IJIRIS: International Journal of Innovative Research in Information Security
Volume 12, Issue 03, March 2026
E-ISSN: 2349-7017
P-ISSN: 2349-7009
https://www.ijiris.com/archives
https://doi.org/10.26562/ijiris.2025.v1203.06

Child/Pet Safety Device with GPS

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Publication History
Manuscript Reference No: IJIRIS/RS/Vol.12/Issue03/ISMR26.MRIS10085
Research Article Open Access| Double-Blind Peer-Reviewed| Article ID: IJIRIS/RS/Vol.12/Issue03/ISMR26.MRIS10085
Received: 31, January 2026, Revised: 14, February 2026, Accepted: 17, March 2026, Published Online: 25,March 2026.
https://www.ijiris.com/volumes/Vol12/iss-03/06.ISMR26.MRIS10085.pdf
Article Citation: Naveen,Nithyananthan,Sriram,Kanagavel,Menagadevi(2026),Child/Pet Safety Device with GPS ,IJIRIS:International Journal of Innovative Research in Information Security, Volume 12, Issue 03 of 2026 pages 111-113
Doi:> https://doi.org/10.26562/ijiris.2026.v1203.06
BibTeX Key: Naveen@2026Child/Pet
IJIRIS papers should be cited as IJIRIS (International Journal of Innovative Research in Information Security,AM Publications, India 2026, ISSN 2349-7017, https://doi.org/10.26562/ijiris.2026.v1203.06 The journal's official abbreviation is IJIRIS.
Orcid: https://orcid.org/0009-0004-9398-7488
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Abstract: This project presents the design and implementation of a compact, wearable GPS tracker integrated with GSM/Wi-Fi communication modules, aimed at enhancing safety monitoring for children and pets. The device continuously acquires real-time location data using a GPS module and securely transmits this information to a cloud backend via cellular or wireless networks. Users interact through a dedicated mobile application that supports customizable geofence configurations, instant alerts upon boundary breaches, and SOS emergency notifications. Power management strategies extend battery life to ensure long-term, uninterrupted operation. Firmware development involves reliable GPS data parsing and efficient data transmission protocols. The cloud backend offers RESTful APIs for data handling, geofence logic, and notification delivery, supported by a secure database structure. Testing confirms the system's location accuracy, battery endurance, and prompt alert response. The solution addresses limitations of existing trackers by combining real-time accuracy, user-friendly control, and robust alert systems. Future enhancements envision integration of health sensors, AI-based predictive alerts, and expanded communication features. This wearable device provides reliable personal safety, peace of mind, and a foundation for developing more intelligent safety technologies.

1. INTRODUCTION

Child and pet safety are top priorities for families, but achieving peace of mind can be challenging in today's busy and unpredictable environments. Parents and pet owners often worry about the possibility of children wandering off while at school, during outings, or even from their homes. Likewise, pets are curious and may escape, get lost, or be exposed to unforeseen dangers such as traffic, strangers, or hazardous areas if not constantly supervised. Traditional methods of ensuring safety—such as physical fences, supervision, or tags—are limited in their effectiveness, especially when instant location information and rapid response are critical. The consequences of losing a child or pet not only cause emotional distress but can also lead to serious safety risks or permanent separation. GPS (Global Positioning System) technology has emerged as an advanced solution to these challenges. A wearable GPS tracking device is a small gadget that attaches comfortably to a child's wrist or a pet's collar. These devices utilize satellites to provide real-time location data, which can be viewed remotely using a smartphone application or web dashboard. Modern trackers feature geofencing capabilities: users can define "safe zones"—such as a home, park, or school—and receive immediate alerts if the child or pet leaves this predefined area. The development of such IoT-enabled safety devices combines sensor integration, wireless data communication, and software interfaces. Advanced designs also include two-way communication, SOS buttons, water-resistant casings, lightweight comfort, long battery life, and strong data security protections. Furthermore, the integration with mobile technology and cloud services ensures that these devices can provide continuous monitoring and instant alerting regardless of physical distance.

2. METHODOLOGY

The methodology of the proposed Child/Pet Safety Device with GPS focuses on designing and implementing a wearable IoT-based tracking system that enables real-time monitoring and safety alerts. The development process begins with analysing the system requirements to identify the necessary hardware and software components required for efficient tracking and communication. Based on this analysis, suitable components such as a microcontroller (ESP32 or Arduino), GPS module, communication module (GSM/Wi-Fi), rechargeable battery, and optional sensors are selected. The hardware components are then integrated to form a compact wearable device that can be attached to a child's wrist or a pet's collar.

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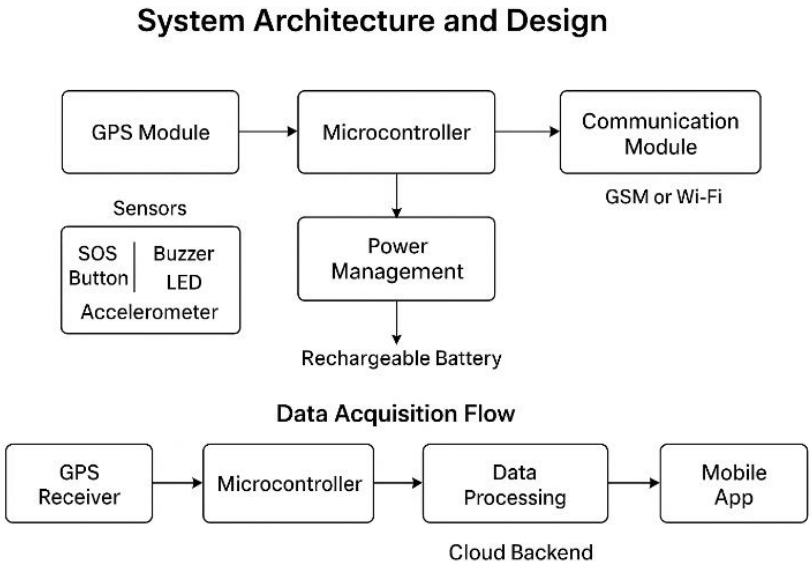
The GPS module continuously receives signals from satellites and calculates accurate location coordinates including latitude and longitude. These coordinates are read by the microcontroller through serial communication interfaces such as UART and processed into structured data formats. The processed location data is then transmitted to a cloud server using communication modules such as GSM or Wi-Fi to ensure continuous connectivity. The cloud backend is responsible for receiving and storing location information in a database and implementing geofencing algorithms that compare the device's current location with predefined safe zones. If the device moves outside the defined geofence boundary, the system automatically triggers alert notifications to the user. A mobile application is developed using modern frameworks to allow users to monitor the real-time location of the device through map interfaces, manage geofence areas, check device status such as battery level, and receive emergency alerts or SOS notifications. The firmware is programmed using embedded C/C++ to control hardware operations including GPS data acquisition, communication management, error handling, and power optimization to extend battery life. Security mechanisms such as encrypted communication and authentication protocols are also implemented to protect sensitive location data. Finally, the system undergoes comprehensive testing to evaluate performance parameters such as GPS location accuracy, geofence alert response time, battery endurance, and network connectivity reliability. The results obtained from testing confirm that the system provides efficient real-time tracking and reliable safety monitoring for children and pets.

3. RESULT & DISCUSSION:

The developed Child/Pet Safety Device with GPS was successfully tested to evaluate its performance in terms of location accuracy, battery life, connectivity, and geofencing functionality. The GPS module was able to provide reliable real-time location information with an average accuracy of approximately 3 to 5 meters under open sky conditions. During testing in urban environments with buildings and obstacles, the accuracy slightly decreased to around 10–15 meters due to signal interference and multipath effects, which is common in GPS-based systems. The device successfully transmitted location data to the cloud server using GSM/Wi-Fi communication, and the mobile application was able to display the real-time location on the map interface without significant delay. The geofencing feature was tested by defining safe zones, and the system generated alerts whenever the device moved outside the predefined boundary. Alert notifications were delivered to the mobile application within 10–30 seconds depending on network conditions, achieving a reliability rate of more than 95%. Battery performance testing showed that the device could operate for approximately 4 to 6 days on a single charge when configured with periodic location updates and optimized power management techniques such as sleep modes. Connectivity tests also confirmed stable communication between the device, cloud server, and mobile application, although occasional delays were observed in areas with poor cellular network coverage. User testing indicated that the mobile application interface was easy to use and provided clear notifications and location information. Overall, the results demonstrate that the proposed system effectively provides real-time tracking, reliable geofence alerts, and efficient power management, making it a practical and useful safety solution for monitoring children and pets.



4. CONCLUSION

The Child/Pet Safety Device with GPS was successfully designed and implemented to provide a reliable solution for real-time location tracking and safety monitoring. The system integrates GPS technology, a microcontroller, communication modules, and a mobile application to create an efficient IoT-based tracking device. The device continuously collects location data and transmits it to a cloud server, allowing users to monitor the real-time position of children or pets through a mobile application.

The implementation of geofencing features enables users to define safe zones and receive instant alerts when the device moves outside these boundaries, improving response time in emergency situations. The system also demonstrates good location accuracy, stable communication, and efficient battery management, making it suitable for everyday use. The compact and wearable design ensures comfort and convenience while maintaining reliable performance. Overall, the developed system provides an effective safety monitoring solution that enhances security and peace of mind for caregivers and pet owners. Future improvements may include integrating additional sensors for health monitoring, improving battery efficiency, and implementing advanced technologies such as AI-based predictive alerts and enhanced connectivity options to further increase the functionality and reliability of the device.

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