Autonomous Passenger Baggage Carrier Vehicle in Airport

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Abstract - *The rapid growth of air travel necessitates efficient and secure baggage handling systems within airports. To address this need, we propose the development of an Autonomous Passenger Baggage Carrier Vehicle in Airport equipped with advanced navigation, security, and location tracking features. The system integrates a line-following mechanism for precise navigation, a multi-layer security system utilizing Radio Frequency Identification (RFID) technology, and real-time location tracking using RFID, Global System for Mobile Communications (GSM) modules, Liquid Crystal Display (LCD), and a keypad. Controlled by an Arduino microcontroller, this system promises to streamline baggage handling operations while enhancing security and transparency in airport logistics. The line-following mechanism enables the vehicle to autonomously navigate predefined paths, while the RFID-based security system ensures restricted access to baggage containers. Additionally, the location tracking system provides real-time updates on the vehicle's progress, with notifications sent to relevant personnel via SMS through the GSM module. This project represents a significant advancement in airport logistics technology, offering a comprehensive solution to the challenges of baggage handling and security in airport environments.*

Key Words: Air travel, Baggage handling, Autonomous system, Navigation, Security, RFID technology, Location tracking, GSM module, LCD, Keypad, Arduino microcontroller, Efficiency, Transparency, Airport logis

1.INTRODUCTION

Efficient baggage handling and security are essential components of airport operations, ensuring a seamless experience for travelers and optimizing operational efficiency for airport authorities. To meet the increasing demands of air travel, our project focuses on the development of an innovative Autonomous Passenger Baggage Carrier Vehicle in Airport. This system integrates advanced technologies to automate baggage transportation, enhance security measures, and provide real-time location tracking within airport environments.

The Autonomous Passenger Baggage Carrier Vehicle in Airport consists of three main subsystems: a line-following mechanism for precise navigation, a multi-layer security system utilizing Radio Frequency Identification (RFID) technology, and real-time location tracking using RFID, Global System for Mobile Communications (GSM) modules, Liquid Crystal Display (LCD), and a keypad. Controlled by an Arduino microcontroller, the system promises to revolutionize baggage handling operations while improving efficiency and transparency in airport logistics.

1.1 OBJECTIVES

1. Implement a robust security system utilizing RFID technology for secure access control.
2. Integrate a track following mechanism with IR sensors and motor control for precise navigation.
3. Establish centralized control and communication functionalities for efficient operation.
4. Enhance passenger experience by automating baggage transportation and reducing physical strain.
5. Validate system performance through rigorous testing in simulated and real-world environments.
6. Explore opportunities for scalability, customization, and future enhancements.
7. Contribute to advancing autonomous technologies in airport management for improved efficiency and convenience.

2. LITERATURE SURVEY

Russell, (2001), International Journal of Robotics and Waurzyniak, (1999), Manufacturing Engineering Journal, Robotics Evolution, in this field with a view of helping to boost robot‟s accuracy and also to design and construct a reliable line follower control system with high degree of freedom.

Thilakshan (2010) used an inertia measuring unit of an accelemeter and gyroscope for measuring acceleration and angular velocity. The output from the sensor was sent to a microcontroller. An algorithm was developed and programmed to the microcontroller to translate the sensor data into information on orientation and position movements of attitude and displacement. The project needed improvement because it could perform in three – dimensional space due to the missing attitude angles required in the rotation matrix computation. Also time integration of inertia sensor data leads to errors and increased position uncertainty.

Techbitar (2012) used arduino uno, adafruit motor shield, pololu‟s QTR-8RC line sensors. He said one could build a cheaper and lighter version of robot using the Atmel atmega 328 and the L293D h-bridge.

Sheikh and Rakesh (2013) the wheel movement of robot was controlled by the use of several sensors and D.C motors. For robot, steered by the motors to move along the line smoothly, ATmega microcontroller performed and implemented Pulse Integrated Derivative (PID) algorithms to control the speed of the motors. Response was better than open loop controller. The tuning utilized was the manual tuning method. Due to limitations in the hardware (motors and sensors) perfect control was not obtained.

Sushil (2013) the robot used arduino duemilanove ATmega 328 which received information from the sensors and converted them into digital values using ADC of the microcontroller. He compared the result and generated output to the motor to keep it in track. The robot was Two-wheeled driven by a motor IC circuit. The line track was determined by sending an infrared signal to the track and photo-transistor used to sense the infrared signals. Thus, the robot was able to solve a maze of which it had no more information than that the track was in black and the background was white.

Slam and Rayman (2013), robot was made by use of op-amps and transistors, due to the motor speed of rotation the speed was ON and OFF using the output signal from comparator. The robot used two line sensors, so the line could not be tracked due to fluctuation of the line. Therefore they recommended that the techniques of using comparator could be replaced by Pulse Width modulation (PWM) using more sensors, microcontroller and H-Bridge motor controller IC(L293D), also, instead of Light Dependent Resistor (LDR), Phototransistor could be used. Five sensor array may be used to detect the black/white line. However, robot could track the black line and carry some load likely 500g.

Walaa, Sheba, Elnemr and Gamal (2014), the robot consists of webcam mounted on vehicle. A Pulse Integrated Derivative control algorithm was used to adjust the robot on the line. Microcontroller PIC16F877 and DC motor were used to provide control signal and steer the robot wheels. They used the camera to take the surrounding environment image which was to be processed through the MATLAB environment to produce an output signal informing the microcontroller the location of the line with respect to the robot. Digital image processing techniques was used which was robust against environmental factors such as darkness, lighting, camera distortion as well as a line colour.

3. WORKING PRINCIPLE

3.1 Track-following mechanism for movement:

Working Principle:

The Track-following mechanism utilizes infrared (IR) sensors and two motors controlled by an H-bridge to enable the autonomous vehicle to navigate predefined paths within the airport. The principle behind this mechanism is based on detecting and following a contrasting line or path on the ground.

Detailed Working:

1. Infrared Sensors: The vehicle is equipped with multiple IR sensors positioned underneath it. These sensors continuously emit infrared light and detect the reflected light from the surface below.

2. Line Detection: The IR sensors detect the contrast between the line/path and the surrounding surface. When the vehicle moves over the line, the sensors detect the difference in reflectivity, allowing the vehicle to distinguish between the line and its surroundings.

3. Feedback Control: Based on the sensor readings, the vehicle's microcontroller adjusts the speed and direction of the motors to keep the vehicle centered on the line. If the sensors detect that the vehicle is veering off the line, the microcontroller corrects its course by adjusting the motor speeds accordingly.

4. Motor Control: The motors are controlled by an H-bridge, which allows the microcontroller to control their direction and speed independently. By varying the speed of the motors on each side of the vehicle, it can make precise turns and maintain alignment with the line.

5. Navigation: The vehicle follows the predefined path by continuously adjusting its direction based on the line detected by the IR sensors. This enables it to navigate through the airport environment autonomously, moving between terminals, baggage claim areas, and aircraft docking stations.

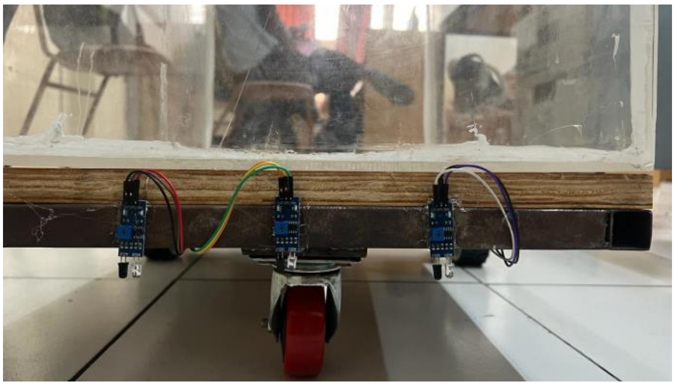

Fig -1: IR Sensors for Track Following

3.2 Security system using RFID and solenoid lock:

Working Principle:

The security system utilizes RFID technology for access control, coupled with a solenoid lock to restrict access to baggage containers. RFID tags are attached to the containers, and authorized personnel are issued RFID cards. The solenoid lock remains engaged until an authorized RFID card is scanned.

Detailed Working:

1. RFID Technology: Each baggage container is equipped with an RFID tag, which contains a unique identifier. Authorized personnel are issued RFID cards programmed with matching identifiers.

2. Access Control: When a baggage container is loaded onto the vehicle, its RFID tag is scanned by an RFID reader. The reader sends the tag's information to the microcontroller.

3. Authorization Verification: The microcontroller compares the RFID tag information with a database of authorized RFID card identifiers. If the tag matches an authorized card, the microcontroller sends a signal to disengage the solenoid lock.

4. Solenoid Lock: The solenoid lock remains engaged by default, preventing unauthorized access to the contents of the baggage container. When the microcontroller authorizes access, it sends a signal to deactivate the solenoid, allowing the container to be opened by authorized personnel.

5. Security Enhancement: This system enhances security by ensuring that only authorized individuals with matching RFID cards can access the contents of the baggage containers, reducing the risk of theft or tampering.

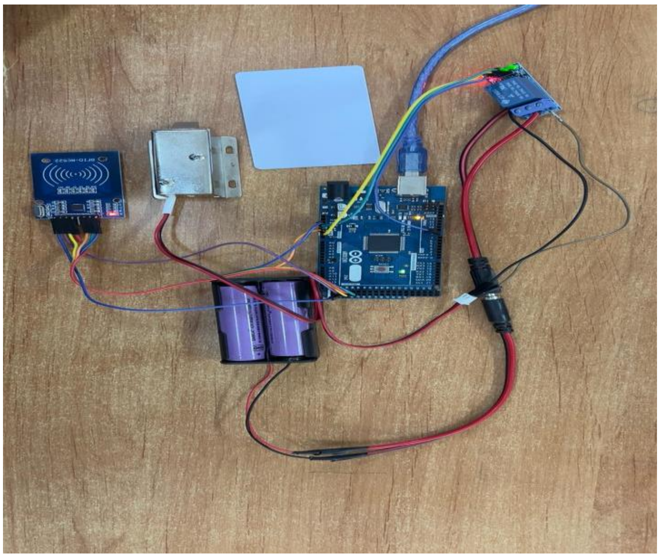

Fig -2: Security System

3.3 Location tracking using RFID, GSM Module, LCD, and Keypad:

Working Principle:

The location tracking system utilizes RFID technology, a GSM module, LCD display, and keypad to track the movement of the vehicle within the airport environment and provide real-time notifications to relevant personnel.

Detailed Working:

1. RFID Location Markers: RFID cards are strategically placed along predefined routes within the airport. Each RFID card contains a unique identifier corresponding to a specific location.

2. RFID Tag Scanning: As the vehicle moves along its route, RFID tags on the vehicle are scanned by RFID readers located at each location marker. When a tag is scanned, its information is sent to the microcontroller.

3. Location Calculation: The microcontroller processes the scanned RFID tag information to determine the vehicle's current location based on the identifier of the RFID card scanned.

4. LCD and Keypad Interface: To facilitate communication with the system, an LCD display and keypad are installed on the vehicle. Airport personnel can input their phone number using the keypad, which is displayed on the LCD screen.

5. Progress Monitoring: The microcontroller calculates the percentage of the journey completed based on the number of RFID markers scanned relative to the total number of markers along the route. This

provides real-time feedback on the vehicle's progress to airport personnel.

6. Message Notification: When the vehicle reaches specific milestones along its route, such as reaching the final destination, the microcontroller sends a message via the GSM module to the phone number inputted through the keypad and displayed on the LCD screen. This ensures timely communication and coordination of baggage handling operations within the airport.

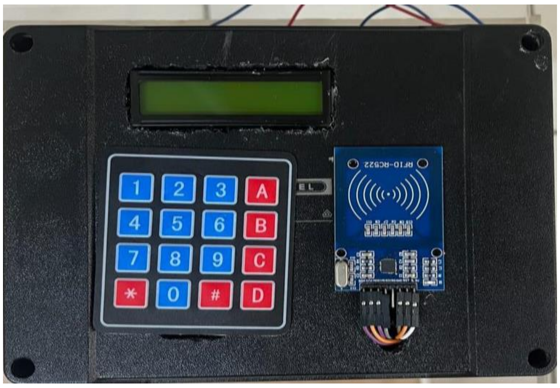

Fig -3: Control Box

3. CONCLUSIONS

In conclusion, the development of the Autonomous Passenger Baggage Carrier Vehicle in Airport represents a significant advancement in airport logistics technology. By integrating advanced navigation, security, and location tracking features, the system offers a comprehensive solution to the challenges of baggage handling and security within airport environments.

The project objectives have been successfully achieved through the implementation of the line-following mechanism for precise navigation, the multi-layer security system utilizing RFID technology, and the real-time location tracking system using RFID, GSM modules, LCD, and a keypad. These subsystems, controlled by an Arduino microcontroller, work together seamlessly to automate baggage transportation, enhance security measures, and provide real-time monitoring of baggage movement within the airport.

The Autonomous Passenger Baggage Carrier Vehicle in Airport promises to streamline baggage handling operations, reduce processing times, and improve overall efficiency in airport logistics. Furthermore, the system enhances security by restricting access to baggage containers and providing real-time notifications to relevant personnel.

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