



Smart Wearable Iot Device For Child Safety And Location Tracking

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Abstract: Child safety is a growing concern in today's fast-paced world. Traditional monitoring methods are no longer sufficient to track children in real-time. This paper proposes a smart wearable IoT device designed to provide child location tracking and emergency alerting through a GPS and GSM-enabled wearable. It connects with a parent's mobile device and sends live location updates, SOS alerts, and geofence notifications. The system is lightweight, cost-effective, and suitable for real-world implementation. Parents can monitor their child's location using a mobile application that communicates with the device via a cloud platform. In the event of danger, the child can press the SOS button, instantly notifying guardians with the precise location.

Index Terms — The proposed system focuses on child safety through real-time GPS tracking and geofencing alerts. It incorporates an Arduino Nano microcontroller, GPS and GSM modules, and is designed as a smart IoT wearable device. The system enables real-time monitoring, emergency alert notifications, and enhances location-based services. This cost-effective solution supports smart parenting technology by ensuring the safety and security of children in dynamic environments.

I. INTRODUCTION

In today's fast-paced world, ensuring the safety of children has become a growing concern for parents and caregivers. With increasing cases of child abduction, getting lost in crowded places, or wandering into unsafe areas, the need for a reliable child monitoring solution is more urgent than ever. As urban environments grow more complex and technology becomes a central part of daily life, families seek peace of mind knowing their children are safe—even when they are not physically present. Many working parents struggle with balancing professional responsibilities and constantly supervising their children, especially in public spaces like parks, malls, or during school commutes. Traditional methods like verbal instructions or physical boundaries often fall short in unpredictable situations. Hence, there is a strong social demand for innovative safety measures that offer real-time monitoring and immediate alerts.

Existing solutions such as smartphones or RFID tags offer partial security but lack real-time tracking and active alert systems. With advancements in the Internet of Things (IoT), compact wearable systems can now offer continuous monitoring and two-way communication. This paper introduces a smart wearable IoT device that combines GPS for real-time location, a GSM module for data communication, and an emergency alert system (SOS button) that provides rapid response in critical situations. The device interacts with a mobile application to enable parents to monitor their child's movement, receive notifications, and store history on a cloud database. In today's fast-paced and technology-driven world, ensuring the safety of children has become increasingly challenging. With the rise in urban populations, traffic, public gatherings, and other environmental risks, it is not uncommon for children to become lost or separated from their parents or guardians. While conventional safety

measures—such as verbal instructions, identification tags, or school tracking logs—are still in use, they lack the immediacy and precision needed in real-time scenarios

With the growth of smart technologies and the Internet of Things (IoT), there is an opportunity to implement wearable solutions that not only monitor a child's location but also facilitate quick communication in emergency situations. Smart wearable devices combine compact hardware components with cloud connectivity and mobile applications to provide a continuous, always- available safety network. These devices can alert parents when their child moves beyond designated areas (geofencing), and also allow the child to send an SOS signal at the press of a button.

Technology can play a crucial role in bridging this gap, providing both prevention and rapid response in case of emergencies. By integrating location tracking and emergency communication, such systems can reduce anxiety for parents while promoting freedom and independence for children in a controlled and secure way. This project aims to address these social challenges through a practical, tech-enabled solution that enhances child safety and parental assurance. The solution not only enhances child safety through live monitoring and quick response capabilities but also encourages independence for children while maintaining peace of mind for parents.

II. BACKGROUND

The safety and security of children in public and private spaces have always been a primary concern for parents and guardians. With the rapid increase in urban population, rise in crimes against children, and growing complexity of daily life, traditional safety approaches are proving insufficient. Manual methods such as verbal instructions, identification cards, and supervised watch are unreliable in dynamic and busy environments like malls, amusement parks, school premises, and public transport. These situations call for technology-driven solutions that offer real-time monitoring, remote accessibility, and instant alerts in case of emergencies. With the evolution of smart systems, the Internet of Things (IoT) has emerged as a transformative technology enabling physical objects to interact with the digital world through internet connectivity and intelligent sensors. IoT allows for the development of compact, connected wearable devices that can monitor physical parameters and send information to a remote system with minimal human intervention. Among the technologies driving this revolution, GPS (Global Positioning System) is a well-established solution for determining the location of objects or individuals with a high degree of accuracy. GPS-based systems can track outdoor locations globally using satellite signals, making it ideal for tracking mobile targets such as children. However, GPS alone cannot send location updates to caregivers in real-time.

To bridge this communication gap, GSM/GPRS (Global System for Mobile Communication / General Packet Radio Service) modules are incorporated into the system to transmit GPS coordinates via SMS or internet services to a mobile phone or server. A microcontroller, such as the ESP32 or Arduino, acts as the brain of the system, handling sensor input, decision-making, and communication tasks. Earlier solutions included mobile apps that share location using a smartphone's built-in GPS. While functional, such solutions require the child to carry and maintain a smartphone, which may not be ideal or practical, especially for younger children. Other alternatives, like RFID-based systems or passive GPS loggers, either lack real-time capability or are confined to limited environments like schools. To overcome these limitations, recent research has focused on building smart wearable devices—like wristbands or pendants—that are small, comfortable, durable, and feature-rich. These devices are equipped with multiple functionalities such as:

- SOS/panic buttons
- Geofencing alerts
- Cloud-based data logging
- Mobile app integration for live monitoring

Earlier child tracking systems often relied on basic GPS loggers or mobile phone apps, but these solutions come with several limitations—such as dependence on smartphones, lack of emergency response mechanisms, high power consumption, and limited network coverage. Additionally, many systems do not offer features like geofencing, SOS alerts, or cloud data storage. By integrating multiple functionalities into a single wearable unit, the proposed system aims to address these limitations. It not only tracks a child's location in real time but also provides a way for the child to send an emergency alert to parents. With geofencing, the system can define safe zones, and automatically alert guardians if the child leaves these zones. Moreover, with increasing awareness of data privacy and digital security, it is also essential that these IoT devices use encrypted communication channels and offer secure cloud integration to protect sensitive user data.

III. ARCHITECTURE

The architecture of the proposed system is based on a modular and layered approach that ensures real-time tracking, reliable communication, user-friendly monitoring, and emergency alert functionality. The entire system is divided into three logical layers: Device Layer, Communication Layer, and Application Layer. These layers work in synchronization to provide a seamless and efficient child tracking and safety solution. The architecture of the Smart Wearable IoT Device is designed to be compact, efficient, and reliable for real-time child monitoring. It integrates multiple hardware and software components to ensure seamless communication between the wearable device and the parent's smartphone via cloud or GSM-based data transmission.

6to4 or Teredo, NAT64 is based on algorithmic mapping translation rather than encapsulation, allowing for direct communication over an IPv6-only transport network. This mechanism is particularly useful in data centers, cloud environments, ISPs, and enterprise networks that are transitioning to IPv6 while maintaining access to legacy IPv4-based services.

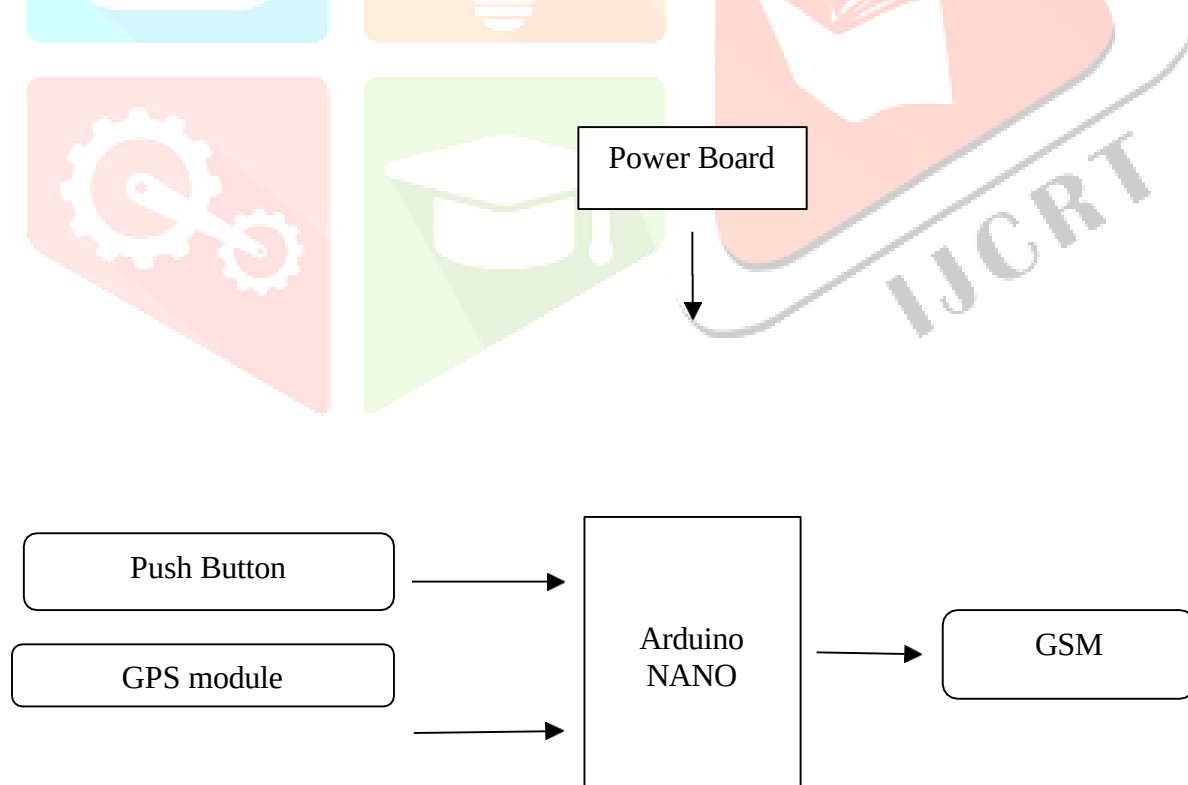


Fig. 1. NAT64

1. Arduino IDE:

It gathers the statistics and information from the various modules connected to it, such as the Global positioning system module. This system is activated by the Arduino Uno by receiving short message service from GSM module. This module is used as a link to send the data received by the Arduino Uno through short message service to a mobile.

2. OrCAD :

OrCAD is a proprietary software tool suite used primarily for electronic design automation (EDA). The software is used mainly by electronic design engineers and electronic technicians to create electronic schematics and electronic prints for manufacturing printed circuit boards. The name OrCAD is a portmanteau, reflecting the company and its softwares origins: Oregon + CAD. OrCAD PCB Designer is a printed circuit board designer application, and part of the OrCAD circuit design suite.

3. Esp32 microcontroller :

ESP32 Development board is based on the ESP WROOM32 WIFI+BLE Module. This is the latest generation of ESP32 IoT development module. This development board breaks out all ESP32 modules pins into 0.1" header and also provides a

3.3 Volt power regulator, Reset and programming button and an on-board CP2102 USB to TTL converter for programming directly via USB port. At the core of this module is the ESP32 chip, which is designed to be scalable and adaptive. ESP32 integrates a rich set of peripherals, ranging from capacitive touch sensors, Hall sensors, low-noise sense amplifiers, SD card interface, Ethernet, high-speed SDIO/SPI, UART, and I²C.

4. Step-down Module :

This is a LM2596 based Adjustable DC to DC Buck converter module. This is a non isolated step down module with adjustable output of 1.5 volt to 35 volt and rated current of 2 Ampere. The maximum current can go up-to 3 ampere if heat sink and proper cooling technique is used.

5. DHT11 Sensor :

It uses thermistor to measure the surrounding air temperature and a capacitive humidity sensor to measure the moisture content. It sends digital readings on data pin so there is no need to use an Analog to Digital Converter (ADC) chip. It is very easy to use but the only problem with this sensor is that it sends data every 2 seconds. There are lot of resources online on how to interface DHT11 Sensor to Arduino which will make this sensor easy to interface to any Arduino Board.

6. Push Button:

Push Button Switch is widely used as a standard input “buttons” on electronic projects. These work best when you mount it on PCB but can also be used on a solder less breadboard for temporary connections in prototypes. The pins are normally open (disconnected) and when the button is pressed they are momentarily closed and complete the circuit

7. Conclusion:

The development of a smart wearable IoT device for child safety and location tracking offers a practical and efficient solution to one of today's most pressing concerns—ensuring children's security. By integrating real-time GPS tracking, SOS alerts, and geofencing functionalities, the system empowers parents and guardians with continuous awareness of their child's whereabouts. This project demonstrates how IoT technologies can be leveraged to create low-cost, portable, and user-friendly safety devices. The wearable ensures that location data is collected and transmitted securely, and emergency alerts are delivered instantly through mobile applications. Additionally, the incorporation of cloud storage, analytics, and smartphone integration adds to the effectiveness and accessibility of the system. Overall, the proposed solution not only enhances parental peace of mind but also sets the foundation for future improvements such as health monitoring, AI-based movement prediction, and integration with school or transportation systems.

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