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IoT Based Smart Railway Station System with Trust Based Secure Parking Allocation and Comprehensive Waste Management Solution

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Abstract

This project aims to develop a smart railway station based on Arduino Uno and IoT. First of all, this is an Arduino project that implements both a parking system and a train crossing system. This project uses various components such as IR sensors, a buzzer, LEDs, and servos to detect the presence of cars in a parking lot and control the opening/closing of a train gate. The parking system portion of the code checks if a car is present by using IR sensors at the entrance and exit of the parking lot. If a car is detected entering the lot and there are available parking spaces, the system will lower a barrier arm and decrement the available parking space count. When a car exits the lot, the system will raise the barrier arm and increment the available parking space count. If the lot is full, the system will display a message on an LCD screen indicating that the lot is full. The train crossing system portion of the code also uses IR sensors to detect when a train is approaching. When a train approaches, the system will lower a gate arm and activate a red LED and buzzer to signal drivers to stop. Once the train has passed, the system will raise the gate arm and activate a green LED to signal drivers to proceed. A Smart Garbage Dustbin will also be developed based on the Web and will be interfaced with a NodeMCU and an ultrasonic sensor. The sensor will be placed at the top of the bin. Using 10cm as the threshold, will set the level. In the event that the garbage in the bin reaches the threshold level, the sensor triggers the NodeMCU, which alerts the associated authority until the bin has been emptied. For night vision, there will be some lighting which can also be controlled by Web based monitoring system. Overall, this project demonstrates how an Arduino and NodeMCU can be used to implement systems to control physical objects in real-time.

Keywords: Smart Railway Station, Parking System, Smart Lighting,Power System Management, IoT, Garbage System.

1. Introduction

Imagine a world where railway transportation is not just a means of getting from point A to point B, but a smarter, safer, and more efficient way of traveling. This world is not a distant dream but a tangible reality, made possible by the latest advancements in technology. One such project, aimed at revolutionizing the railway system, is the development of a smart railway station based on Arduino Uno and IoT. The project focuses on ensuring the safety and security of passengers in the railway system, with the implementation of automatic railway gates that close when a train passes through the railway crossing. The arrival and departure of trains are detected using two IR sensors, and the opening and closing of the gates are controlled using servo motors that are operated by an Arduino. This system provides enhanced protection from accidents, with LCD displays and alarms to indicate the closing of gates to people trying to cross the tracks.

But, that is not all. Alongside the railway station, a parking area for vehicles has been designed, with an automated system that finds available parking slots for incoming cars. As soon as a train reaches the first IR sensor, there is a five-second delay, during which the cars that were on the railway tracks move to the parking area, making the tracks free for trains to pass. The parking system has the capability of automatically finding empty slots for parking, allowing incoming vehicles to enter the parking area. If there are no empty slots, the entrance is blocked by a servo barrier controlled by an Arduino Uno based system.

In addition, a smart garbage dustbin has been developed, which uses NodeMCU and ultrasonic sensors to detect when the bin is full. The sensor, placed at the top of the bin, triggers the NodeMCU when the garbage reaches a threshold level of 10cm, alerting the associated authority until the bin has been emptied.

These ground-breaking initiatives demonstrate the power of technology in transforming the railway system into a smarter, safer, and more efficient means of transportation. The smart railway station, parking system, and garbage dustbin, all based on cutting-edge technology, are poised to usher in a new era of railway transportation that is sustainable and secure.

2. Literature Review

Various researchers worldwide are working on developing intelligently operated rail level crossing gate control systems. Throughout the past few decades, researchers have been attracting attention to the need for automated systems in Bangladesh. Most developed nations already have automated system. The automated gate control system for railway level crossings is yet to be developed in some developing countries, like Bangladesh. (Siddh et al.,2015) proposed an automatic railway gate control system using IR and pressure sensors along with voice declaration. This system allows the gate to close when the train arrives or leaves a railway-road level crossing. Microcontroller was used to trigger the siren to alert people who may be near or on the track. And closing or opening the gate by rotating the servo motor. (Abu Salman Shaikat, 2021)

The project addresses some of the major challenges and opportunities in developing smart railway systems for smart cities, such as safety, efficiency, sustainability, and user comfort. According to (Ali et al. 2023), rail accidents are a major problem in many countries around the world, and there is an urgent need to install protective elements to prevent accidents. They propose a sensor-based smart railway accident detection and prevention system for smart cities using real-time mobile communication, which consists of several sensors, LTE module, micro-controller, motorized gate and various displays fortraffic control. They claim that their system can achieve real-time two-way communication between the train and the control room, and can detect and prevent accidents effectively. (Ali M., Rasheed O., Rehman S., Ullah F., Ahmed S. 2023)

Another aspect of smart railway systems is power utilization and management, which can enhance the performance and comfort of railway operations (Dethe et al. 2022) propose an IoT-based smart railway management system for passenger safety and comfort, which can automatically turn lights and fans on and off based on the number of people in the coach. They also propose a prototype for automatically examining and identifying cracks, obstacles, and fire in railway tracks using various sensors. They state that their system can update the status of all sensors on a website to assist railway administrators (Dethe T., Maheswari B.U., Ullas S., 2022).

The project also incorporates some innovative features that are not commonly found in existing smart railway systems, such as automated car parking and smart garbage dustbin. These features can improve the convenience and cleanliness of railway stations, as well as reduce traffic congestion and environmental pollution. However, there is limited literature on these aspects in relation to smart railway systems, and more research is needed to evaluate their feasibility and effectiveness.

In conclusion, this literature review has provided an overview of some of the existing research on smart railway systems based on Arduino Uno and IoT, as well as identified some of the gaps and limitations in this field. The project has a potential to contribute to this field by developing a comprehensive and integrated smart railway station that can address multiple aspects of safety, efficiency, sustainability, and user comfort.

3. Objectives

The objectives of this project are given below:

- To develop a smart railway station using Arduino Uno and IoT technology.
- To ensure safety and security of passengers in the railway system.
- To create a parking area for vehicles alongside the railway station.
- To develop a smart garbage dustbin using Web technology, NodeMCU and ultrasonic sensors, which alerts authorities when the bin is full.

4. Hardware Architecture & Project view.

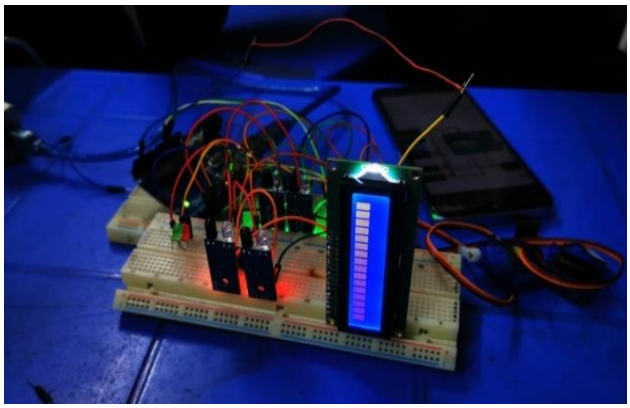

Figure 1: Hardware Architecture of Project.

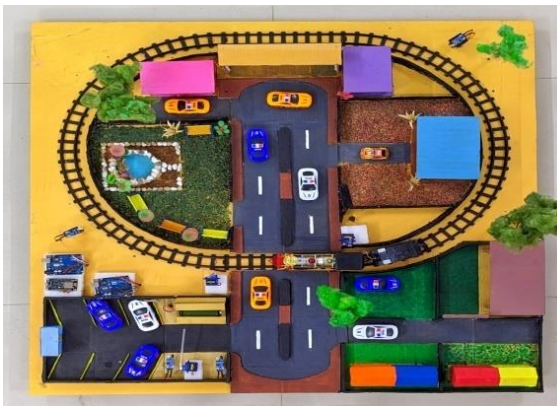

Figure 2: Overview of Project.

5. Flow Chart

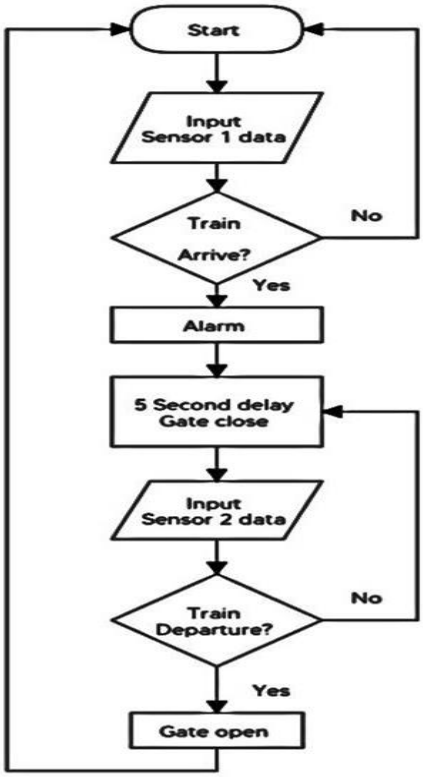

Figure 3: Flow chart of smart railway station.

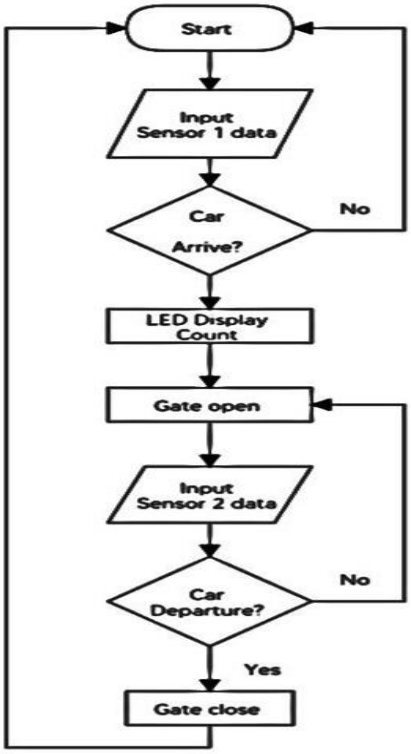

Figure 4: Flow chart of smart parking system

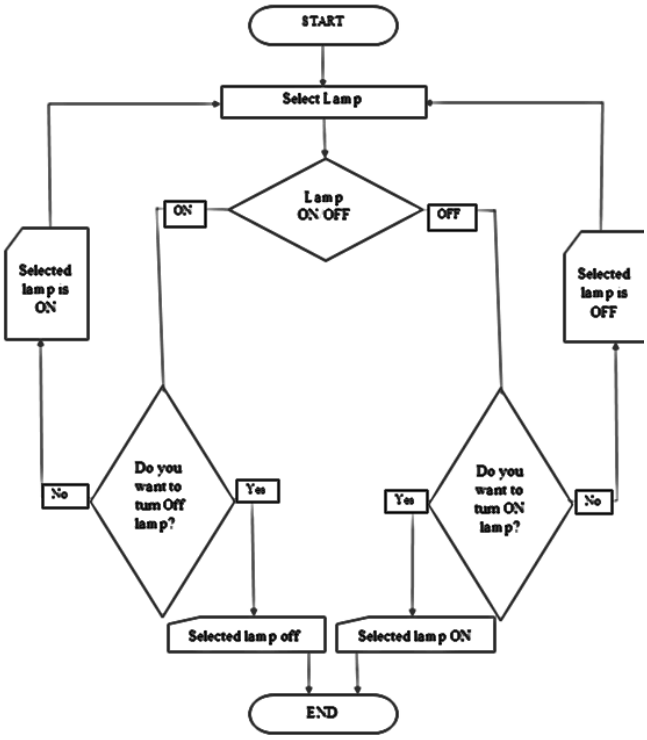

Figure 5: Flow chart of smart lighting by Node MCU

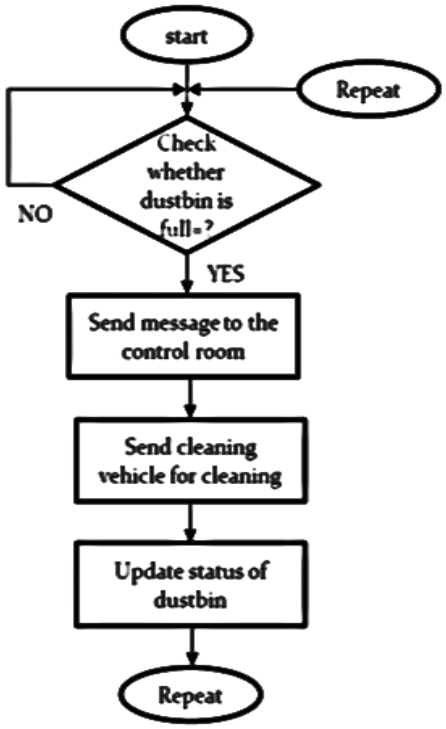

Figure 6: Flow chart of garbage system by Node MCU

6. Block Diagram

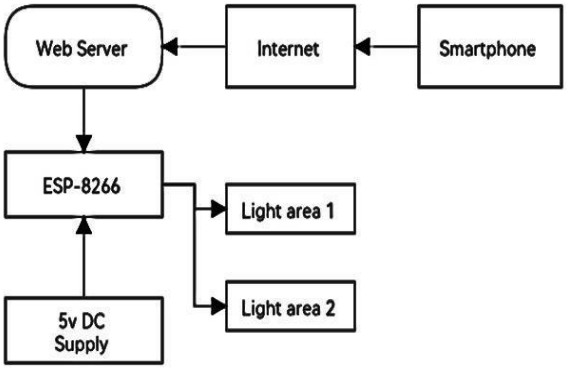

Figure 7: Block Diagram of Smart lighting system by NodeMCU

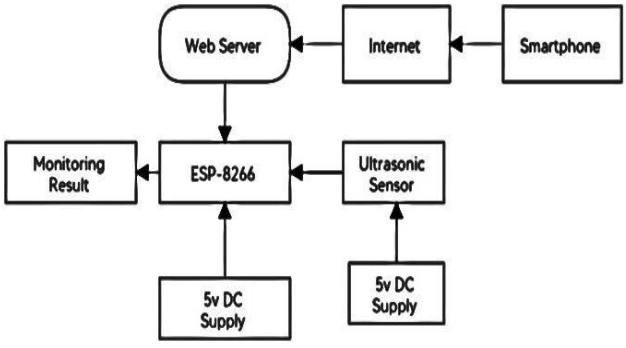

Figure 8: Block diagram of smart Garbage system by NodeMCU

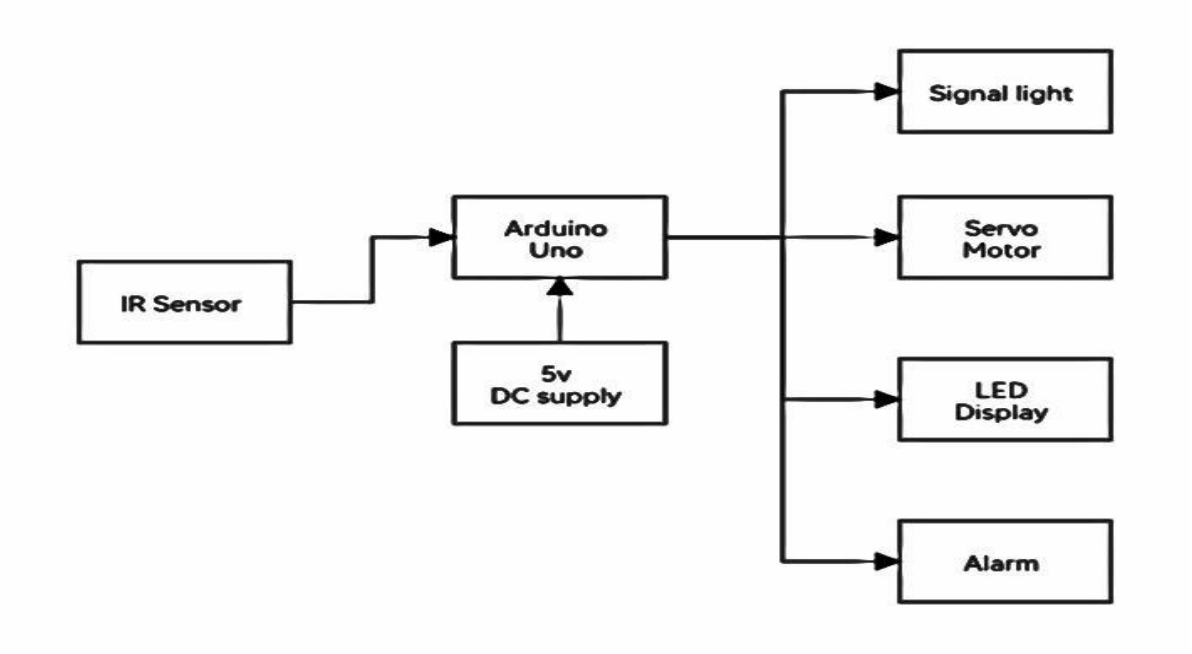

Figure 9: Block diagram of smart Parking and Railway station system by Arduino

7. Circuit Diagram

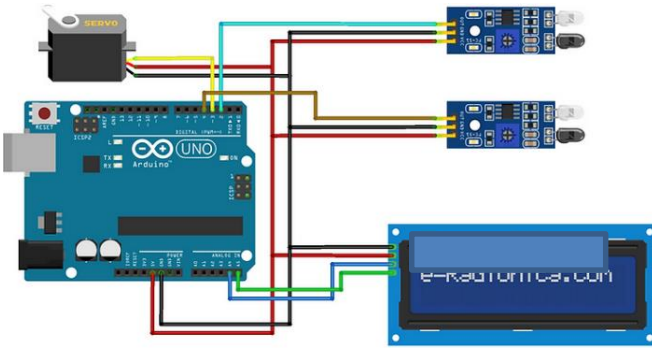

Figure 10: Circuit diagram of smart Parking System

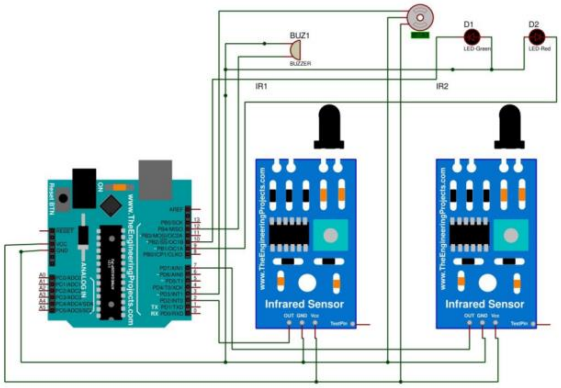

Figure 11: Circuit diagram of smart Railway System

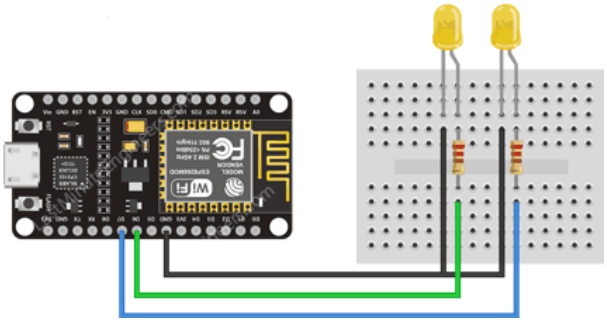

Figure 12: Circuit diagram of smart lighting system by NodeMCU

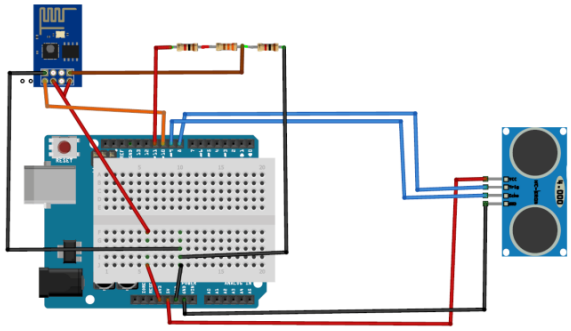

Figure 13: Circuit diagram of smart Garbage system by NodeMCU

8. Working Principle

The working principle of the smart railway station based on Arduino Uno and IoT can be described as follows:

Automated Railway Gate: The system uses two IR sensors to detect the arrival and departure of trains, it's circuit diagram shows in Fig.11. As soon as the train approaches the railway crossing, the first IR sensor triggers a 5-second delay, during which any cars on the railway will move to the parking area. After the delay, the second IR sensor detects the train's presence and closes the railway gate automatically, using a servo motor controlled by an Arduino Uno, as shows in Fig.3.

Parking Area: The system has an automated parking area alongside the railway station, it is circuit diagram shows in Fig.12. As soon as the railway gate closes, the system searches for empty parking slots using an Arduino Uno-based system. If an empty slot is found, the upcoming vehicle will be allowed to enter the parking area, and the entrance barrier will open using another servo motor controlled by an Arduino Uno. If no empty slots are found, the entrance barrier will remain closed, preventing vehicles from entering the parking area, as shows in Fig.4.

Smart Garbage Dustbin: The system uses an ultrasonic sensor placed at the top of the bin to detect the garbage level, it's circuit diagram shows in Fig.13. Once the garbage level reaches a predefined threshold of 10cm, the sensor triggers a NodeMCU, which alerts the relevant authority to empty the bin. The system's web interface allows the authorities to monitor the garbage levels and empty the bin as needed, as shows in Fig.6.

In summary, the working principle of the smart railway station based on Arduino Uno and IoT involves using various sensors, servo motors, and microcontrollers to automate the railway gate, parking area, and garbage dustbin. The system ensures the safety and security of passengers by automating the railway gate, provides efficient parking management, and helps to keep the station clean and hygienic by automating the garbage collection process.

1. Advantages

1. Improved Safety: The system's automated railway gate ensures the safety of passengers by preventing accidents and collisions between trains and vehicles.
2. Efficient Parking Management: The automated parking area helps manage parking spaces efficiently and prevents congestion, leading to a better user experience for passengers.
3. Cost-Effective: The use of Arduino Uno and IoT technology reduces the cost of the system as compared to traditional solutions.
4. Low Maintenance: The system is designed with minimal moving parts, reducing the maintenance requirements and making it more reliable.
5. Easy Installation: The system is easy to install and integrate into existing railway infrastructure.
6. Real-Time Monitoring: The system allows real-time monitoring of the parking area and garbage dustbin, enabling efficient management of these facilities.
7. Environmentally Friendly: The system reduces the environmental impact of railway transportation by automating the garbage collection process.
8. Increased Efficiency: The use of automated systems and IoT technology helps to increase the overall efficiency of the railway station, reducing waiting times and improving the passenger experience.
9. Enhanced Security: The system's automated railway gate and parking area help to enhance the overall security of the railway station.
10. Scalable: The system can be easily scaled up or down based on the requirements of the railway station, making it a flexible and versatile solution.

2. Limitations

Here are a few possible limitations of the project:

1. Maintenance and Repair: The maintenance and repair of the system may require specialized technical expertise and equipment, which can be costly and time-consuming.
2. Limited Detection Range: The IR sensors used to detect the arrival and departure of trains may have a limited detection range, which could potentially cause issues with the system's accuracy.
3. Connectivity Issues: The system's effectiveness may be hindered by connectivity issues or signal interference, which can cause delays and potential safety concerns.
4. Limited Scope: The project focuses on developing a smart railway station, but does not address other issues or challenges faced by the railway transportation system, such as scheduling or maintenance of trains and tracks.

It is important to note that these limitations can be mitigated through proper design, testing, and implementation of the system.

3. Applications

1. Railway Safety: The project can enhance the safety and security of passengers and vehicles by automating the closing of the railway gate when a train approaches, which helps to prevent accidents and injuries.
2. Smart Parking: The system's ability to detect available parking slots and automatically move cars to the parking area can optimize parking management at the railway station, saving time and reducing congestion.
3. Smart Garbage Management: The smart dustbin developed as part of the project can improve waste management at the railway station, ensuring that garbage is collected and disposed of in a timely manner, promoting cleanliness and hygiene.
4. IoT Integration: The project uses IoT technology to automate various processes, making the railway station more efficient and reducing the need for human intervention.
5. Scalability: The system can be scaled up to accommodate larger railway stations or expanded to include additional features or functions, making it adaptable to the needs of different transportation systems.

4. Result Analysis

After completing all the necessary steps, it was finally able to implement the project work based on and the results are as follows:

- A smart railway station using Arduino Uno and IoT technology.
- Ensure safety and security of passengers in the railway system.
- Create a parking area for vehicles alongside the railway station.

A smart garbage dustbin using Web technology, NodeMCU and ultrasonic sensors, which alerts authorities when the bin is full.

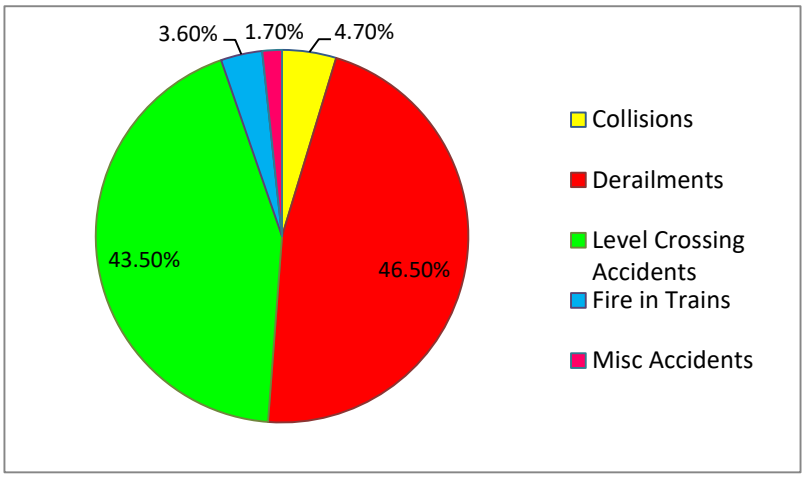

Figure 14: Percentage of Accidents by Types

Each time there is a train accident, the issue of safety in Railways comes to the fore. Between 2009-10 and 2014-15, there were a total of 803 accidents in Railways Station. By far, the highest number of accidents are because of derailments & accidents at level crossings. 9 out of 10 railway accidents during 2009-10 and 2014-15 have been due to derailments and accidents at level crossings. The other type of accidents includes collisions, etc. But their number is relatively much lower. (Rakesh dubbudu,2016)

There have been various causes for train accidents ranging from Human Failure to Equipment Failure to Sabotage etc. In the 6-year period between 2009-10 and 2014-15, human failure has caused more than 86% of the total accidents. Out of this, 41% accidents were caused due to the failure of railway staff and the rest due to the failure of others. Equipment failure caused only 2.2% of the accidents. (Rakesh dubbudu, 2016)

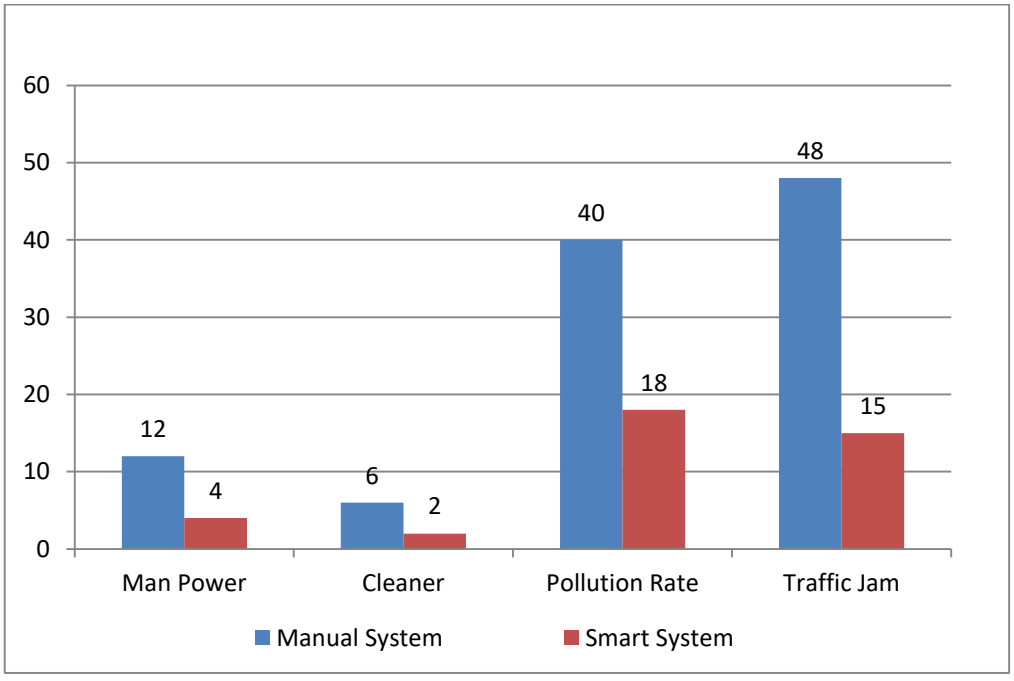

Figure15: Saving Analysis of Smart System

This will be happened if the implement of this project has done properly. It will reduce man power and cleaner in railway station. which is directly connected to a big amount of annual cost. On the other hand, it will also reduce a big amount environment pollution rate and traffic jam beside railway station which analysis before. There are different types of dust available in our environment. This smart garbage system will collect them properly and notice authorities when it will become filled.

This different type of dust to make fertilizer. It will help agriculture sector. Avoids the overflow of the dustbin. This IoT based waste management is very useful for smart cities in diverse aspects. In cities there are dissimilar dustbins located in different areas and dustbins become over flown many times and the concerned people do not get info about this. This system is designed to crack those issues and will offer complete details of the dustbins located in different areas throughout the city. (Rakesh dubbudu, 2016)

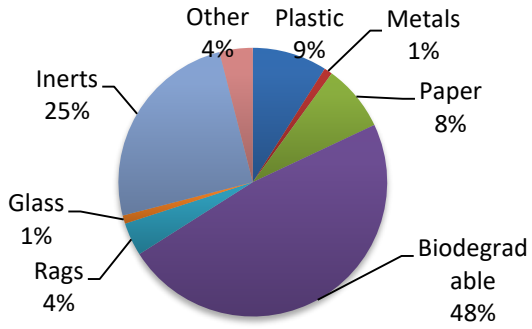

Figure16: Various of Dust gathered by Garbage System

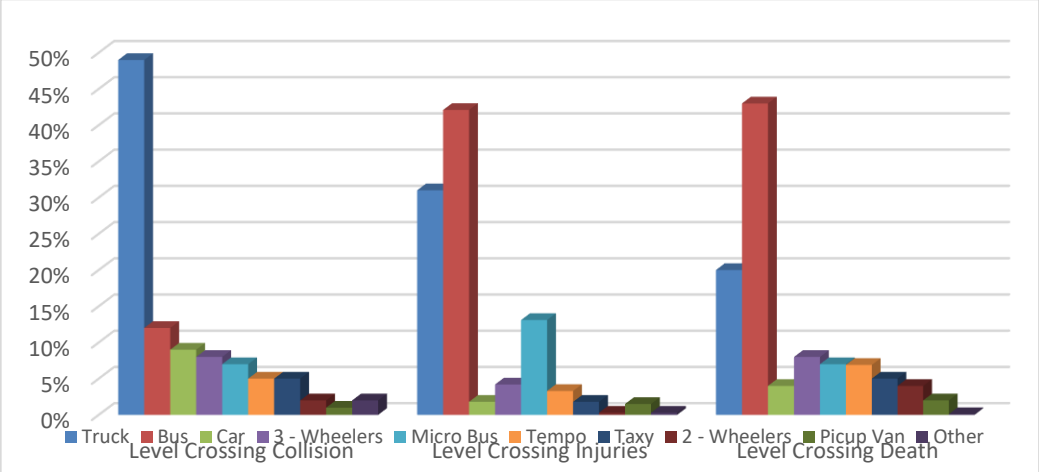

Figure 17: Level Crossing Accidents by Different Type of Road Vehicles

Accidents can be reduced by developing automatic control system namely advanced train engine system, advanced and automated railway level crossing gate control mechanism etc. Moreover, the time-consuming process of level crossing gate opening and closing mechanism results in huge traffic problems in cities. This hazard can be prevented by this system.

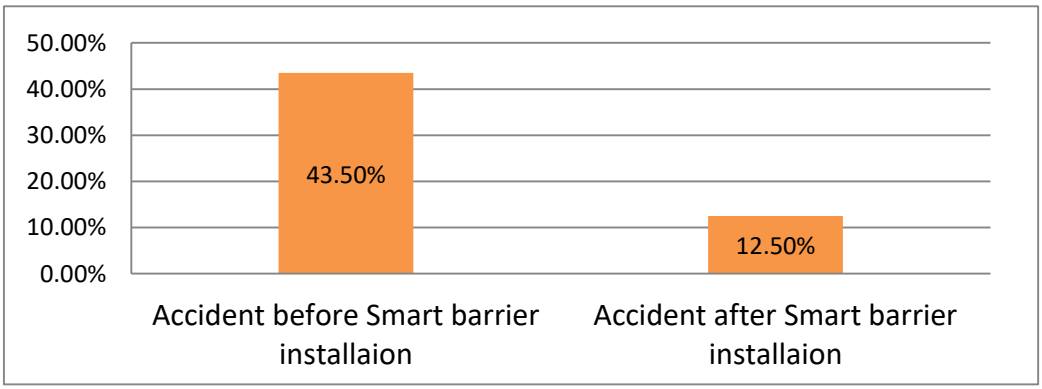

Figure 18: Effect on Crossing accident rates of Smart barrier installation

No productive steps have been taken so far despite the risk of human lives and huge time consumption. This calls for the need to implement an automated level crossing gate controlling system in level crossing of Dhaka city as well as everywhere in BR network. This work designs and develops an automated railway level crossing gate control system using IR sensor and programmable logic control that avoids the time-consuming process of level crossing gate opening and closing mechanism and ensures safety to the road users reducing accidents. (Abu Salman Shaikat, 2021)

5. Discussion

The smart railway station project is a significant step towards making railway transportation safer and more efficient. By integrating IoT technology and automation, the project aims to enhance the security and convenience of passengers and vehicles using the railway station.

This project code combines the original two codes and defines both myservo1 and myservo2. The loop () function now includes both the train system and parking system functionality. If the train IR sensor detects an obstacle, myservo1 will move to the 90-degree position and the red LED will light up. If the second IR sensor detects no obstacle, myservo1 will move to the 0-degree position and the green LED will light up. If the first parking IR sensor detects a car and there are available slots, myservo2 will move to the 0-degree position and the number of available slots will decrease by one. If there are no available slots, the LCD will display an apology message. If the second parking IR sensor detects no car, myservo2 will move back to the 90-degree position and the number of available slots will increase by one. The LCD screen will always display a "welcome" message and the number of available slots.

Another notable feature of the project is the smart garbage dustbin, which can improve waste management at the railway station. By detecting when the bin is full, the system can alert the authorities to empty it, promoting cleanliness and hygiene at the station.

However, there are some limitations to this project that need to be addressed. For instance, the system's ability to detect empty parking slots may be limited by the accuracy of the sensors used. Similarly, the automated gate closing mechanism may not work in situations where there are multiple trains passing through the railway crossing. Furthermore, the cost of implementing this project may be a barrier to adoption, particularly in developing countries with limited resources. The project's reliance on IoT technology and automation may also pose challenges in terms of maintenance and repairs, as specialized skills and expertise may be required.

6. Conclusion

In conclusion, the development of a smart railway station based on Arduino Uno and IoT is a highly innovative and promising project. This project aims to enhance the safety and security of railway transportation by automating the closing of railway gates and managing the flow of vehicles in the adjacent parking area. Additionally, the project includes a smart garbage dustbin that is capable of detecting when it is full and alerting the relevant authorities. While there are limitations and challenges to overcome, the benefits of this project are significant and it is a step towards a safer, more efficient, and sustainable transportation system.

7. Future Scopes

- Integration with other transportation modes: The smart railway station could be integrated with other transportation modes such as buses, taxis, and subways to create a seamless and efficient transportation system.
- Improved waste management: The smart garbage dustbin could be further developed to incorporate more advanced waste management technologies such as recycling and composting.
- Smart ticketing system: The project could be integrated with a smart ticketing system that would allow passengers to purchase tickets and access the railway station through a mobile app.

References

Abhijeet, P. Vaidya, D. and Chandanshive, S. (2021). "Smart City Services Using IoT" https://www.researchgate.net/publication/323386239_Smart_City_Services_Using_IoT

Shaikat. A.S. (2021). Accident data of Dhaka Railway Division | Download Scientific Diagram (researchgate.net) https://www.researchgate.net/figure/Accident-data-of-Dhaka-Railway-Division_tbl1_347536514 [Source: Bangladesh Railway Bhaban].

Ali, M. R. Rehman, O. S. Ullah, F. Ahmed, S. (2023). "Sensor Based Smart Railway Accident Detection and Prevention System for Smart Cities Using Real Time Mobile Communication. Wireless Personal Communications" 128:1133–1152.) Sensor Based Smart Railway Accident Detection and Prevention. - Springer. https://link.springer.com/article/10.1007/s11277-022-09992-5

Aniruddha, B. S. and Sushil, U. K. (2016). “Smart Garbage Monitoring System Using IoT”. https://ieeexplore.ieee.org/document/8363398

Bhavesh, P. and Nirav, P. (2015). “Smart Waste Management System for Smart Cities using IoT and WSN” https://www.researchgate.net/publication/325028123_Smart_Waste_Management_System_for_Smart_Cities_using_IoT_and_WSN

Dethe, T. Maheswari, B.U. Ullas, S. (2022). “IoT-Based Smart Railway Management for Passenger Safety and Comfort.” Proceedings of the 6th International Conference on Advance Computing and Intelligent Engineering. Lecture Notes in Networks and Systems, vol 428. Springer, Singapore. https://doi.org/10.1007/978-981-19-2225-1_17 IoT-Based Smart Railway Management for Passenger Safety and ...- Springer. https://link.springer.com/chapter/10.1007/978-981-19-2225-1_17

Devi, P. V. & Sumathi, V. (2021). Design and Implementation of Smart Dustbin System Using IoT. In Proceedings of the 3rd International Conference on Communication and Electronics Systems (pp. 1937-1941). Springer. https://doi.org/10.1007/978-981-15-9731-8_190

Swathi, G. R. and Meenakshi, K. (2015). “Smart Parking System Using IoT and Cloud Computing”. https://ieeexplore.ieee.org/document/9052437

Vishnupriya, K. and Anbazhagan, A. (2022). "Smart Railway System Based on Internet of Things". https://ieeexplore.ieee.org/document/8242380

Musab, A. T. Ali, A. S. and Fahad A. K. (2020). “Smart Parking System using Internet of Things and Cloud Computing”. https://www.researchgate.net/publication/333765166_Smart_Parking_System_using_Internet_of_Things_and_Cloud_Computing

Palanisamy, S. Srinivasan, S. (2021). An IoT-Based Smart Railway Station System for Train Detection and Vehicle Parking Management. IEEE InternetArora, R., & Nagarajan, R. (2019). Smart Railway Crossing System Using Arduino. In 2019 3rd International Conference on Trends in Electronics and Informatics (ICOEI) (pp. 1041-1045). IEEE. https://doi.org/10.1109/ICOEI.2019.8862827

Palanisamy, S. Srinivasan, S. (2021). An IoT-Based Smart Railway Station System for Train Detection and Vehicle Parking Management. IEEE Internet of Things Magazine, 4(2), 33-39. https://doi.org/10.1109/MIOT.0001.2100106

Patel, N. Patel, D. (2018). Smart Railway Station using IoT. International Journal of Research in Engineering and Technology, 7(6), 400-404. http://dx.doi.org/10.15623/ijret.2018.0761051

Kumar, P. Singh, S. and Singh, P. (2017) “Internet of Things Based Smart Garbage Monitoring System”. https://doi.org/10.1109/ICACCI.2016.7732275

Dubbudu, R. (2016). “Accidents in Indian Railways- Review of the last 6 years” https://factly.in/indian-railway-accidents-statistics-review-last-5-years/

Rani, S. Singh, A. K. & Kumar, V. (2020). Smart Waste Management System Using IoT. In Advances in Signal Processing and Intelligent Recognition Systems (pp. 445-454). Springer. https://doi.org/10.1007/978-981-15-2387-4_42

Singh, S. P. Hussain, M. A. and Singh, R. (2018). “Smart Parking Management System Based on IoT”. https://ieeexplore.ieee.org/document/8704470

Singh, S. P. Hussain, M. A. and Singh, R. (2022). “Smart Waste Management System Based on IoT” https://www.sciencedirect.com/science/article/pii/S187705091732272X

S. K. Singh, N. V. Jagtap, and M. B. Chavan. (2018) “Smart Garbage Monitoring Using IoT”. https://www.sciencedirect.com/science/article/pii/S2405452617328873

Sivasubramanian, T. and Saravanakumar, R. (2011). “Automated Train Level Crossing with Traffic Signal Control”. https://ieeexplore.ieee.org/document/7470771