Smart Luggage Theft Detection and GPS Tracking System

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Abstract: Two of the biggest challenges facing the global aviation and transportation industry are lost baggage, luggage theft, and damage to traveler's belongings. To address these chronic problems, we have developed and implemented a luggage tracking system based on the IoT technology. So, in this, the GSM/GPS module is used for continuous and the Arduino microcontroller is used for data processing. The luggage position is continuously monitored by the GPS module; it constantly receives relevant position information and sends it to the microcontroller. The GSM module is responsible for sending the data to the passengers through SMS and service provided will allow them to easily check on their bags in real time, specifically in the form of a map. This real-time tracking seeks to minimize the occurrence of lost - misplaced or stolen baggage providing reassurance for passengers and operational benefits for the aviation sector. This relieves stress, resulting in passengers knowing the position of their suitcase all the time and has the ability to tracing and reclaiming it if required. This IoT solution implementation emphasizes the positive happened in the technology of passenger service, thus trust and satisfaction improvement in the global transports.

1 INTRODUCTION

"Luggage Theft Detection and Tracking System" prevents theft, and helps in their fast location tracking. At its heart, a power-fed Arduino Uno microcontroller keeps track of multiple functions and alerts. It incorporates an HC-05 Bluetooth module that communicates wirelessly with a mobile device owned by the user. For security reasons, users get their own personalized username and password, which they enter for Bluetooth pairing. Once the luggage gets paired with the user's mobile device, it stays in range for monitoring (W. Yang and Y. Chen 2022). In case the Bluetooth link is lost from the luggage moving outside range or being stolen the system sounds off a buzzer. The Arduino triggers this alert, for example, if the user moves the luggage out of Bluetooth range, the system activates its location mode. A GPS module then receives the precise coordinates of the luggage and transmits this information to a GSM module, which establishes a connection through mobile networks to send the user location data. Real-time location updates are sent to the user through a dedicated app called "A-Alert." The system is an integration of Bluetooth, GPS and GSM technologies that enables travelers to track and find their baggage in a secure manner which will help them minimise their stress of lost or stolen baggage (S. Lee, J. Kim, and H. Oh, 2022).

2 LITERATURE SURVEY

Mishra and Khare analyze how industry 4.0 technologies, specifically IoT (Internet of Things), can be adopted to facilitate passenger experience and operational efficiency in the aviation industry. The study emphasizes that IoT technologies facilitate real-time tracking and communication between multiple stakeholders to minimize delays, optimize resource management, and enhance safety in airports and airline companies (D. Mishra and A. Khare, 2023). Dutta and Park explain the merging of IoT and Artificial Intelligence (AI) for predictive analytics for airport operations. Their research demonstrates the potential of utilizing IoT sensors integrated with AI algorithms to predict flight delays, anticipate maintenance requirements, and allocate resources more efficiently, leading to improved airport operational performance and reduced disruptions (S.

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Dutta and Y. Park, 2023). IoT-based Radio Frequency Identification (RFID) technology is used in Wang and Zhang's paper to track the baggage in the airport. They show how RFID improves the efficiency and accuracy of baggage handling systems, minimizes lost baggage situations and increases convenience for passengers and airport personnel by giving real-time tracking details (X. Wang and H. Zhang, 2023).

IoT based solutions for baggage tracking and airport security considering Digital airport ecosystem Kumar and Rao As demonstrated in their study, IoT technologies can facilitate real-time tracking of baggage, enhance security checks, and boost airport operations, leading to an improved passenger experience and efficiency of modern airports (Kumar and V. Rao, 2024). We strive to make sure that lost or missing luggage problem is eliminated with its seamless, secure, and cost-effective solution by combining Bluetooth with other existing technologies. It outlines several ways to leverage these technologies in order to enhance overall baggage handling efficiency, process time and passenger satisfaction in modern airport (H. A. Adjei et al. 2020).

Pros and cons of the aforementioned models exist with each. The existing solutions are limited and we introduce a better solution by utilizing Bluetooth technology along with other state of the art technologies. This combination helps to overcome the shortcomings of existing systems by providing improved functionality, efficiency, and overall enhanced user experience in aviation, especially in baggage tracking, predictive analytics, and overall operational performance (M. Ö. Demir et al. 2020).

3 PROPOSED METHOD

This System was designed which we named as the "Luggage Theft Detection and Tracking System" to overcome the theft problem as well as to quickly locate luggage if lost. The system utilizes an arduino uno microcontroller as the main control unit powered by an external power supply to trigger the necessary components required for the tracking and alert functions. A Bluetooth module, the HC-05, may allow the suitcase to exchange information wirelessly with the user's mobile device. Unique username and password for every user for security purpose. The baggage stays within range of the mobile device once it is Bluetooth-enabled, making tracking simple. If the Bluetooth connection is lost, whether because the luggage has moved out of range or due to a potential theft, the system triggers an alarm. A buzzer connected to the Arduino immediately activates, emitting a loud sound to alert the user of the disconnection. This audible notification helps the user quickly detect and retrieve the luggage if it is nearby. In the case of theft or when the luggage moves beyond the Bluetooth range, the system switches to location tracking mode. The system incorporates a GPS module to deliver accurate position information. The GSM module is in charge of delivering the data to the user's mobile device after receiving the baggage's current coordinates from the GPS module.The GSM module uses mobile networks to communicate the luggage's exact location. The mobile app "A-Alert" is used to notify the user in real-time, offering instant updates on the luggage's whereabouts. This allows the user to effectively track the luggage (P. Devaki and M. Karthika, 2019).

The technology guarantees constant monitoring by fusing GPS and GSM technologies, allowing the user to trace the position of the luggage at all times. Connect RX pin of Bluetooth module to TX pin (D2) of Arduino Uno and TX pin of Bluetooth module to RX pin (D1) of Arduino Uno*. The ground (GND) and VCC (VCC) circuits of the Bluetooth module are connected to the GND and VCC pins of the Arduino Uno. An input supply of 3.3V to 5V powers the Bluetooth module. The GPS (Global Positioning System) module is connected to a Global System for Mobile Communications (GSM) module. Sending position data from the GPS (GSM Module) PG via its TX pin (attached to Arduino Uno's Digital pin 3) to be processed by the Arduino Uno.

GND and VCC pins of GSM module are connected to GND and VCC pins of Arduino Uno. This GSM module needs an input source of around 3.3V to 4V in order to operate its tasks and the coordinates of location info (longitude, latitude) are sent from the GSM module to the user mobile device with the help of A-Alert app. It will display the bag's location on Google Maps, and forward it to the user's mobile device. The buzzer will ring if the mobile device loses Bluetooth connectivity. While the buzzer's negative pin is linked to GND, its positive pin is directly attached to the Arduino Uno's Digital pin 7. The position of the bag is continually sent to the user's mobile phone using the GSM module. In addition to offering consumers the ability to retrieve their baggage in the event that it is lost or stolen, this technology effectively deters theft. They use Bluetooth, GPS and GSM technology to give travelers shady security and minimize that little pang of anxiety when possessions go missing. If baggage is lost or stolen, the accurate position tracking of "Luggage Theft Detection and Tracking System: provides accurate position tracking, and this prevents

theft (M. Ghazal et al. 2016).

The heart here consists of Arduino Uno microcontroller and external powered circuits, which controls all of tracking and alert parts. To achieve wireless communication, it uses an HC-05 Bluetooth module that establishes a secure connection between the luggage and the owner's mobile phone. Unique usernames and passwords are issued to users for security purposes. To connect, the system uses Bluetooth technology to keep the luggage within a defined distance — allowing users to keep an eye on their luggage when it's within range. Should the Bluetooth connection be severed — either from the luggage moving out of the range of the smart device or a potential theft — the system sets off an immediate alert. The buzzer connected to the Arduino now gets activated making a hard noise to inform the user that the connection is disconnect. This sound alert lets the user search and collect the luggage in case it is near. If the luggage moves outside of Bluetooth range the system goes into location tracking mode, employing a GPS module to collect accurate position coordinates. The coordinates are transferred to a GSM module, and the real-time location is dispatched to a user's mobile. Transport notification is available by the mobile application "A-Alert", that can allow the user to gain immediate updates of the luggage's location and how to find it (M. Goldstein, 2017).

Travelers have to face this luggage theft where this advanced solution is coming into the picture which is known to be the "Luggage theft detection and tracking system" which is a combination of Arduino Uno Microcontroller with Bluetooth, GPS, and GSM module. HC-05 Bluetooth module is used as part of the system to create a secured wireless connection between the luggage and users mobile device authenticated with a unique username and password. Within a specific range, this Bluetooth connection enables the user to track the luggage. On disconnection between the luggage and the mobile device because the luggage moves beyond range or in the case of possible theft the system raises an alarm which rings a buzzer attached to an Arduino and generates a loud sound to notify and alert the user. When the luggage is not nearby, the device is switched to location tracking mode, and a GPS module provides precise coordinates of the luggage. This data is transmitted to a GSM module, which uses the "A-Alert" program to provide real-time position updates to the user's mobile device. The module then shows locations on Google Maps for convenient tracking. The connections are carefully set up such that the RX and TX pins of the Bluetooth module are linked to the TX and RX pins of the Arduino, and the GPS module sends position data to the GSM module, which relays this information to the Arduino using the GSM's TX pin. The buzzer, responsible for the alert sound, has its positive terminal connected to Digital pin 7 on the Arduino, allowing immediate activation upon disconnection. Through the integration of Bluetooth for proximity alerts, GPS for precise location tracking, and GSM for real-time communication, the system provides a dependable, user- friendly solution to safeguard luggage, offering peace of mind to traveller's and GSM module, which sends real-time location updates to the user's mobile device. Notifications are delivered through the mobile app "A-Alert," allowing the user to access instant updates on the luggage's whereabouts and track it effectively (S. Karthick, 2020). Figure 1 shows the block diagram of the luggage.

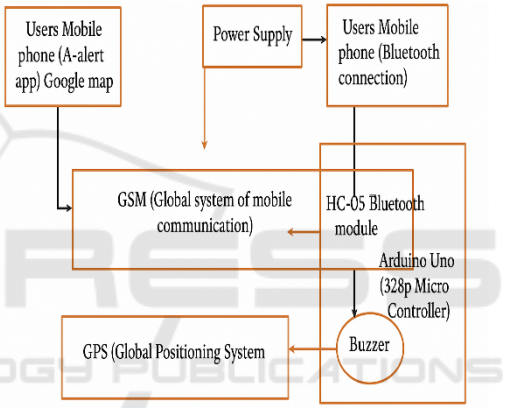

Figure 1. Block diagram of the luggage theft detection and tracking system.

3.1 Arduino Uno Microcontroller

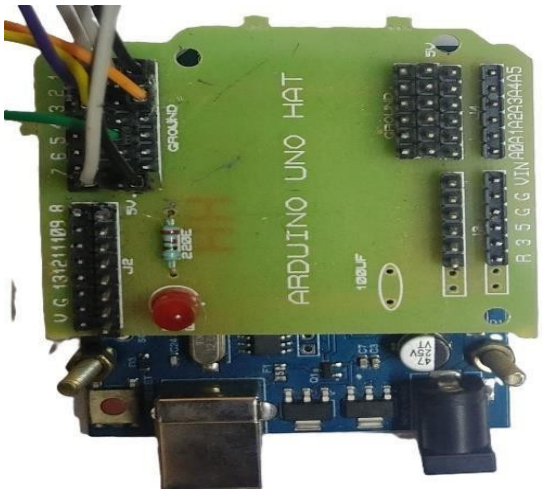

Figure 2: Arduino Uno microcontroller.

Figure 2 shows the Arduino uno microcontroller. In a luggage theft detection and tracking system, the Arduino Uno serves as the main controller, managing sensors like accelerometers, GPS, RFID readers, and proximity sensors to monitor luggage movement and detect unauthorized handling. It processes sensor data to identify potential theft situations, such as luggage movement without the authorized owner nearby. When theft is suspected, the Arduino triggers alert mechanisms, like sounding a buzzer or flashing LEDs, and can send notifications to the owner's phone via Bluetooth or GSM modules.

Additionally, if equipped with a GPS module, the Arduino provides real-time location tracking, transmitting data to the owner's device even when out of Bluetooth range. This integration of sensing, processing, and communication functions makes the Arduino Uno the "brain" of the system, ensuring effective theft detection and tracking (Karvinsky, 2020).

3.2 Bluetooth module

An essential part of the system for tracking and detecting luggage theft is the HC-05 Bluetooth module You need 5V DC power supply for it to work. The serial communication between the microcontroller and the module's TX and RX pins allows for data exchange. VCC and GND pins are connected to power and ground. The EN pin controls when the module turns on and off, and the STATE pin indicates its current state. KEY pin is used for pairing and setup.

Bluetooth module: Choose a compatible Bluetooth module with microcontroller and smartphone. An effective serial communication protocol, such as UART, shall be implemented to ensure reliable data transmission from the module to microcontroller and vice versa. Use secure data transmission techniques to ensure sensitive information is protected and unauthorized access is denied. Furthermore, appropriate techniques on power management are necessary to prolong the lifetime of system battery (E. Newton, 2020).

Considering these considerations, the HC-05 Bluetooth module can be effectively integrated with the luggage theft detection and tracking system enabling robust and reliable wireless communication. This module is crucial for tracking the luggage in real time, providing alerts if the luggage is moved without authorization, and for monitoring the system's status remotely.

3.3 GPS Module and GSM Module

Figure 3 shows the GPS module is an important part of many electronic devices that enable accurate tracking and navigation. GPS modules calculate a device's latitude, longitude and altitude by receiving signals from several satellites and calculating the time difference between the transmission and reception of the signals. A GPS module consists of an antenna, GPS receiver, microprocessor, and message communication means such as UART or I2C. Most of these modules return data in CSV format, NMEA data which will contain information about Time, position and other relevant information about the device. GPS modules are commonly used in mapping devices, GPS trackers, and navigation systems. However, none of these elements, such as air conditions, signal obstructions and quantity of them both in the periphery and in high altitude can affect how well they function. The Ublox NEO series and Adafruit Ultimate GPS (Purwar et al. 2016) are common GPS modules.

GSM (Global System for Mobile Communications) modules are pieces of electronic equipment used in various electronic devices to provide cellular connectivity so that they can transmit data over mobile networks, make voice calls, and send SMS messages. All these modules typically include a microcontroller, an antenna, a GSM chipset, and a SIM card slot. They connect with microcontrollers using serial protocols like UART. GSM modules are able to send and receive SMS as well as voice calls when connected through a SIM card to a mobile network.

Figure 3. GPS and GSM module.

Applications such as GPS tracking, home

automation, and remote monitoring frequently employ GSM modules. They are widely accessible and reasonably priced, but they depend on the availability of cellular networks and can use a lot of power when communicating. The GSM modules SIM900, SIM800, and SIM5320 are widely used (S. Safdar et al. 2018. The flow chart for the Luggage theft detection and tracking system is shown in Figure 4.

4 WORK FLOW AND METHODOLOGY

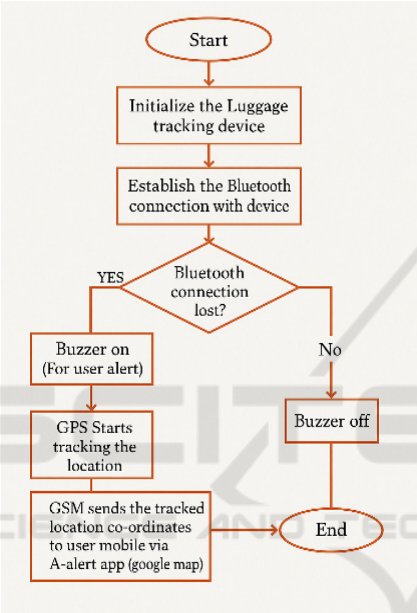

Figure 4: Flow chart for the luggage theft detection and tracking system.

Table 1: Technical specifications of components.

S.NO	Components	Specifications
1	Microcontroller	ATmega328
2	GPS Module	Tek MT 3318
	Temperature	-40 °C to 85 °C.
	Power Supply	3.3 – 6 V
	Baud Rate	9600bps
3	Bluetooth module	Hc05
4	GSM Module	SIM800
	operating voltage	3.7 ~ 4.2V

5 RESULTS

The systems near real time accuracy on luggage location is precisely measurable. The individual must assess how precise and accurate the GPS updates are, and how frequent the location data is. The system must regularly offer real-time information about the Luggage's location (en route, at an airport, or at a destination) and provide a record of the delivery speed and correctness of this experience history. This also evaluates how well the system informs travelers about their luggage's location and the speed and reliability of alerts and notifications sent to users.

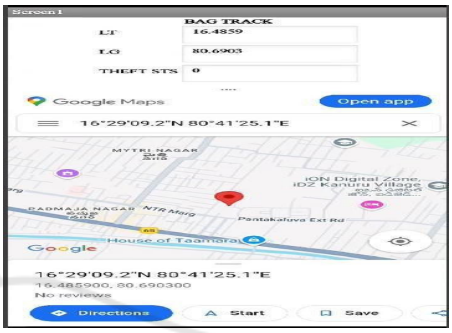

Figure 5: Tracking interface of the A-Alert app in mobile (Google Map).

You may also evaluate the user experience of the system, encompassing the mobile app UI, how straightforward it is to pair the baggage tag with it, and how simple it is to be presented with monitoring data and status updates. Running tests on the data handling capabilities of the system, performance of Bluetooth, and interactions with the cloud can allow one to analyze the adaptability of the system, the rate at which it transfers information, and the energy economy. Another important consideration is reliability, which involves keeping an eye on how efficiently the system manages data loss, monitors luggage, and reacts to mistakes or interruptions. Discussions may center on the system's scalability, namely its capacity to handle several baggage tags and users at once, and how flexible it is in the face of unforeseen disruptions. The result tracking location interface is shown in the Figure 5 and figure 6 and 7 luggage tracker hardware prototype and detected location.

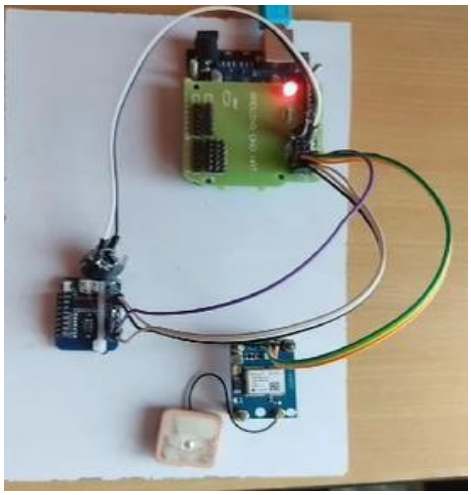

Figure: 6. Luggage tracker hardware protype.

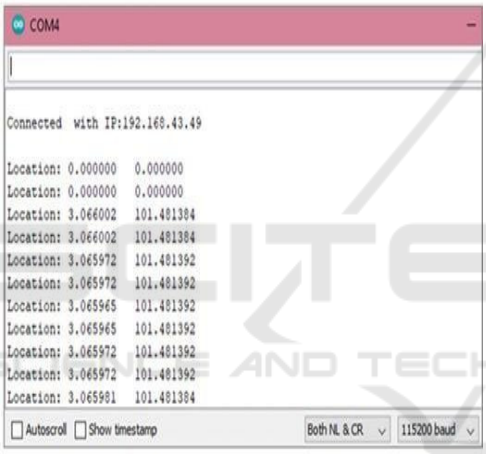

Figure 7: Coordinates of the detected location on serial monitor.

6 CONCLUSIONS

This Bluetooth-based luggage monitoring device is quite useful in busy places and on public transportation, such as buses and trains. When carrying valuables in their baggage, people frequently rely on this gadget. This project is a straightforward but effective way to keep an eye on passenger luggage and, if needed, offer security by sending an SMS alert with the position of the luggage and setting off an audible alarm. The system is a significant development in access control and security technology, built on a microcontroller-based security mechanism that uses a mobile phone. It successfully addresses security issues that conventional chain-and-lock techniques are unable to, marking a major advancement in digital design and technical advancement. Many applications require security as a basic necessity, and this gadget works on the tenet that "prevention is better than cure". Instead than tracking baggage just after it has been reported misplaced, it secures it as soon as it is in the vicinity.

Even if the bag becomes lost, it may still communicate its location to the user's smartphone, which will keep updating its position until it is found. This system uses open-source tools, such as Google Earth and Google Maps, to provide a GPS-based tracking solution. It provides a real-time tracking feature via a client-server architecture, informing customers of the whereabouts of their luggage as needed.

7 FUTURE SCOPE

For future development, this study should expand its focus to incorporate a GPS module to enhance accuracy in locating luggage. Although the current system offers useful features, there is room to improve both the mobile application and the device's tracking capabilities. Recommendations for future work include adding specific location addresses on Google Maps to help users easily locate their luggage, as well as implementing a location history feature, allowing users to monitor past locations of their luggage over time.

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