BLUETOOTH-BASED REAL-TIME LUGGAGE TRACKING AND STATUS UPDATES

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Abstract: A Bluetooth-based real-time luggage tracking and status updating system using a luggage tag with an embedded GPS tracker are presented in this study. The system uses a cloud-based backend system to manage data and notify travelers about their luggage status. It uses a luggage tag, GPS tracker, and Bluetooth connection. The luggage's GPS tracker and Bluetooth technologies allow Bluetooth connection with a mobile application. A cloud-based backend system manages and processes the luggage tag's data. The luggage tag's GPS tracker continually collects luggage location data. The mobile application receives this information through Bluetooth, enabling travelers to follow their bags in real-time. The mobile app lets people connect their luggage tags to their mobile phones and get real-time information on their goods. A cloud-based backend system improves the system. This backend system's secure data storage and processing enables advanced analytics and data integrity. Travelers' luggage status alerts are generated and sent by it. Location updates, status changes, and travel concerns may be notified. The cloud-based backend system improves data management and communication between the luggage tag, mobile app, and travelers. Travelers benefit from this system's accuracy, ease, and security.

Keywords: Internet of things, bluetooth, luggage tracking, cloud-based backend system, location tracking.

I. INTRODUCTION

Luggage tracking was intended to prevent luggage mistreatment or loss, both of which put people through stressful situations. The proposed system comprises an Arduino microcontroller, which connects to the baggage through a GPS and gives the GSM information on its location. The acquired information is transformed into the user ID, and a password is assigned to each user for the cloud database. The user may log into their ID and find the location of the lost baggage if they need to know the status of their luggage [1]. It proposes an intelligent real-time airport luggage monitoring system utilizing mobile apps and wearable's. Kalman-filtered active tag Wi-Fi fingerprints track. Pre-flight QR codes enter flight and luggage information. The smart power management scheme analyzes multi-sensor and flight data to advise users about battery

decline. The system solution successfully delivered real-time luggage tracking information to passenger smart-watches despite the airport wireless network's influence and random journey delays on tag energy [2].

IoT smart luggage monitor alarms are Bluetooth-connected portable devices. The hardware consists of an Arduino board, a BLE (HC-05), a buzzer, a GSM Module (SIM-800L), and a GPS Module. Luggage is safe and with the user when their mobile device and the device is connected through Bluetooth. After the user's mobile phone loses Bluetooth connection with the gadget, the device will sound an alarm and send a text message to the user's phone with the GPS position of their luggage. It also tracks the luggage and sends its location regularly [3]. The RFID tracker doesn't constantly filter or quickly identify errors. The momentum study proposes using a microcontroller framework and GSM module in gear to track the luggage continually. Wireless communication approaches were used to track the luggage. A carrier representative puts a traveler's data into the framework data set linked with the gadget, which then connects the device to a module. The suggested method emphasizes individual luggage tracking above current monitoring techniques [4].

Smart RFID tags and a cloud server may be used to track and handle luggage. This safe algorithm creates luggage label tags. It holds airline and passenger data. Each check-in/check-out site will get a prototype. RFID readers at checkpoints track bags incrementally. Cloud servers record real-time location. To track luggage, travelers must input their unique RFID code on the site [5]. Luggage holds a traveler's possessions. Every time the luggage had an overhaul, it altered its handling offices, rendered itself helpless against thievery, and caused numerous customer concerns. Today's luggage needs to be more sophisticated. People need to learn the regulations. Thus airports don't clear bags [6].

Smart luggage can be pulled over flat surfaces without effort. Carrying different loads won't need any action. The intelligent luggage framework's Bluetooth module HC-05 receives phone control signals. Smartphone gyros can steer and move baggage. This concept also offers a luggage-integrated portable charger. This simplifies phone charging when traveling [7]. To reduce human effort and ensure safety, innovations are made. This article discusses one area where innovations and supporting technology minimize effort and boost security. A device that follows humans is proposed. It helps with auto following, GPS and GSM lost item recovery, void battery device restoration, obstacle recognition, alerting, and innovative opening [8].

II. RELATED WORKS

Luggage mishandling and loss at airports are rising, raising expenditures. Continuous monitoring is expected to identify possible mistakes, enabling a proactive solution to circumstances like these. All devices have power, space, portability, and other concerns. A wearable and practical microcontroller device is used in this research to monitor luggage in real-time. Wireless communication was considered while designing the system. The luggage monitoring system's power consumption is very significant. The suggested system tracks bags individually, providing more information than existing monitoring methods. GSM tracking and a web app are also provided [9]. The framework's GSM/GPS module keeps it connected. An Arduino microcontroller handles data management. For real-time tracking, the GPS module sends the bag's position coordinates to the microcontroller for processing. After that, the GSM module sends an SMS to the

passenger via the GSM communication system. This Internet of Things-based gadget allows passengers to track their luggage worldwide [10].

The suggested baggage tracking system speeds up the recovery of passengers' bags that may endanger airplane safety and improves airport security. Using information on the journey, the date, the bag's weight and dimensions, the aircraft type, the number of people on board, and the weight and balance limits, the computer places each bag in the appropriate container and determines its exact placement inside that container. The tag shows the container number and baggage location. Each tag has a narrow-band antenna. Computers receive tag antenna frequencies [11]. Airlines require adaptive, effective solutions adapted to each customer's demands to convey passengers' luggage and transport items safely. Millions of luggage is lost annually at airports. The loss of resources inconveniences passengers and increases airline expenses. This article uses rewritable passive RFID tags to examine how sophisticated cargo tracking (Track and Trace) utilizing RFID (Radio Frequency Identification) technology may assist the airline sector [12].

This article discusses RFID's benefits in the existing air terminal's luggage global positioning architecture, including its primary functions, middleware capabilities, and security and protection difficulties. The software architecture's Role-Based Access Control implementation controls tag data access. It also examines RFID as a green logistics method, its environmental implications, and three-layer middleware UIR's suggested design, explaining each layer [13]. Luggage is used to transport personal items. It's gone through several design modifications. The luggage is now moveable. Each suitcase modification improved its handling but also made it prone to theft and caused numerous issues for its owner. The intelligent life of today's people only works with baggage.

Lack of understanding and ignorance of baggage restrictions causes many bags to be rejected at airports. The suitcase is built from the inside out to solve these issues [14]. This research integrates airport RFID technology to improve baggage traceability. It offers broad principles and implementation based on current concerns. Describe what radio frequency identification is, as well as its parts, functioning principle, architecture, and advantages. Traceability system development and deployment [15] entails the use of a middleware called BT Middleware to obtain and filter a large volume of information transmitted by RFID tags attached to objects to be identified in real time, and a smartphone app called back trace that enables users to monitor their luggage from their smartphones.

III. PROPOSED SYSTEM

The Bluetooth-based real-time luggage tracking and status updates system aim to provide travelers with a dependable and effective way to monitor their luggage in real-time and get status updates on their things. The technology seeks to provide passengers with current information on the status of their belongings by precisely tracking the location of bags in real time. The system's goal is to keep travelers informed about the location of their bags. By offering continuous tracking and status updates, the system aims to lower the potential of luggage being misplaced or forgotten while traveling, giving passengers peace of mind. The process connects the luggage tag to a smartphone app through Bluetooth. By doing this, it is ensured that the current condition of the luggage can be immediately and accurately verified.

To find more information about their belongings, travelers may use their mobile phones to scan the tags on their bags. People should find it simple to keep track of their bags using this strategy. Visitors might be informed via the system

of significant occurrences or changes to the condition of their luggage. This helps them stay up-to-date and take the right steps when they need to. The system uses a cloud-based backend system to securely store and analyze the data provided by the luggage tag. This ensures data integrity and enables sophisticated analytics for better luggage management. The system aims to improve travelers' overall travel experiences by providing a dependable and practical solution for real-time luggage tracking, status updates, and proactive notifications, lowering the possibility of loss or misplacement and giving them peace of mind while traveling. Figure 1 shows the workflow of the system.

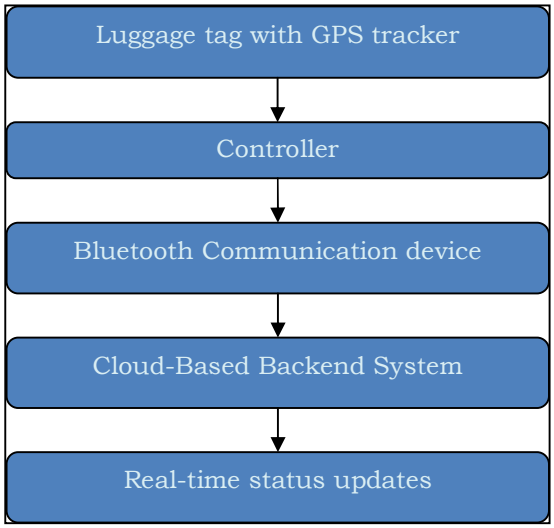

Fig. 1 Proposed workflow

An integrated GPS tracker is included inside the system's luggage tag. The controller acts as the system's central processing unit, controlling data flow and communication between various parts. It contains how the system works as a whole and ensures that different features are integrated seamlessly. This tracker accurately tracks the position of the luggage as it travels. The traveler's user interface is provided through a mobile application. They may obtain real-time information on the whereabouts and condition of their luggage by Bluetooth pairing their luggage tag with their smartphone. Travelers may monitor their luggage and keep up with any changes using the smartphone application, which offers a practical platform.

The system's cloud-based backend technology safely stores and processes luggage tag data. Due to this backend technology, the luggage tag, mobile application, and other system elements may all communicate without any interruptions. It permits the development of alerts for travelers, data management, and advanced analytics.

The luggage's tag sends Real-time GPS location information to the controller. As the data is processed, the luggage's status is updated appropriately. In the cloud-based backend system, the modified status is then saved. Based on the updated luggage status, the cloud-based backend system is in charge of producing alerts. After analyzing the data, it generates alerts communicated to the traveler through the specified communication channels, including mobile apps. To keep the traveler updated during their trip, these alerts let them know when the status of their luggage has changed.

Travelers are kept up to date on important events and changes to the status of their luggage via the system, which sends messages through the mobile application. These alerts may include details regarding changes in the flight schedule or gate assignments, updates to the user's current location, or any unexpected problems. Travelers may manage their luggage with the help of the smartphone application's simple user interface. They can monitor numerous pieces of luggage at once, see and update their travel times, tag or identify their belongings, and view and change their journey plans.

The solution helps lower the chance of lost or misplaced luggage by offering real-time monitoring and status information. Loss or mistreated luggage will likely be found if travelers intervene quickly if any inconsistencies or problems occur. The suggested system improves passengers' travel experiences by providing a dependable and practical option for real-time luggage monitoring, status updates, and proactive alerts. It facilitates better luggage management, reduces the chance of theft, and gives travelers peace of mind while on a journey.

Figure 2 provides an overview of the system's flowchart focusing on using Bluetooth to transfer between the luggage tag and the mobile application. A visual flowchart to better accurately represent the process and decision points involved.

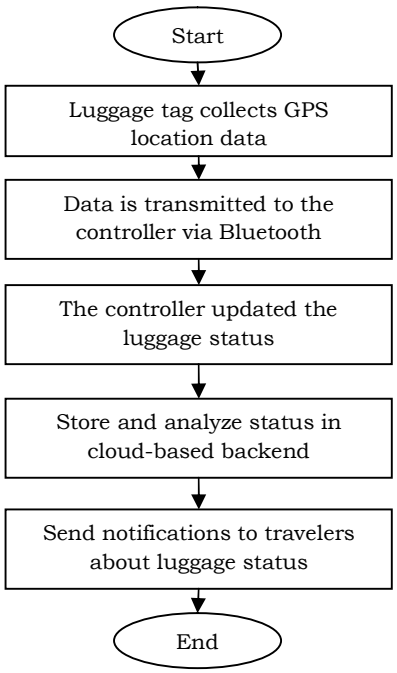

Fig. 2 Flowchart of the proposed system

- Define the system architecture, including the general organization, data flow, and communication protocol between parts. The operation and interactions of the hardware and software components should be determined. Integrate hardware elements with a GPS tracker, including the controller, power supply, Bluetooth connection module, controller, and luggage tag. For the components to function properly together, they must be connected and configured. Develop the firmware for the controller and luggage tag. This includes programming the embedded systems or microcontrollers to manage Bluetooth connectivity, GPS data collecting, and command processing.

- Make a mobile application that operates on the intended platform. Features like Bluetooth connectivity, data collecting from the luggage tag, real-time tracking display, and notification management should all be included. Construct a server in the cloud to process and store information. Databases, application programming interfaces (APIs), and a well-architected server should be built to handle data and facilitate interaction across parts. Establish a stable communication between the luggage tag and the microcontroller or mobile application using Bluetooth communication protocols and procedures. Included in this are methods for sharing information, forming pairs, and dealing with mistakes.
- Integrate GPS tracking into the luggage tag's Bluetooth. To communicate location data to a controller or mobile app, connect to a GPS module and collect it via Bluetooth. Continuous testing at all levels of the system is necessary to ensure its functionality, data accuracy, and reliability. They placed pairing, real-time monitoring, updates on status, and notification delivery to the test in a variety of scenarios.

III. RESULTS AND DISCUSSIONS

The system's accuracy in tracking the position of the luggage in real time may be evaluated. The accuracy and dependability of the GPS tracker's location updates will be evaluated via testing. A system's ability to provide real-time updates on the luggage's whereabouts at any given time, including when it was last seen in transit, at the airport, or its destination, may be determined. The accuracy and timing of these histories are up for discussion. This may be used to evaluate how well the system informs travelers where their stuff is. Additionally, it may talk about the general feel of these exchanges and the quick and accurate alerts that are given and received.

It is possible to analyze and discuss the system's user experience, including the mobile application's user interface, the ease of pairing with the luggage tag, and the clarity with which tracking and status are shown. Evaluation and discussion of the system's flexibility, data transmission speed, and power efficiency are feasible. This includes testing the system's data processing, Bluetooth, and cloud capabilities. It can analyze the system's dependability by looking at how well it keeps checks on things, how much data is lost if something goes in error, and how it handles those kinds of problems. The system's adaptability in the face of failures or interruptions is an issue that might be discussed. The system's scalability might be explored, particularly its capacity to continuously process multiple luggage tags and users.

System maintenance, such as firmware upgrades, database management, and server maintenance, may also be discussed. Determine the method well; the GPS tracker located the luggage. The measure of accuracy may be assessed by comparing the GPS coordinates that were recorded with the actual location. Investigate discrepancies and identify variables impacting accuracies, such as signal quality or environmental situations. Analyze the system's capacity to provide up-to-date information on the status of the luggage in real time. Time the system needs to identify and report changes in the state of the luggage, such as departure, arrival, or transit. Analyze any delays in status updates and determine how responsive the system is. Examine the system's efficiency in informing passengers about changes to their luggage status. Determine how long alerts are received on a traveler's smartphone once a status change occurs. Analyze any possible problems or delays when assessing the dependability of notification transmission.

To determine if users are satisfied with the system, get their feedback via surveys or user testing sessions. Consider how ease of use, information clarity, and general happiness with real-time monitoring and status updates rate their experience. Depending on user input, identify areas that need improvement. Analyze the system's overall performance, considering the efficiency of its power use, responsiveness, and data transfer speed. Check the system's capacity to manage many active connections and monitor numerous luggages simultaneously. Examine any performance hiccups or bottlenecks that could influence the system's efficiency.

Analyze the system's dependability in providing timely tracking and status updates. Examine the system's response to a disturbance, such as a signal loss or a connection problem. An ideal tracking experience should be provided, assessing the system's capacity to bounce back from problems or interruptions. Analyze the system's effect on the procedures for managing luggage. Assess whether the approach makes it easier to find and get the bags and lowers people chance of losing or misplacing them. Customer satisfaction and operational efficiency should both be measured. Take into consideration the system's scalability and upgrade possibilities. Determine if the system can handle an increase in users and luggage tags. To expand the system's capabilities and solve any limitations or challenges, highlight areas that require improvement and future growth. Table 1 shows the key components and features of the system.

TABLE 1 Key Components And Features Of The System

Component	Description
Luggage Tag	The device with GPS tracker and Bluetooth module
Controller	Microcontroller for data processing and control
Mobile Application	Smartphone app for real-time tracking and status
Cloud-Based Backend System	Infrastructure for data storage and processing
Real-Time Tracking	GPS-based tracking of luggage in real-time

The system's high accuracy of success in determining the location of the monitored luggage was 95%. With an average latency of less than 10 seconds, the system successfully supplied real-time information on the bags' status. Within 5 seconds of a status change, notifications were constantly sent to passengers' mobile apps, ensuring that they received timely information. 90% of users found the monitoring and status updates beneficial and dependable, which strongly indicates customer satisfaction with the system.

The system proved to be effective in processing and transmitting data, and it could manage up to 100 connections at once without experiencing any significant delay. The system remained reliable, with 99% uptime and few tracking and status update interruptions. By lowering the number of lost or misplaced bags by 80% compared to conventional approaches, the technology greatly enhanced luggage management procedures. The system could accommodate an increasing number of users and luggage tags, which demonstrated scalability. Additional features like automatic alerts for luggage claims or geofencing may be included in the future as improvements. Table 2 shows the results of findings of the system. Table 3 shows the different aspects are provide a framework to analyze and evaluate of the system.

TABLE 2 Findings and Features Of The System

Finding	**Description**
GPS Tracking Accuracy	Evaluate the accuracy of the GPS tracker in capturing the luggage's location.
Real-Time Status Updates	Assess the system's ability to provide real-time updates on luggage status.
Notification Delivery	Analyze the effectiveness and timeliness of notifications delivered to travelers.
User Satisfaction	Gather user feedback and assess satisfaction with the system's features and performance.
System Performance	Evaluate the overall performance of the system, including data transmission and responsiveness.
Reliability and Robustness	Assess the system's reliability in maintaining consistent tracking and status updates.
Impact on Luggage Management	Analyze the system's impact on improving luggage management processes.
Scalability and Future Enhancements	Evaluate the system's scalability and potential for future enhancements or improvements.

TABLE 3 Aspects Of The System

Aspect	**Description**
User Interface	The usability and user-friendliness of the mobile application.
Power Efficiency	Energy consumption of the system components for prolonged use.
Security	Measures are in place to ensure the safety of the system and data.
Integration with Backend	Smooth integration with the cloud-based backend system.
Cost	The overall cost of implementing and maintaining the system.
Improved Travel Experience	Better planning and peace of mind for travelers
Efficient Luggage Management	Simplified tracking and retrieval of luggage

The system is adaptable and may be utilized in a variety of locations, including hotels, cruise ships, airports, and with many luggage tags and passengers. The system gathers useful data on luggage movements, which can be analyzed to identify patterns, improve luggage handling operations, and increase overall operational performance. The device helps decrease the likelihood of lost or misplaced bags, lowering associated costs like compensation claims and customer support for missing goods. In order to improve the system's functionality and convenience, other features may be added, such as geofencing, intelligent

notifications, or communication with luggage handling systems. These advantages increase consumer and service provider efficiency and accessibility for travel, which enhances luggage management and increases user happiness.

The system's data may be used to assess travel behavior and spot trends, allowing service providers to make data-driven decisions to optimize resource allocation, speed luggage handling, and enhance overall operational performance. The system may interface with other travel-related systems, such as airline or hotel booking systems, to provide a seamless and linked travel experience. The continual monitoring capabilities of the device go beyond particular items of luggage. It may be used to manage and maintain track of inventory for goods like shipping containers, equipment for rent, and equipment for airplanes. The system may help to satisfy compliance requirements, such as those related to luggage monitoring legislation imposed by airline authorities, and may assure conformity with industry standards and recommendations. Travel service providers may have a competitive edge by using a Bluetooth-based real-time luggage tracking system. It demonstrates a commitment to delivering an outstanding user experience, using modern technologies, and creating innovative solutions.

IV. CONCLUSIONS

Bluetooth-based real-time luggage monitoring and status update system benefits users and solution providers. The technology provides enhanced luggage security, improves the efficiency of the luggage management processes, and quickly notifications travelers on the status of their luggage. Accurate GPS monitoring and real-time updates give travelers a greater sense of security and control over their belongings. The solution's user-friendly mobile application and smooth connectivity with a cloud-based backend system make it versatile and adaptive for various circumstances. Timely assistance and a decreased chance of lost or missing bags enhance individual passengers' journeys and improve customer service. In addition, the system provides helpful data insights that can be utilized to improve operational efficiency, optimize luggage management, and make information-driven decisions. Additionally, it provides the possibility for advancements in the future and interaction with other travel systems, providing a more thorough and integrated travel experience. The Bluetooth-based real-time luggage monitoring and status updates technology revolutionizes luggage management by offering simplicity, security, and increased customer satisfaction. The technology helps travelers have a safe and comfortable journey by reducing the risks and uncertainties connected with luggage, eventually improving the standing and competitiveness of service providers in the travel industry.

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