The Development of Detection System for Bus Passenger Monitoring

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Abstract
The Bus Passenger Detector System (BPD) is a device that utilises electronic components to assist bus operators, particularly those in the travel bus industry. Passengers frequently miss the bus during R&R (Rest and Recuperation) due to the necessity for more time to attend to personal matters, such as using the lavatory or eating. In addition, abandoned belongings pose significant challenges for passengers to reclaim or may be susceptible to theft. The objective of this project is to effectively address and resolve both of the identified issues. In order to ensure the success of the project, it is essential to develop a fundamental report, such as a flowchart and schematic diagram, prior to the implementation of the product. This device is specifically engineered to deliver instantaneous data regarding the passenger count on the bus as well as the contents of the overhead storage compartment. Additionally, it can enhance the effectiveness of bus operations and enhance customer convenience by delivering up-to-the-minute data on bus capacity and the whereabouts of unoccupied seats. This project is implemented based on specific criteria, including user-friendliness, ease of installation, high quality, ease of comprehension, and affordability. The Bus Passenger Detector project is an advantageous instrument for surveilling individuals and articles on a bus.

Keywords*:* Arduino Uno, Travel bus, BPD, Passenger detector, Item detector*.*

Introduction

While a bus journey may offer convenience, it is inevitable that certain unpleasant circumstances arise upon arrival at the destination. One of these situations is that passengers are often left behind by the bus at R&R (Rest and Recuperation). This is because R&R is a rest stop for all long-distance travelers. Therefore, passengers need to take more time to do their own business such as going to the toilet, eating, to prayer and other things. In the meantime, the driver cannot determine whether the passengers are in their seats or not. Another situation occurs when passengers accidentally leave their belongings behind. This is due to haste or forgetfulness. All these items left behind are very difficult for the passenger to retrieves it back or could probably be stolen.

According to the existing product, an Internet of Thing (IoT) bus seat occupancy uses sensors to detect whether a seat is occupied or not and sends this information over a network to a central server (Sharma & Sawant, 2020; Zeeman *et al*., 2013). Another existing product is equipped with a face detection system that can recognize the passenger's face (Cao *et al.,* 2022). This system can have multiple functions, such as real-time seat occupancy monitoring and passenger counting. The main advantage of this system is that it can improve the efficiency of transport operations by providing real-time information on seat availability, which can help optimize routes and reduce waiting time for passengers. In addition, fare collection costs can be reduced by eliminating the need for manual ticket inspection, and passenger safety can be improved through real-time bus monitoring and passenger identification. In addition, a face detector can help track passengers and create a safer environment (Khawar Islam *et al.,* 2021).

An IoT system for detecting seat occupancy on busses (Martínez-Estrada, Gil, & Fernández-García, 2023), also a CCTV facial recognition product (Azlan *et al.,* 2021) aims to improve the efficiency of bus operations by providing real-time information on seat availability and passenger identification which can help optimize routes and reduce passenger waiting times. However, it also has some potential drawbacks, such as privacy concerns, cost, complexity, data security, false detections, and technical malfunctions, which need to be considered before implementation. In addition, the use of facial recognition technology may be subject to legal restrictions in certain jurisdictions.

Based on this problem, our project aims to develop a smart and efficient bus system that can improve overall passenger comfort. The bus passenger detector is to provide real-time information about the passenger's seat and reduce the loss of passengers, and the third goal is to help passengers recover their belongings.

Methodology

The maker and Do It Yourself (DIY) communities have utilized Arduino in tens of thousands of projects and applications because of its straightforward and approachable user interface. It is already used in many commercial and professional applications because of Industrial Shields and other industry disruptors. The Arduino Uno R3 is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz crystal, a USB port, a power jack, an ICSP header, and a reset button. It is an open-source platform commonly used for building electronics projects and interacting with a variety of sensors and actuators. The board is compatible with several programming languages including C and Python and can be programmed using the Arduino integrated development environment (IDE). The Arduino Uno R3 can be used in combination with a keypad, a seat pressure sensor, and an ultrasonic sensor to create a variety of projects. For example, the keypad can be used as an input system where the user must enter certain data to gain access. The seat pressure sensor can be used to detect whether a person is sitting on a particular seat, and the ultrasonic sensor can be used to measure distance or detect objects.

Figure 1 shows the block diagram of the Bus Passenger Detector project (BPD), which includes several components that work together to provide real-time information about seat availability and detect passengers' belongings. The main components of the system are Seat Pressure Sensor, Ultrasonic Sensor, 4x4 Keypad, Arduino Uno R3 Microprocessor, 16x2 LCD, LED, and Buzzer. The seat pressure sensor is placed under each seat to detect whether a seat is occupied or not, the ultrasonic sensor is used to detect passengers' belongings, and the keypad is used to control display and to enter numbers to limit the number of passengers on the bus. The Arduino Uno R3 microprocessor acts as the brain of the system, processing input signals from the sensors and controlling output devices such as LCD, LED and the buzzer. The system can be integrated with a central server to provide real-time information about seat availability, passenger belongings and other relevant data.

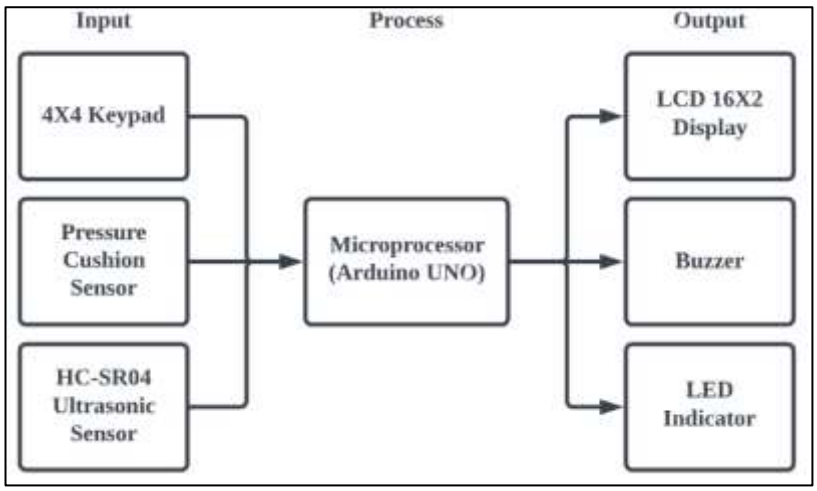

Figure 1: The block diagram of bus passenger detector project(BPD)

According to the system operation flowchart in Figure 2, programmers can use flowcharts to debug or clean up buggy code by identifying likely problem areas and locating them. Figures below shows the flowchart used in the Bus Passenger Detector (BPD) project. To start the program, the user can use the keypad to enter the maximum number of passengers. Then, when the seat cushion sensor is triggered, the number of passengers is incremented by one to determine the total number of passengers on board. When the number of passengers exceeds the set limit, the buzzer ON will sound to notify the user. LED indicates ON which seat is occupied by a passenger. A range of 20 cm is set as the minimum range for the ultrasonic sensor. As a result, an object detected below this range is classified as an object and the system is triggered. The data obtained is displayed on 16X2 LCD in real time.

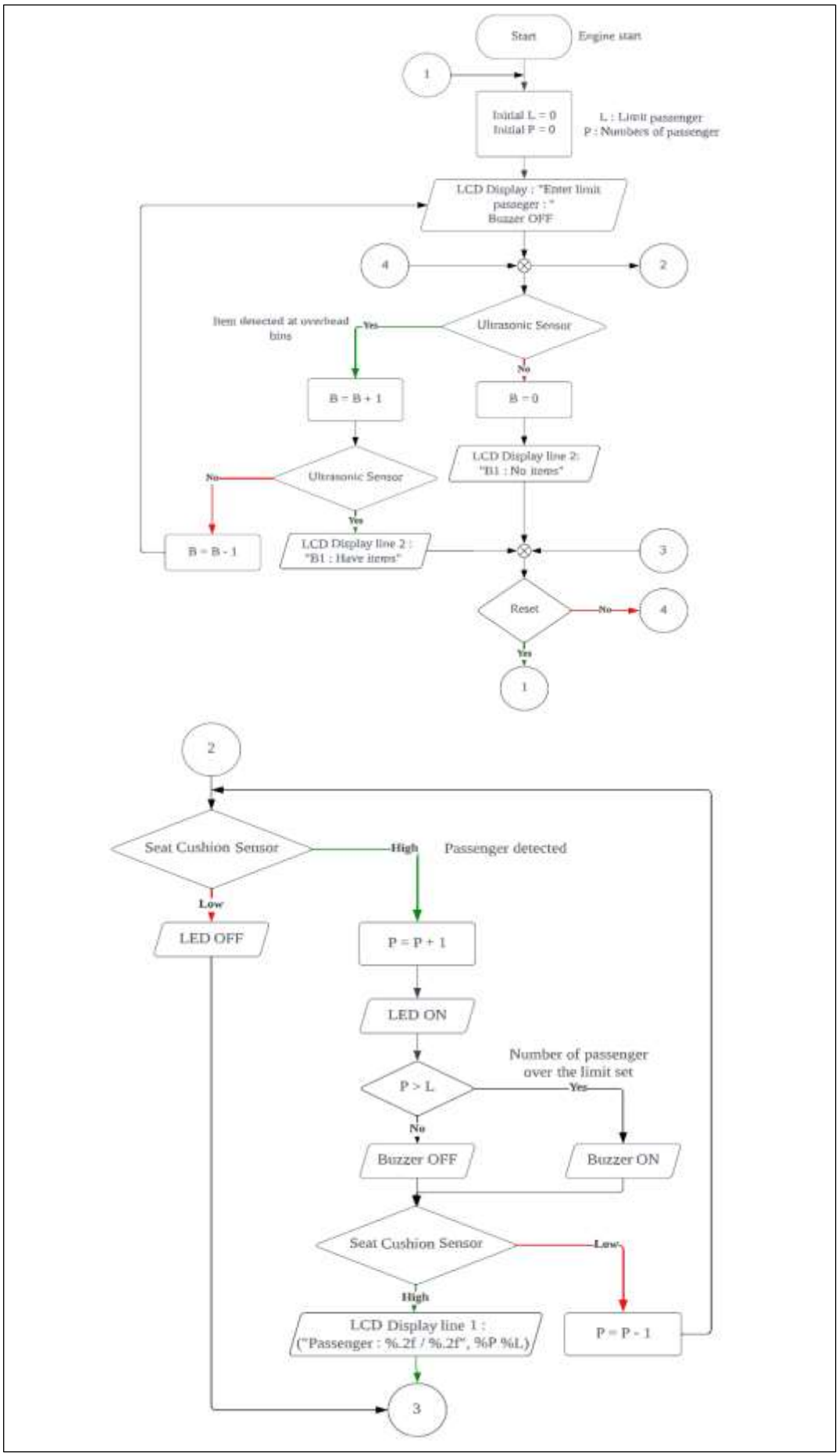

Figure 2: The Flowchart of Bus Passenger Detector project(BPD)

The circuit diagram of Bus Passenger Detector consists of several components connected to form a complete circuit. The main components of the circuit are: -

- Arduino Uno R3 Microprocessor: This microcontroller board serves as the brain of the circuit. It receives input signals from the sensors, processes the data, and controls the output devices. It needs to be connected to a power source, typically a 9V battery or a power adapter.
- Seat cushion sensor: This sensor is connected to one of the digital input pins of the microprocessor. When a seat is occupied, the sensor sends a digital signal to the microprocessor.
- Ultrasonic sensor: This sensor is connected to one of the digital input pins of the microprocessor. When an object is detected, it sends a digital signal to the microprocessor.
- 4x4 Keypad: This keypad is connected to the microprocessor's digital input pins. When a button is pressed, the keypad sends the corresponding code to the microprocessor.
- 16x2 LCD: This display is connected to the microprocessor's digital output pins. The microprocessor sends data to the LCD to display the status of the seats and the passenger's belongings.
- LED: This component is connected to one of the digital output pins of the microprocessor. The microprocessor sends a signal to the LED to indicate the occupied seats.
- Buzzer: This component is connected to one of the digital output pins of the microprocessor. The microprocessor sends a signal to the buzzer to alert the passengers when there's more passenger than the limit that already set before the trip.

All these components are connected using wires and a breadboard. The circuit diagram would also include the connection of the microprocessor as shown in Figure 3.

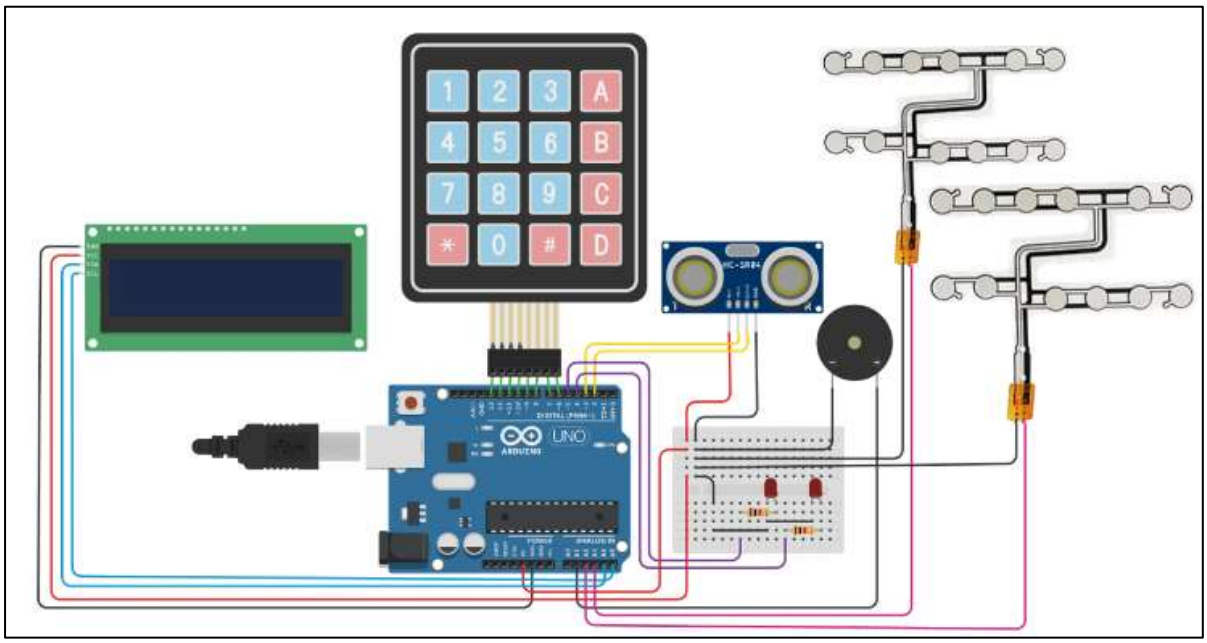

Figure 3: Circuit diagram of the proposed system

Results and Discussion

This project was developed to provide real-time information on the number of passengers on the bus and items in head bin. Besides that, it can improve the efficiency of bus operations, reduce the workload for bus staff, and enhance the passenger experience by providing real-time information on bus capacity and the location of available seats.

In this project, the performance evaluation of the constructed proof of concept was tested on Pitch Perfect day where this project get encouragement from students and lecturers. By conducting survey also help to evaluate the necessity of this project. From 47 respondence, 66% are really agree that by adding this feature can smooth the journey by bus.

Figure 4:Prototype of bus passenger detector

Figure 4 shows the actual proof of concept circuit developed in this project. To start the system evaluation, the respective C file codes were download and run on the Arduino UNO microcontroller via Arduino IDE. The display is used in which the users can select between A, B, C and D to conduct the program wanted. The normal SOP is by press A to set up the limit of passenger first according to the number of passengers that should be on the bus.

Figure 5: LCD display of bus passenger detector

After entering the limit, the display will show the amount of passenger and the limit such as Figure 5. Pressure cushion sensor are used in this project to detect the seat that occupied by passenger. Data are update in real time to make it easier for the

user to notify about the passengers on board. It should be noted that if the number of passengers exceeds the limit set, buzzer will be triggered to alert the user about the unwanted passenger on the bus. Next, second line of LCD display are showing the existence of items in the head bin.

Figure 6 shows the situation if there are items on the head bin. The system will detect the item by using an ultrasonic sensor. By set the range of the head bin in system operation, the existence of item will interrupt or make the range of echo short and at the same time triggered the system. The LCD display will update the data to “Have items” to alerting the user. By press “B”, user also can monitor the range of item form the sensor in the head bin.

Fig 6. Item on the overhead bin

Based on the result, it is found that the accuracy of this project is high. Because the trigger weight of the sensor is around 20kg, items that left in the seat are mostly will not disturb the system. For overhead bin, the items left need to be big enough to alerting the system. Item that are small such phone or small box will not be detect.

In summary, the Bus Passenger Detector project (BPD) is a useful instrument for keeping track of the passengers and items in a bus. The findings from the prototyping measures showed that the suggested system might make a good foundation for a bus monitoring system's actual implementation. The bus industry really needs a feature that can help improve the existing system. Overall, compared to manual passenger counting and tracking, bus passenger detectors offer several advantages. They are faster, more accurate, and less prone to errors than manual methods. The ability to provide data in real-time can make a different and the work for driver easier.

Conclusion

In conclusion, the system deployment in this project is realistic and straightforward because it requires only a simple kind of method to function. The problem statement can be solved by implementing this project. In the future, IoT can be added to make the device more useful. By implemented this feature, the data can be access just by using a computer or smart phone in real-time on cloud database.

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