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TRANSIT GUARD - An Intelligent Bus Capacity Management System

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***Abstract* - Transit Guard is an application based on the latest technology, which introduces a new approach to controlling the work of the public transport in a more efficient way. Transit Guard will also have the integration of infrared sensor technology to keep track of the number of passengers within the buses to ensure that capacity limit set is met, and passenger comfort and efficient operation are put into consideration. Transit Guard accurately captures the movement of passengers in real-time with high technology infrared sensors at the entry points and the exit points. When the count of the passengers surpasses the stipulated limit, it triggers an instant alert which alerts onboard staff and the Motor Vehicle Department (MVD) through the GSM technology. Along with its existing safety precautions, Transit Guard has the state of the art innovation: an integrated valve system that, when the occupancy levels exceed the acceptable limit, is automatically cut off to prevent any fuel to the engine. This new feature improves safety measures by ensuring that the bus does not proceed with its trip in a congested form, and risk factors related to overcrowding are reduced like accidents and health issues. Transit Guard ensures that there is proactive control of the movement of people during peak times and this is more prevalent during the busy evenings in Kerala where overcrowding is a common phenomenon among office workers, students and commuters. Transit Guard also enhances passenger safety and comfort along with regulatory compliance through integrating real-time occupancy tracking with rapid response, including fuel cut off.**

Keywords - GSM, Threshold Check, Solenoid Valve, Fuel Cut Off, MVD

I. INTRODUCTION

Public transit systems are very important components of the urban infrastructure, as millions of people across the globe rely on them to get to their daily destinations. Nonetheless, such systems are often faced with problems of efficiency, safety of passengers, and compliance with regulations especially during the rush hour where crowding is the norm. In addition to being uncomfortable, crowded buses provide serious risks, such as health issues and accidents. To address these issues and enhance the administration and safety of the public transportation, it is necessary to adopt the innovative solutions utilizing the latest technologies. Transit Guard is an innovative product which is designed to merge state of the art technologies to revolutionize management of public transit. As a relatively recent technology, Transit Guard operates under an advanced infrared (IR) sensor technology that views and manages the occupancy of passengers in the buses, and their primary concern is passenger safety and efficiency of operation. The system makes real time monitoring of the movement of passengers possible because of the IR sensors installed in the entrance and exit points. This constant check-up prevents overcrowding by making sure that buses do not exceed the occupancy limits.

The major task of the Transit Guard is to accurately count the number of people who are entering and leaving the bus. The device also rings an alarm when the number of passengers becomes more than the set amount. This notice is received by the Motor Vehicle Department (MVD) and onboard staff through GSM technology, which allows responding in time to this alert. Not only does Transit Guard monitor the number of people on board, it has a ground-breaking safety feature, a built in valve system, which instantly cuts off fuel flow to the engine when the number of people on board is greater than safe levels. By preventing the bus from traveling in an overcrowded condition, this preventive measure reduces the risks related to carrying too many passengers. An essential intervention to stop possible mishaps and health risks brought on by crowding is the automated fuel cut-off system.

Transit Guard is quite successful during the peak hours such as those of the busy evenings in the state of Kerala where

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buses often transport a big crowd of passengers, office workers, students, and ordinary commuters

Figure 1: An Overcrowded Bus

An overcrowded bus has following problems

- Accidents: Overcrowding can lead to accidents as the driver's visibility and manoeuvrability are compromised. In an emergency situation, passengers may not be able to exit the bus quickly, increasing the risk of injury.
- Falls and Injuries: Passengers standing or sitting in cramped conditions are more likely to lose balance and fall, leading to injuries.
- Obstructed Exits: Overcrowding can block emergency exits, making it difficult for passengers to evacuate in case of an emergency
- Stress and Discomfort: Crowded conditions can cause stress and discomfort, leading to a negative travel experience. Prolonged exposure to such conditions can also have adverse effects on mental health.
- Reduced Efficiency: Overcrowding can strain the bus's mechanical systems, such as brakes and suspension, leading to more frequent maintenance and reduced operational efficiency.

II. LITREATURE REVIEW

Devi. R Lakshmi et al [1] proposed a social distancing in the pandemic period is an important matter of concern so that they introduced a counting system. Here, they kept a fixed limit for persons entering into the bus and before that they had to pass the temperature check and mask detection checks. The device consists of a raspberry pi Module which acts as a system, a camera module, PIR Sensors, Infrared Temperature Sensors, LCD Monitor. It is captured and determined whether or not the person is wearing their mask in the entrance by the Camera Module, PIR Sensors are used to monitor the count of the persons entering or exiting the bus which is displayed in the LCD monitor. So, these work together and make the entry screening while entering a transport system.

William David Moreno Rendon et al [2] proposed a computer vision method that estimates the number of people in TransMilenio's boarding platforms using deep learning techniques. They release the TransMilenio- javeriana dataset with nearly 900000 head labels on buses and stations. From these images, a deep learning architecture tuned for crowd counting was trained to generate density maps around the heads in the scene. After testing these methods with 10800 images the results show a mean absolute error of 1 head per frame, equivalent to 11% relative error.

Donatella Darsena et al [3] proposed a taxonomy and review of sensing technologies based on the IoT for real-time crowd analysis, which can be adopted in the different segments of the PT system (buses/railway). To discuss such technologies in a clear systematic perspective, they introduce a reference architecture for crowd management, which employs modern information and communication technologies. In this new framework, additional services can be delivered to the passengers, such as online ticketing, vehicle access control and reservation in severely crowded situations.

III. TECHNOLOGY IN GENERAL

A. Block Diagram

The block diagram shown in Figure 2 illustrates the system designed to monitor and control the number of passengers on a bus. The system ensures that the number of passengers does not exceed a predefined limit by controlling the fuel supply using a solenoid valve. Additionally, the system provides visual and auditory alerts via an LED and buzzer when the passenger limit is exceeded. The block diagram highlights the key components and their interactions, enabling seamless operation and communication.

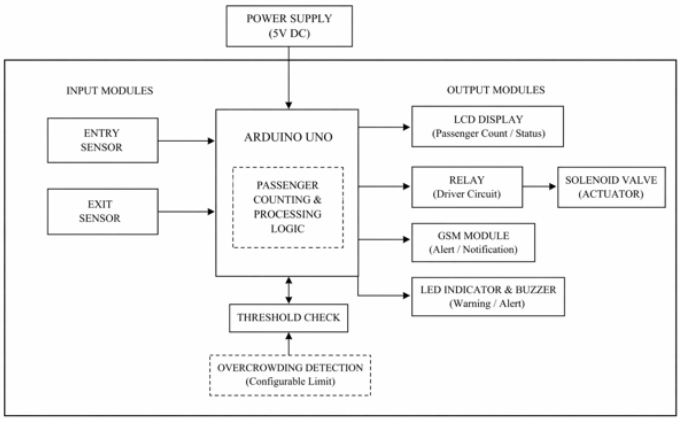

Figure 2: Block Diagram of the Proposed System

- Arduino Uno Microcontroller: Serves as the central processing unit. It receives data from the IR sensors, processes the passenger count, and sends control signals to the solenoid valve, LED, buzzer, and GSM module.
- IR Sensors: Detect the presence of passengers at the entrance and exit doors. The sensors are configured to send digital signals to the Arduino microcontroller.
- LCD Display: Provides a visual display of the current passenger count and system status.
- Solenoid Valve: Controls the fuel supply to the engine. The Arduino switches the valve on or off based on the passenger count.
- GSM Module (SIM800L): Facilitates wireless communication, enabling the system to send SMS notifications to the MVD when the passenger limit is exceeded.
- LED and Buzzer: Provide immediate visual and auditory alerts when the passenger limit is exceeded. The Arduino activates these components to alert the driver and passengers.
- Power Supply (5V,12V): Supplies the necessary voltage to all components of the system.

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To identify people getting on and off the bus, the system has infrared sensors. One of the infrared sensors is located at the entrance door to detect the people entering the building, and another sensor is located at the exit door to detect the people leaving the building. An Arduino microcontroller receives the signals from the sensors and processes them. In case of overloading the passenger limit, the Arduino receives the number of passengers on the bus by constantly counting them and sends a text message to the Motor Vehicle Department (MVD) and turns on an LED and a buzzer to notify the driver and passengers.

B. Communication and Control Flow

The block diagram shown in Figure 3 illustrates how the passenger counting system operates.

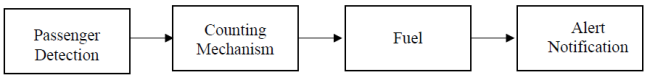

Figure 3: Block Diagram of Communication and Control Flow

1. Passenger Detection: The presence of passengers is detected using infrared sensors. The signals from the sensors are read by the Arduino microcontroller.

2. Counting Mechanism: In response to sensor inputs, the microcontroller modifies the number of passengers. An LCD panel shows the count.

3. Fuel Control: The Arduino turns on a solenoid valve to stop the engine's fuel supply when the number of passengers surpasses the predetermined threshold.

4. Alert Notification: To notify the driver and passengers, the system simultaneously turns on an LED and a buzzer. In order to inform the MVD of the issue, the system additionally uses a GSM module to send an SMS message.

C. User Interface and Integration

The user interface of the Transit Guard system has been designed in a manner that ensures that the bus drivers/ operators have a hassle-free experience. It ensures that key information such as the number of passengers and system status is easily accessible and understandable. This user-friendly interface is what makes the effective functioning and control of the system that ultimately enhances the safety and compliance in the transportation of the people.

- LCD Display: The driver or operator is the main source of information, and the LCD display is the focal point of the user interface. The display has a high visibility of the number of passengers in the aircraft, which has real-time updates that are critical in maintaining safe occupancy levels. In addition to the number of passengers, any important message or notification can be displayed on the LCD panel. These alerts could consist of system failures, or notifications about the passenger limit approaching capacity to make sure that the operator is constantly aware of the state of the system.
- LED Indicators and Buzzer: The LED indicators and buzzer will complement the visual information presented on LCD. These elements provide immediate, clear, notification when the number of passengers exceeds the limit. As the bus gets congested, the LED would light in a conspicuous colour, such as red. In order to swiftly get the operator's attention, the buzzer simultaneously makes a loud sound. This dual system of alerting makes it possible to act quickly to avoid hazardous situations by making the operator aware of any dangerous conditions immediately.
- The GSM module is also introduced to enhance communication capabilities of the system. This module is in charge of instantly sending vital information to the appropriate authorities, like the Motor Vehicle Department. The GSM module ensures that the authorities are promptly informed in case there is an overload of passengers by automatically sending a notification with relevant details.
- Integration and Interaction: The Transit Guard system provides a unified and effective user interface through the integration of various technologies. Operators don't need a lot of technical expertise or training to monitor passenger numbers and react to alerts thanks to the user-friendly design. The bus always works within safe passenger limits because to a mix of real-time data display, instant audio-visual alerts, and automatic communication with authorities..

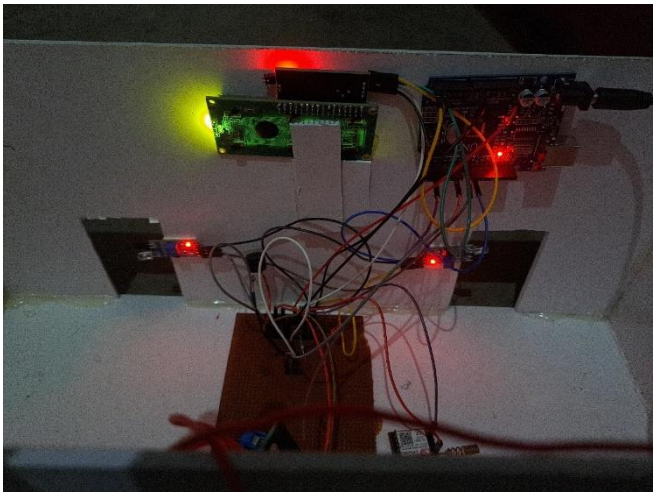

Figure 4: Working Model of the System

D. Hardware Implementation

The passenger counting and control system's hardware implementation marks the shift from design to function. Precision is used in the assembly of carefully selected parts, such as the Arduino Uno microcontroller for processing, infrared sensors for tracking passenger movement, the SIM800L GSM module for communication, and a solenoid valve for regulating the fuel supply.

The list of components used are

- The Arduino Uno is a central microcontroller used for controlling outputs and processing inputs.
- IR sensors: Used to identify people getting on and off the bus. When the passenger limit is surpassed, the GSM Module (SIM800L) is used to send SMS messages.
- Solenoid valve: Used to regulate the bus engine's fuel delivery.
- Relay Module: This module uses signals from the Arduino to activate the solenoid valve.

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- LED: To provide a visual warning when the number of passengers exceeds the limit. When the passenger limit is surpassed, a buzzer will sound an alert.
- LCD Display (16x2): To show the system status and the number of passengers as of right now.
- Power Supply (5V): The Arduino and other components are usually powered by a 5V power supply.
- Power Supply (12 V):The solenoid valve is powered by a 12V power supply.

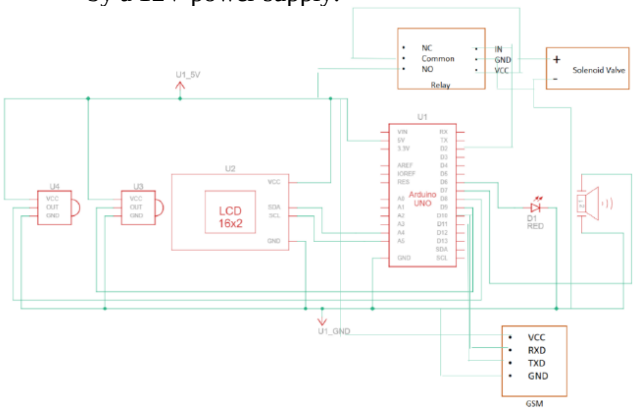

Figure 5: Circuit Diagram

The system works as follows as per the algorithm

- System Activation: Power on the Arduino Uno and ensure all components are properly connected.
- Passenger Detection: IR sensors at the entrance and exit detect passengers and send signals to the Arduino Uno.
- Counting Mechanism: The Arduino Uno processes the sensor signals to increment or decrement the passenger count accordingly.
- Display Update: The current passenger count is shown on the LCD display.
- Limit Check: If the passenger count exceeds the predefined limit: ▪ The Arduino Uno activates the relay, which in turn deactivates the solenoid valve, cutting off the fuel supply to the engine. ▪ The LED lights up to provide a visual alert. ▪ The buzzer sounds to provide an auditory alert. ▪ The GSM module sends an SMS notification to the Motor Vehicle Department (MVD).
- Continuous Monitoring: The system continuously monitors the passenger count and updates the LCD display in real time. The Arduino Uno checks if the passenger count returns below the limit and, if so, reactivates the solenoid valve to resume fuel supply

E. Software Implementation and Flow Chart

The Arduino Uno microcontroller is programmed as part of the software implementation of the passenger counting and control system. Along with the control of the number of passengers and the solenoid valve, the LED, buzzer and GSM module, the code defines the way microcontroller reads the signals of the infrared sensors. This software development controls the operations of the system which means that the number of people on the bus is accurately monitored and controlled. The Arduino programming environment is used to implement the system software. The software updates the passenger count by continuously reading signals from the infrared sensors The number of passengers is computed using

$$P(t) = P(t-1)+E(t)-X(t) \quad (1)$$

where

P(t) = passenger count
E(t) = passengers entering
X(t) = passengers exiting

The system checks whether the passenger limit has been exceeded:

$$P(t) > P_{max} \quad (2)$$

The safety mechanism is triggered if the criteria is met.

The passenger counting and control system's communication method is described in the flowchart. In addition to updating the passenger count and controlling the solenoid valve, LED, buzzer, and SMS notifications in the event that the passenger limit is exceeded, the Arduino Uno also analyzes signals from the infrared sensors.

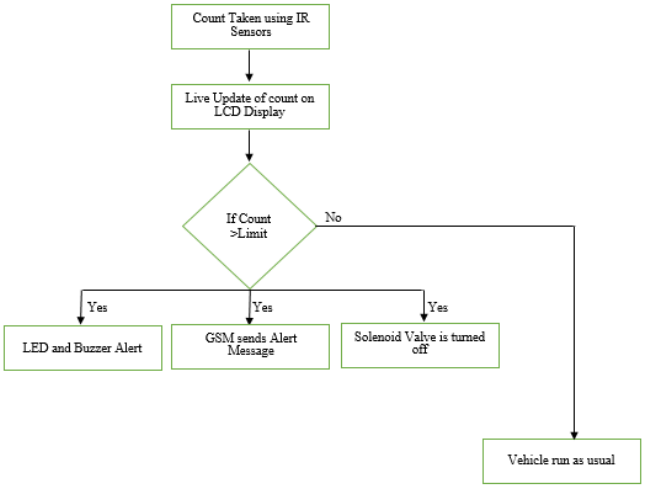

Figure 6: Flowchart of the proposed system

IV. RESULTS AND DISCUSSIONS

The project has successfully built a passenger counting and control system using Arduino Uno, LCD screen, IR sensors, GSM, relay, LED, buzzer, and solenoid valve.

The following is a summary of the main results:

1. Proper Counting of the number of passengers: The IR sensors were able to count the number of people who boarded and alighted the bus correctly. It was the system that continuously maintained the number of passengers in real time under numerous conditions.
2. Real Time Display: The LCD display gave the bus driver a clear and prompt feedback that effectively indicated the number of passengers on the bus.
3. Automated Control Mechanisms: The solenoid valve, LED and buzzer were automatically controlled depending on the number of passengers. When passengers exceeded the set limit, the solenoid valve was turned off to prevent the flow of fuel, the LED and the buzzer were activated and an SMS was sent to warn the authorities. The solenoid valve was turned on to allow the flow of the gasoline and the LED and the

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buzzer remained off when the number of the passengers was between the allowed numbers.
4. Extensive Testing: This was ensured by extensive testing that confirmed the reliability and correct operation of the control logic.
5. Responsive Performance: The system responded quickly with minimal delay time between the passenger counting, detection and control functions and ensured a rapid response to changes in passenger number.
6. System Stability and Reliability: During a number of test runs, the system was stable and reliable. The control algorithms were successful in controlling the operations without any crashes or unforeseen behavior, and all elements collaborated perfectly.

A. Observation Table

Here is the observation table of the real-time working of the passenger counting and control system.

Table 1: Observation while doing demonstration

Time	Action	Passenger Count	Action of the System
9:00 AM	20 Passengers Entered	20	Updated Count on LCD
9:10 AM	15 Passengers Entered	35	Updated Count on LCD
9:20 AM	10 Passengers Exited	25	Updated Count on LCD
9:30 AM	30 Passengers Entered	55	Updated Count on LCD
9:40 AM	25 Passengers Entered	80	Updated Count on LCD
9:50 AM	10 Passengers Exited	70	Updated Count on LCD
10:00 AM	40 Passengers Entered	110	Updated Count on LCD
10:10 AM	30 Passengers Entered	140	Updated Count on LCD
10:20 AM	20 Passengers Entered	160	Updated Count on LCD
10:30 AM	25 Passengers Entered	185	LED and Buzzer Activated (Near Capacity Warning)
10:40 AM	20 Passengers Entered	205	LED, Buzzer ON, SMS Alert Sent (Overcrowding Detected)
10:50 AM	15 Passengers Exited	190	LED and Buzzer Deactivated
11:00 AM	20 Passengers Exited	170	Solenoid Valve Activated (Door Control), System Stable

- Time: Timestamp of the observation.
- Action: Event occurring (e.g., person entered or exited).
- Passenger Count: Number of passengers counted.
- Action of the System: Response of the system based on the passenger count (e.g., update display, activate controls).

CONUCLUSION

The hardware components used in this project was an Arduino Uno, LCD display, IR sensors, a GSM module, a relay, LED, a buzzer, and a solenoid valve to successfully design and implement a passenger counting and control system on a bus. The technology ensures compliance with safety regulations and enhances the safety of passengers by ensuring that the number of passengers is tracked and controlled. The LCD display that has a real-time display of the number of passengers provides a bus driver with a clear and instant feedback. In the event that the number of passengers exceeds the number of slots allocated, the GSM module allows sending SMS notifications, and the IR sensors accurately detect individuals boarding and alighting the bus. The relay enhances the safety features of the system because it controls the supply of fuel using the solenoid valve. Extensive testing was conducted to ensure the functionality of the system, whereby once the number of passengers exceeds the set limit, the LED and buzzer are activated, the solenoid valve is closed and an SMS notification is sent. The solenoid valve allows the fuel flow and the LED and buzzer remain off when the number of passengers are within the allowable limit.

The Future scope of this project are:

1. Interoperability with Smart City Systems: Transit Guard can be integrated with smart city systems to exchange data in real time with city traffic management systems. This can also be used to optimise bus routes and schedules using passenger load data.

2. Advanced Data Analytics: Implementation of advanced data analytics can provide data regarding locations of high demand, busy times, and trends of passengers. This can help the transportation authority's make informed decisions that will enhance services and allocate resources more efficiently.

3. Improved Safety Systems: Additional safety measures can be incorporated such as automated emergency braking and onboard camera alerts in case of suspicion in order to enhance passenger safety.

REFERENCES

[1] Devi. R Lakshmi; K Sangeetha; Sai Rama Krishnan; Saranraj; Sneha Ganesh, "Entry Screening Device for Public Transport During Pandemic Period", IEEE ACCESS 12 May 2022.

[2] William David Moreno Rendon, Carolina Burgos Anillo, Daniel Jaramillo-Ramirez, "Passenger Counting in Mass Public Transport Systems using Computer Vision and Deep Learning", IEEE ACCESS April 4 2023.

[3] Donatella Darsena, Giacinto Gelli, Ivan Iudiceand Francesco Verde, "Sensing Technologies for Crowd Management, Adaptation, and Information Dissemination in Public Transportation Systems.