https://doi.org/10.3390/s17122898

Wang, R., Jiang, S., Ma, D., Sun, Q., Zhang, H., & Wang, P. (2022). The energy management of multiport energy router in smart home. IEEE Transactions on Consumer Electronics, 68(4), 344–353. https://doi.org/10.1109/TCE.2022.3200931

Yuneela, K., & Sharma, A. (2022). A review paper on technologies used in home automation system. Proceedings of the 2022 6th International Conference on Computing Methodologies and Communication (ICCMC), 123-128. IEEE. https://doi.org/10.1109/ICCMC53470.2022.9753928