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# Design of a Monitoring and Tracking System for Children and Patients with Mental Needs Using Arduino

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# تصميم نظام مراقبة وتتبع للأطفال والمرضى ذوي الاحتياجات النفسية باستخدام Arduino

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**الملخص**

تقدم هذه الورقة تصميم وتنفيذ نظام مراقبة وتتبع يعتمد على **Arduino** بهدف ضمان سلامة الأطفال والمرضى الذين يعانون من اضطرابات عقلية ويحتاجون إلى رعاية على مدار 24 ساعة. وبالاعتماد على مبادئ إنترنت الأشياء**(IoT)** ، يدمج النظام متحكم **Arduino** مع حساسات الأشعة تحت الحمراء السلبية**(PIR)** ، ووحدات تحديد المواقع العالمية **(GPS)** والاتصال الخلوي**(GSM)** ، إضافةً إلى**Google Maps** ، وذلك لتوفير تنبيهات آنية وتتبع للموقع عند ابتعاد الطفل أو المريض عن نطاق الأمان المحدد.

يعمل النظام عبر ثلاث مراحل رئيسية. في المرحلة الأولى، يتم الكشف عن الحركة في الظلام باستخدام حساسات**PIR** ، مما يؤدي إلى تفعيل الإنذارات وإرسال رسائل نصية قصيرة **.(SMS)** في المرحلة الثانية، تتم مراقبة حدود منطقة الأمان، حيث يتم إرسال تنبيه عند خروج الشخص من النطاق المحدد. أما في المرحلة الثالثة، فيتم تتبع موقع الهدف باستخدام نظام**GPS** ، مع توفير تحديثات آنية كل دقيقة، وإرسال رسالة نصية تحتوي على رابط **Google Maps** لعرض الموقع بدقة.

يتميز النظام بانخفاض التكلفة، والموثوقية، وسرعة الاستجابة، حيث يتيح لمقدمي الرعاية وأولياء الأمور تلقي إشعارات فورية وبيانات دقيقة عن الموقع. كما أن تصميمه المعياري يتيح إمكانية إضافة مزايا جديدة بسهولة، مما يجعله حلاً عمليًا وفعالًا لحماية وتتبع الأفراد الأكثر عرضة للمخاطر.

**الكلمات الدالة:** Arduino، نظام تتبع، المراقبة، السلامة، حساسات الأشعة تحت الحمراء السلبية (PIR)، نظام تحديد المواقع العالمي (GPS)، النظام العالمي للاتصالات المتنقلة (GSM)، Google Maps.

**Abstract**

This paper presents the design and implementation of an Arduino-based monitoring and tracking system to ensure the safety of children and patients with mental illnesses requiring 24-hour care. Leveraging Internet of Things (IoT) principles, the system integrates Arduino as a controller, passive infrared (PIR) sensors, and GPS/GSM modules with Google Maps to provide real-time alerts and location tracking when a child or patient moves away from a defined safe zone. The system operates in three stages. First, it detects motion in the dark using PIR sensors, triggering alarms and SMS alerts. Second, it monitors the boundaries of the safe zone and sends alerts if the target exits the designated area. Finally, it tracks the target's location via GPS, providing real-time updates every minute and sending an SMS with a Google Maps link for precise location retrieval. The system is cost-effective, reliable, and responsive, providing caregivers and parents with real-time notifications and accurate location data. Its modular design allows for easy integration of new features, making it a practical and effective solution for protecting and tracking vulnerable individuals.

**Keywords**: Arduino, tracking system, monitoring, safety, passive infrared (PIR) sensors, GPS, GSM, Google Maps .

## Introduction

Safety is now the most challenging task in an increasingly complex and fast-paced world. Everyone wants to be safe, but in the current scenario, no one is truly safe—even in their own homes. This is especially true for children, patients, and individuals with special mental needs.Caring for children and patients with special mental needs, such as autism or Alzheimer's, is an extremely challenging and stressful task, as it requires full attention and care 24 hours a day. Caregivers often face tremendous stress and fatigue, as traditional monitoring methods, such as constant visual supervision or simple alarms, are frequently insufficient to address these challenges. These children or patients may exhibit unexpected behaviors, such as wandering off, growing disoriented, or struggling to communicate their needs. For example, children with autism may suddenly leave a safe area without warning, while Alzheimer's patients may grow disoriented and lose their way, even in familiar environments. These situations can be dangerous, as individuals may not know the risks ahead, such as traffic, open water, or unsafe areas.Therefore, the need for advanced monitoring and tracking systems has become more important than ever to ensure the safety and security of individuals. The emergence and development of Internet of Things (IoT) technologies, along with the diversity of microcontrollers of various types including Arduino, have opened up new horizons for designing innovative solutions to protect vulnerable individuals. These systems are especially vital and effective when individuals wander, get lost, or face potential dangers. Monitoring, tracking, and tracing individuals in real-time enhances their safety and provides comfort, assistance, and reassurance to caregivers, parents, and guardians. As a result of saving effort and time and increasing the safety and security rate, monitoring and tracking systems provide quick solutions in emergencies due to early alert of the child or patient moving away from the safe zone boundaries. Designing a Monitoring and Tracking System for Children and Patients with Special Mental Needs Using Arduino" is a technical solution that aims to improve the care and safety of vulnerable individuals. This system uses Arduino, a simple, easy-to-use, and affordable microcontroller, GPS and GSM sensors, and technologies to monitor the movements of individuals with special needs. The system sends real-time alerts and short messages to caregivers via SMS and alarms if the person wanders outside the safety zone or gets lost. These alarms ensure rapid intervention and reduce the risk of harm or loss. The system provides accurate location tracking by integrating the Internet of Things (IoT) and Google Maps, making it easier for monitors and caregivers to locate and assist the individual in need. The importance of designing a monitoring and tracking system for children and patients with special mental needs helps prevent exposure to danger and avoid accidents that may expose individuals to loss or loss of their lives.

The system provides real-time alerts by sending instant notifications through SMS and alarms to those responsible for the care and concern for the safety of the child or patient, allowing them to respond quickly in emergencies. This real-time communication ensures that caregivers are always aware of the person's location and movements.

Arduino-based monitoring and tracking systems have gained popularity due to their high performance, flexibility, low cost, and easy integration with various sensors and communication modules. These systems can be designed to detect motion, monitor gates, and provide accurate real-time location tracking using technologies such as GPS and GSM. By combining these components, Arduino-based systems can create an efficient and robust framework for ensuring the safety and security of individuals, especially in hazardous situations.

Previous research has demonstrated the effectiveness of Arduino-based tracking systems in ensuring the safety of children. For instance, Moodbidri and Shahnasser (2017) developed a *Child Safety Wearable Device* that allows parents to request real-time information such as a child's location, temperature, and UV radiation levels through SMS. The device responds with the requested data, enabling parents to monitor their child's safety in various environments. Similarly, Patel et al. (2018) designed an *Arduino-Based Child Tracking System Using GPS and GSM*, where a tracking device placed in a child's bag responds to an SMS command with the child's exact location (latitude and longitude) via Google Maps. These systems highlight the potential of combining Arduino microcontrollers with GPS and GSM technologies to provide reliable and cost-effective tracking solutions. Previous attempts to address these issues have included wearable devices and smartphone-based tracking systems. While previous solutions have shown acceptable effectiveness, they are limited in their scope and functionality. For example, wearable devices may not be suitable for individuals who feel uncomfortable wearing them or who take them off without warning. Smartphone-based systems rely on the awareness and responsibility of the person holding the phone, a requirement that cannot be met with children or patients with mental disabilities. The proposed system builds on these previous efforts by combining the simplicity of Arduino with the power of the Internet of Things, providing a more comprehensive and easy-to-use solution. It is designed to be easy to install and use, with customizable features that can be adapted to different environments and needs.

The proposed system in this paper aims to achieve the following objectives:

•Help children and patients with special mental needs and protect them from the risk of getting lost and getting involved in serious accidents that may cost them their lives by providing real-time monitoring.

•Help parents and caregivers by reducing effort and fatigue by automating the monitoring and tracking process and enabling parents and caregivers to focus on providing care instead of constantly worrying about safety.

•Design a prototype for monitoring patients and people with mental needs using advanced communication tools, embedded systems, and sensors to solve problems in daily life.

•Develop a model of a monitoring and tracking system using Arduino that can be applied in real-world scenarios. The system should also be flexible and effective in terms of performance and cost.

•Leverage GPS and GSM technologies to provide accurate real-time location tracking, quickly finding individuals who wander or disappear and reducing search and rescue efforts.

**Literature Survey**

Previous studies conducted for the paper "Design of a monitoring and tracking system for children and patients with mental needs using Arduino" have delved into various aspects of vehicle tracking and child safety wearable devices utilizing technologies such as Arduino, GPS, GSM, Bluetooth, and RFID. Alshamsi et al. presented a real-time vehicle tracking system using Arduino Mega, demonstrating the application of Arduino in tracking vehicles (Alshamsi et al., 2016) [1]. Salunkhe et al. developed a vehicle tracking system for school buses employing Arduino, highlighting the importance of tracking systems for ensuring the safety of school children during transportation (Salunkhe et al., 2017) [2]. Tripathi introduced an Arduino-based child tracking system utilizing GPS and GSM technologies, emphasizing the role of such systems in enhancing child security (Tripathi, 2018) [6]. Moodbidri and Jahanser researched a child safety wearable device, shedding light on innovations in ensuring the safety of children through wearable technology (Moodbidri & Jahanser, 2017) [3]. Patil and Thiger reviewed an advanced child-tracking system based on Arduino Nano, underscoring the significance of technological advancements in child tracking for safety purposes (Patil & Thiger, 2018) [4]. Zaidi explored a child-tracking system using GPS and Arduino as part of a B.Sc. thesis, contributing to the field of child safety and tracking systems (Zaidi, 2019) [10]. Elakiya and Radhika conducted a survey on child safety wearable devices to prevent child trafficking using Arduino, addressing the critical issue of child trafficking through innovative technological solutions (Elakiya & Radhika, 2019) [8]. Isa et al. presented a study on children's security and tracking systems using Bluetooth and GPS technology at the IEEE International Conference on Control System, Computing, and Engineering, showcasing the integration of multiple technologies for enhanced child security (Isa et al., 2019) [7]. Bhate proposed a smart wristband for child tracking using a regression technique, offering a novel approach to child tracking for improved safety measures (Bhate, 2020) [11]. Khutar, Yahya, and ALRikabi designed and implemented a smart system for schoolchildren tracking, demonstrating advancements in tracking systems for school children (Khutar et al., 2021) [12]. San Hlaing, Naing, and Naing developed a GPS and GSM-based vehicle tracking system, highlighting the importance of such systems in vehicle tracking and management (San Hlaing et al., 2019) [9]. Zohari and Nazri focused on a GPS-based vehicle tracking system, presenting advancements in vehicle tracking technologies for efficient monitoring and management of vehicles (Zohari & Nazri, 2021) [13].

The following sections explain the design, implementation, and performance of the system, explaining its potential as a vital tool in the field of rescue and safety technology.

**System Overview**

A remote monitoring, tracking, and alerting system using sensors and phone alarms, based on an Arduino as the controller. This system utilizes the concept of the Internet of Things (IoT). It is built on an Arduino controller, various sensors (selected according to their function and purpose), GPS/GSM technologies, and Google Maps as the software platform. The block diagram is shown in Figure 1.

The proposed system in this paper remotely monitors and tracks the location of a child or patient with special mental needs. It alerts parents or caregivers if the child or patient moves outside a specified area through SMS notifications and audio alarms. As a result, parents will have a powerful tool to monitor their children even when they cannot physically be present.

This research's proposed monitoring and tracking system is divided into three stages. These stages are determined based on the location and movement of the target (child or patient):

1.The First Stage: When the Target Moves in the Dark

When the target's movement is detected in the dark using a PIR sensor, and the target leaves the bed, the system will trigger an alarm and send a short text message (SMS) to the phones of the assigned observers. This alerts them to the target's movement.

2.The Second Stage: When the Target Passes the Gate

When the target leaves the designated area (e.g., a room) and passes through the door, the system will activate an alarm and send a short text message to the observer's mobile phone. This notifies the observer that the target has left the room.

3.The Third Stage: When the Target Moves Away from the Safe Zone and Gets Lost

If the target can move in the dark and leave the bed, or if the target exits through the door unnoticed (due to an alarm malfunction, system failure, or the observer's inability to respond to the alerts), and the target moves away from the safe zone (e.g., home) and gets lost, the third stage is automatically activated. In this stage, the target is tracked using the GPS. Once the target's location is determined, a text message containing an internet link is sent to the observer's mobile phone. This link allows the observer to view the target's location on Google Maps, enabling them to locate and reach the target quickly.

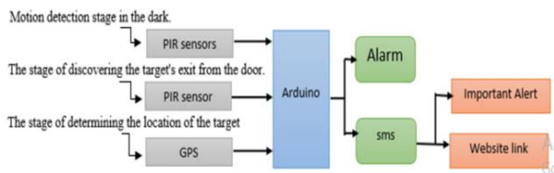


**Fig. 1: Block Diagram of an Arduino-Based Monitoring and Tracking System for Children and Patients with Mental Health Needs.**

## SYSTEM DESIGN AND ARCHITECTURE

### A. Stage 1: Monitoring and alarm circuit detects the movement of a child or patient (the target) in the dark.

Figure 2 shows the block diagram of the target monitoring and tracking circuit for dark environments. This circuit detects the target's movement when entering or exiting a specified area, as well as movement in the dark. When the target's movement is detected, the circuit triggers an alarm and sends a notification to the observers. This circuit is designed using a Passive Infrared (PIR) sensor. This electronic sensor detects the thermal energy emitted by the body of a living organism in the form of infrared rays, which are invisible to the human eye. The working principle of this circuit is summarized as follows: The PIR motion sensors detect infrared radiation, generate an electric charge when exposed to heat, and send a signal to the Arduino based on the intensity of the infrared radiation detected. The design of this circuit provides flexibility and multiple options for the observers. They can design and install the system by placing the sensors in different locations and the required number, depending on the specific conditions or purposes required for the circuit.

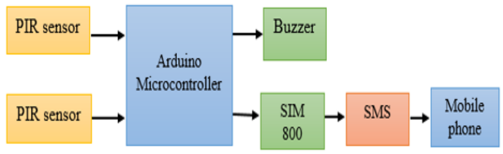


**Fig. 2: Block diagram of the monitoring and alarm circuit for the movement of a child or patient (target) in the dark.**

The monitoring and alarm circuit for the movement of the child or patient (target) in the dark is shown in Figure 3.

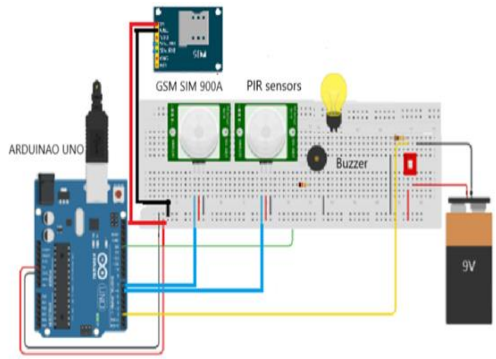


**Fig.3: Wiring diagram of target motion detection and dark alarm circuit.**

The key components of the circuit illustrated in Figure 3, along with their connection methods, are detailed in Table

**Table 1: Wiring instructions for the circuit components are shown in Figure 3.**

| Wire color | PIR sensor to Arduino (UNO) | SIM900 to Arduino | GPS NEO-6 to Arduino | BUZZER to Arduino |
|---|---|---|---|---|
| Red | VCC to +5V | 5V to PIN 5V | 5V to PIN 5V | 5V to PIN 5V |
| BLUE | OUT to PIN#2 | | | |
| Black | GND to PIN GND | GND to PIN GND | GND to PIN GND | GND to PIN GND |
| Green | | SIM-TXD to PIN 10 | SIM-TXD to PIN 13 | |
| Yellow | | SIM-RXD to PIN 11 | SIM-RXD to PIN 12 | |

### 1) The circuit implementation

The sensor sets as follows: When moving the potentiometer in a clockwise direction its value increases, and vice versa, and the values are adjusted arbitrarily.

- The jumper setting on the PIR sensor is set to HIGH.
- Adjust the Time Delay potentiometer clockwise in the middle (almost 2 mins).
- Adjust the sensitivity range of the potentiometer maximum counter-clockwise (almost 2 meters).

### 2) Workflow

As shown in the workflow graph in Figure 4,

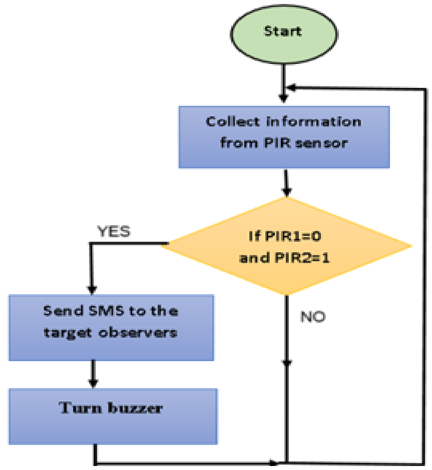


**Fig. 4: Workflow of the Monitoring and Alarm Circuit for Detecting the Movement of a Child or Patient (the Target) in Dark Environments.**

when the room lights are off and the target is sleeping on the bed, the sensor installed at the head of the bed is in a high position (ON), while the sensor installed under the bed is in a low position (OFF). When the target leaves the bed, the signal from the first sensor changes to low (OFF), and the signal from the second sensor changes to high (ON). At this point, the condition is met, and a signal is sent to the Arduino. The Arduino then triggers the alarm bell and sends a message to the observers via the GSM unit, notifying them that the target has left the bed. However, if the lights are on, the condition for the two sensors is not met. As a result, regardless of the target's movement, the Arduino will not issue any commands.

### B. Stage 2: Door Alarm Circuit.

The door alarm circuit is shown in Figure 5.If the observer fails to notice the first warning or if the first-stage circuit malfunctions and does not trigger the alarm for any reason, the door alarm circuit will activate when the target attempts to leave the room. This circuit detects when the target has exited through the door, sends a notification via GSM, and triggers the second-stage alarm. However, if the door is closed normally, the alarm will not be activated.

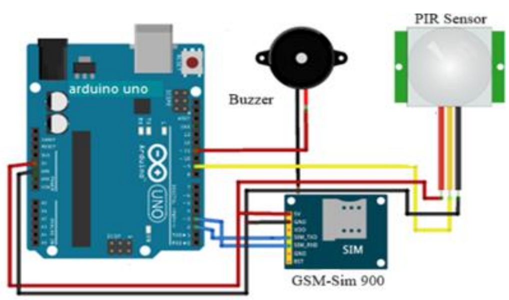


**Fig. 5: Wiring diagram of the Door Alarm Circuit Connections.**

To connect the previous circuit, we use the components and connection instructions shown in Table 2

**TABLE 2: Wiring instructions for the circuit components are shown in Figure 5.**

| Wire color | PIR sensor to Arduino (UNO) | SIM900 to Arduino | GPS NEO-6 to Arduino |
|---|---|---|---|
| Red | VCC to +5V | 5V to PIN 5V | 5V to PIN 5V |
| BLUE | OUT to PIN#2 | | |
| Black | GND to GND | GND to GND | GND to GND |
| Green | | SIM-TXD to PIN 10 | SIM-TXD to PIN 13 |
| Yellow | | SIM-RXD to PIN 11 | SIM-RXD to PIN 12 |

The sensor sets as follows: When moving the potentiometer in a clockwise, direction, its value increases, and vice versa, and the values are adjusted arbitrarily.

- The jumper setting on the PIR sensor is set to HIGH.
- Adjust the Time Delay potentiometer clockwise in the middle (almost 2 mins).
- Adjust the sensitivity range of the potentiometer maximum counter-clockwise (almost two meters).

**1) The circuit implementation**

The circuit implementation is described as follows:

- Begin by connecting the power cable of the door alarm security system to the power supply.
- When an individual passes within a specific distance (the sensing distance is adjustable), the PIR sensor detects the motion.
- Upon detecting motion, the microcontroller sends a signal to activate the LED and buzzer sound module.
- Once the LED and buzzer are activated, the GSM module sends a notification message to the monitor's mobile phone.

**2) Workflow**

Figure 6 shows a monitoring and tracking system for a child or a patient with special mental needs for the second stage of the proposed system in this paper. This system is based on GSM, which works with Arduino and a PIR sensor in front of the building door. When the target leaves the door, the PIR sensor senses the movement and becomes (PIR=ON) and gives a signal to the microcontroller to give the command to trigger the alarm, and also gives the command to the GSM module to send a message to the monitors to alert them that the target has left the building. In the case of (PIR=OFF), the system will repeat a new cycle of monitoring and alarming.

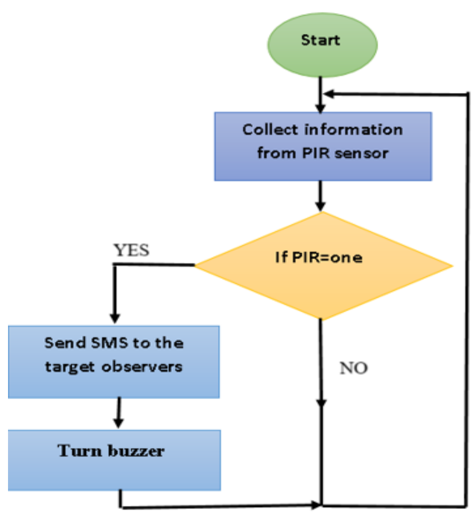


**Fig. 6: Workflow of the Door Alarm Circuit.**

### C. Stage 3: Alarm and Target Tracking Circuit outside the Building

Figure 7 shows the block diagram of the alarm and tracking system to detect the target moving away from the specified area.

This system is an embedded system designed to enable the Arduino to function as a tracking system using GPS and GSM technologies. If the target exits the building, the tracking system will activate to locate the target.

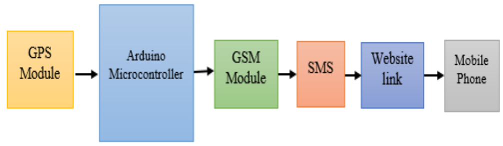


**Fig. 7: Shows the block diagram of the alarm and tracking system to detect the target moving away from the specified area.**

The main components used in the design of the alarm and tracking circuit shown in Figure 8 are the sensors, Arduino, GSM, and GPS.. Power is provided to all the components using a battery. The values of the required parameters are obtained using the sensors.

Arduino is programmed in such a way that it displays the obtained values in the LCD and compares the values with the preset values. The values are sent to the monitoring center using GSM. The location of the target is obtained using GPS.

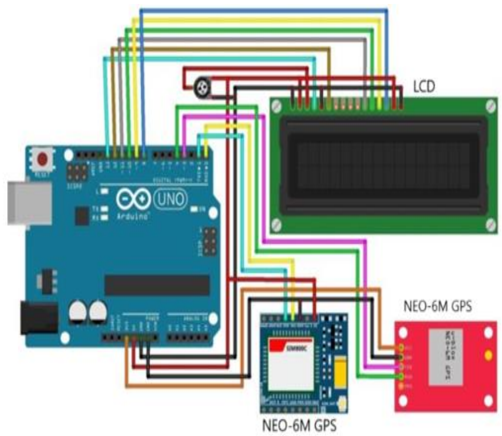


**Fig. 8: Connection Diagram of the Alarm and Tracking Circuit for Target Exit Detection.**

The most important components and their connection instructions for assembling the circuit above in Figure 666 are shown in Table 3.

**TABLE 3: Wiring instructions for the circuit components shown in Figure 8.**

| Wire color | PIR sensor to Arduino (UNO) | SIM900 to Arduino (UNO) | GPS NEO-6 to Arduino (UNO) |
|---|---|---|---|
| RED | VCC to +5V | 5V to PIN 5V | 5V to PIN 5V |
| BLUE | OUT to PIN#2 | | |
| BLACK | GND to PIN GND | GND to PIN GND | GND to PIN GND |
| Green | | SIM-TXD to PIN 10 | SIM-TXD to PIN 13 |
| Yellow | | SIM-RXD to PIN 11 | SIM-RXD to PIN 12 |

### 1) The circuit implementation

The circuit implementation is described as follows:

a. The GPS sensor is initialized with a baud rate of 9600.

b. The GPS module's TX pin is connected to the RX pin (Pin 0) of the Arduino.

c. Upon powering the circuit, the GPS sensor requires an initialization period of approximately 2 to 3 minutes to become operational.

d. The GPS sensor outputs various data strings, including GPGGA, GPGSV, and GPGSA. Among these, the GPGMC data string is utilized for further processing.

e. The relevant data is extracted from the GPGMC string and displayed on the LCD.

f. The processed information is subsequently transmitted as a message to the predefined mobile number specified in the code.

**2) Workflow**

Figure 9 illustrates the flowchart of the third-stage GPS-based tracking system designed for monitoring children and special needs patients, as proposed in this study. The GPS module initiates continuous communication with satellites to acquire and update geographical coordinates, with the LED indicator on the module flashing once the location is successfully locked. Concurrently, the GSM module's LED indicator flashes upon establishing a connection with the mobile communication network, signaling its readiness for data transmission. When both LED indicators (GPS and GSM) are active, the user can activate the system by sending an "ON" command via text message to the GSM module. In response, the GSM module sends a message containing the target location's coordinates and a Google Maps URL link for precise visualization.

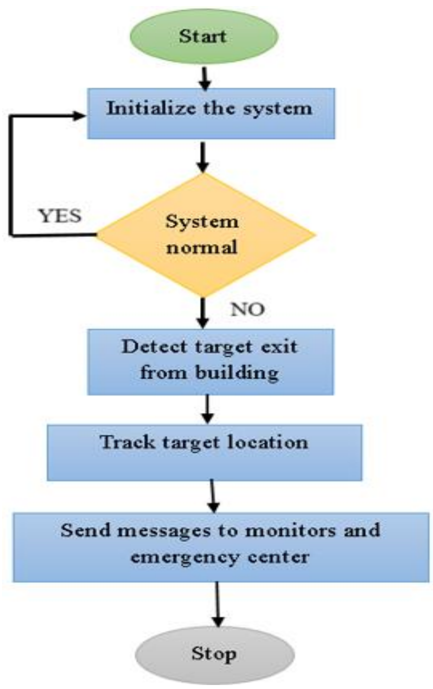


**Fig. 9: The flow chart of the third-stage GPS-based child and special needs patient tracking system.**

The system updates the location information at one-minute intervals to ensure real-time tracking accuracy. To deactivate the system, the user sends an "OFF" command to the GSM module, which halts further message transmissions and resets the system to initiate a new monitoring cycle. This workflow ensures reliable and continuous tracking, providing real-time location updates and user-controlled activation and deactivation functionalities.

**EXPERIMENT AND RESULTS.**

Figure 10 provides a general view of the project prototype.

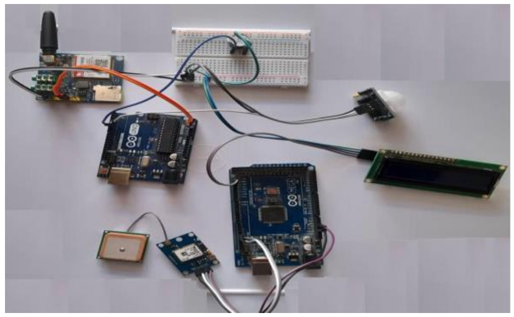

**Fig. 10: A general view of the system prototype.**

Figure 11 illustrates the monitoring and alarm circuit for target movement in the dark.

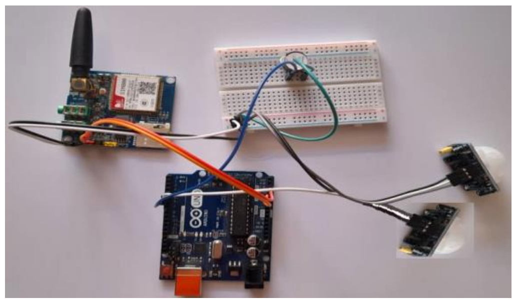

**Fig. 11: The monitoring and alarm circuit for target movement in the dark**

The monitoring and alarm circuit was tested to detect the target movement in the dark several times and the response time was recorded each time. The circuit showed a fast response and high performance each time. The quality of the circuit's performance depended on the location of the PIR sensors and adjusting their sensing range. The efficiency of the circuit can be increased by increasing the number of PIR sensors and choosing the appropriate places to install them.

In Figures 12 and 13 alarm messages appear when the target leaves the bed or when movement is detected in the dark.

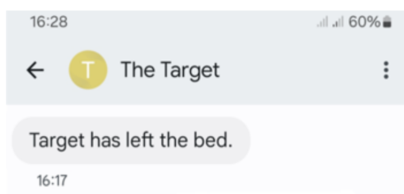


**Fig. 12: Shows the alarm message that appears when the target leaves the bed.**

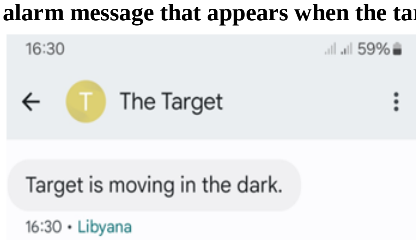


**Fig. 13: Shows the alarm message that appears when the target's movement is detected in the dark.**

Figure 14 shows the practical implementation of the circuit for detecting the target leaving the door. This circuit was very simple in construction but perfect in performance, as no failures were recorded in detecting the target leaving the door during multiple tests. In addition, the circuit was quick to warn and alert the observer with a short message, as shown in Figure15.

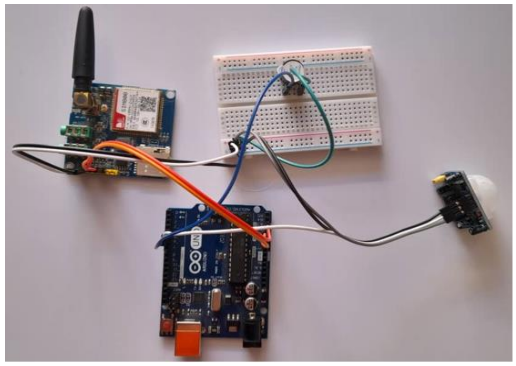

**Fig. 14: Illustrates the practical circuit designed to detect the target's exit from the door.**

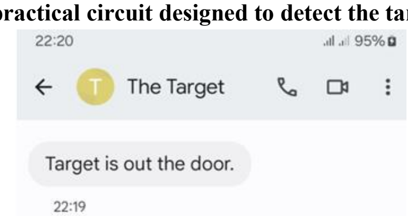


**Fig. 15: Illustrates the alarm message generated when the target exits the door.**

Fig. 16 illustrates the GPS-based target tracking circuit during testing.

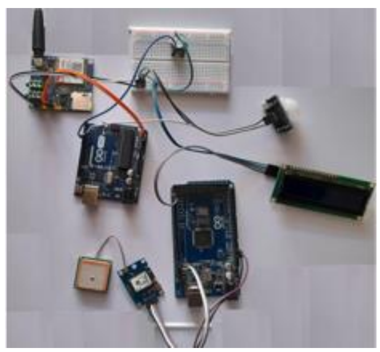

**Fig. 16: Illustrates the GPS-based target tracking circuit.**

The process begins by uploading the program to the Arduino. The system then waits for the GPS to acquire coordinates and the GSM to establish a phone line. Once the GPS obtains coordinates, its LED blinks every 3–4 seconds.

Similarly, the GSM LED blinks every 3–4 seconds after acquiring a line. When both the GPS and GSM LEDs blink, the modules are ready to transmit information. This occurs when the user receives a message from the second stage stating, "Target has left the building." This message triggers the controller to issue a "Start" command, activating the target tracking circuit.

The GPS module sends the target's location coordinates, the Arduino extracts the GPS data, and the GSM module transmits a message containing the target's coordinates to the controller. The coordinates are shown on the LCD screen in Figure 17


**Fig. 17: Displays the coordinates on the LCD screen.**

The response message, shown in Fig. 18 includes the coordinates and a Google Maps URL. Once activated, the tracking circuit updates the target's location every minute. To terminate the system, the user sends a "Stop" command to the GSM module, which halts the system immediately.

To restart, the controller requires the "Target outside the building" message to issue the "Start" command again.


**Fig. 18: Shows the coordinates and URL for Google Maps.**


**Fig. 19: Displays the target map generated by activating the link received in the location message.**

The target's location map, displayed in Fig. 19, is updated at programmed intervals as defined in the circuit's operating code. The circuit demonstrates high accuracy in locating the target, with a minor error margin that varies depending on whether the target is in enclosed or open spaces. This issue can be mitigated by using higher-quality and more efficient GPS components.

**Conclusion**

The main results of the practical experiments are summarized in the following points:

- The circuit built on the PIR sensor effectively detected the target's movement in the dark and their departure from the bed. This led to the activation of alarms and the sending of short messages to the observers without any failure or delay.
- The circuit for detecting the target's exit from the door reliably detected the target's exit through the gate and recorded no malfunctions or failures during testing.
- The circuit for real-time tracking via the Global Positioning System (GPS) successfully tracked the target with high accuracy, delivering alerts through short messages containing Google Maps links to pinpoint the location. The system effectively integrated Google Maps, sending links with the target's coordinates, which enabled observers to quickly and precisely identify the target's location.
- The system, when tested, gave a quick response in detecting movement, sending alerts, and updating the target location, ensuring timely intervention from the observers.
- The system succeeded in recording high performance and working efficiently in all stages (movement in the dark, exiting the gate, and GPS tracking), proving its reliability and effectiveness.
- The system succeeded in recording high performance and working efficiently in all stages (movement in the dark, exiting the gate, and GPS tracking), proving its reliability and effectiveness.
- Through multiple tests, the system did not record any failures in detecting target movement, triggering alarms, or sending SMS.
- The system succeeded in sending SMS alerts in real time.
- The simple and uncomplicated system design is scalable and expandable, making it adaptable to different monitoring scenarios.
- The system is cost-effective and available for practical applications because it uses widely available and inexpensive components.
- The system's efficiency depends on sensor tuning, sensitivity adjustments, and the skill involved in selecting optimal installation locations of sensors to monitor the target effectively.
- The system has proven to be a reliable tool for enhancing the safety and security of children and patients with special mental needs.
- In conclusion, the system has successfully addressed the challenges of monitoring and tracking vulnerable individuals, demonstrating high performance, reliability, and real-world application.

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