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Pyroshield - Innovating Bus safety through automatic window reactivity

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Abstract: The frequent issue of AC buses catching fire is one of the problems that is of prime concern and needs immediate attention when it comes to the inaccuracy of public transport. These fires claim huge number of lives amongst the passengers travelling in the buses, one of the root causes being insufficient escape routes for early escape. To address this issue and to ensure well-being of the people travelling, there is the need to transform the design of the buses that facilitates ample escaping routes in case of emergency. In this paper, an innovative designing of the AC buses to provide spacious escape routes for passengers is put forward. This design of the bus activates the automatic window opening in case of fire accidents so that passengers can escape in time. Along with the automatic window reactivity it streamlines the alarming system consisting of the blinking LED's, Buzzer and the LCD screen to alarm the passengers. This system can be deployed in the buses to secure the passengers and to ensure integrity of the public transport.

Index terms: AC buses, Alarming system, Fire Accident, Public transport, Window reactivity.

I. INTRODUCTION

The frequent fires caught by the AC buses is an alarming problem that is claiming the lives of the passengers. The root cause for AC buses catching fires vary, including the issues like faulty wiring, usage of the substandard parts, or the crash between the vehicles. Regardless of the root cause the fires undoubtedly pose a high risk to the lives of the passengers when the escape routes are blocked due to certain circumstances like the sideways collapsing of the bus. Tough the buses provide with the tool like the hammer to break the window panes in case of emergency, still it is not an efficient solution. In case of fires, the passengers may face the problems like suffocation caused by the gases that are released with the fires, this is due to lack of ventilation in the AC buses. The inefficient escape routes make it inaccessible to all the passengers to escape in time. All these challenges together cause the situation of panic amongst the passengers and it claims the lives.

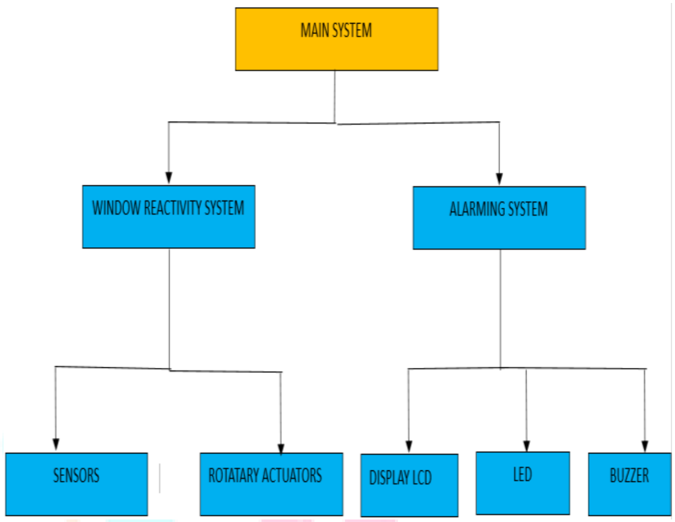
II. LITERATURE REVIEW

Mitrovics et.al [1], proposed a flexible sensor system with a digital bus, for flexible sensing with easy technology integration for specific uses. Shepherd et.al [2], created a low-cost chemical sensor with surface-mount LEDs for efficient colorimetric gas detection using a simple microcontroller circuit. Park et.al [3], put efforts for development of sensor less torque estimator which enhances window safety by detecting pinched conditions through motor currents, surpassing hall sensor difficulties. Ramya et.al [4], presented a microcontroller-based toxic gas detection system with immediate alerts via alarm and SMS. Shrivastava et.al [5], developed an automated gas leakage detection system with sensitive sensors and GSM modules for swift warnings. Stazi et.al [6], proposed a unique design of an automatic window opening system for classrooms, prioritizing thermal comfort over air quality, with efficiency. Li et.al [7], presented a CFD modeling which shows opening middle windows in school buses reduces exhaust infiltration, improving air quality, with driving speed impacting air circulation. Kodali et.al [8], developed a low-cost gas detector which enhances industrial safety. Samiha et.al [9], presented a gas detection system which activates ventilation, notifies users, preventing damages from LPG and natural gas leaks. Sai et.al [10], fabricated a low-cost Arduino-based air quality monitoring setup, utilizing gas sensors for portable awareness and cloud-based analysis of health impacts. Sun et.al [11], fabricated a windowsystem which offers automated adjustments and security alerts. Megalingam et.al [12],presented an automated system which identifies harmful gases, initiates safety actions, and sends user alerts for various uses. Tai et.al [13], performed breath analysis for health monitoring, emphasizing wearable sensors for breathing behaviors and gas sensors for disease diagnosis, with emphasizing integrated arrays and self-powered tech. Khan et.al [14], developed an automatic gas leakage detection system for enhanced safety in diverse settings. Tien et.al [15], presented a deep learning framework for real-time window operation detection, optimizing HVAC energy use in buildings. Sanger et.al [16], created a sensor system utilizing microcontrollers to detect harmful gases in the garbage, highlighting elevated sensor values in contaminated air. Nahid et.al [17], fabricated a microcontroller-based LPG gas leakage detection system using an MQ-6 sensor, microcontroller, and LEDs for real-time alerts, to ensure household safety and avert gas-related. Naveen et.al [18], created a gas leakage detection system using Gas Sensor and Arduino Uno to prevent fire accidents and activate safety measures. Tasnim et.al [19], fabricated a gas leak detection system with modules for gas detection, location tracking, emergency alarm, and adaptability. Niu et.al [20], created ESEG smart window that integrates louver solar cells, hydrogel, and ITO glass for enhanced energy efficiency and active control. Corzo et.al [21], performed CFD simulations to show that HVAC systems reduce virus transmission risks in buses, while open windows during travel nearly eliminate the risk. Very Recently, Banka et.al [22], developed an innovative IoT-based fire detection system utilizing various microcontrollers and sensors for timely alerts via mobile devices, safeguarding diverse environments.

However, research carried out till date is either related to the alarming system for the passengers or is about the gas detecting techniques. The action taken to counter the fire accidents are not necessarily implemented in designing the buses according. The system discussed in this paper applies the findings of previous research and incorporates the integrated knowledge to develop innovative design of the window panes of the AC bus that would react by opening widely as soon the fires and gas is detected in the bus. Additionally, the system consists of the alarming system that make passengers alert regarding the potential danger.

I. METHODOLOGY

1.1 Block Diagram



1.2 Components

Alarming System: Arduino UNO, MQ-2 Gas sensor, Flame sensor, 16x2 LCD Display, Red LED light, Buzzer.

Window Reactivity System: Arduino UNO, MQ-2 Gas sensor, Flame sensor, Servo Motors.

1.3 Working:

Gas and Flame Detection:
The integrated system relies on continuous monitoring by specialized MQ-2 Gas and flame sensors, acting as the bus's vigilant eyes. In the prototype version, the thresholds for the MQ-2 gas and flame sensors are set at 250 and 350, respectively. If the gas levels exceed 250 or flames are detected surpassing 350, the alarming system is immediately activated, initiating a swift safety response mechanism.

Alarming System Activation:

Upon detection of gas or flames, the Arduino Uno Microcontroller takes charge by receiving signals from the sensors. The Arduino Uno processes this critical data swiftly and efficiently, triggering the alarming components. This activation includes the illumination of LED lights, the sounding of a buzzer, and the display of vital information on an LCD display. Passengers within the bus are instantaneously alerted through a combination of visual and audible signals, effectively communicating the potential danger and prompting immediate attention.

Window Reactivity System Activation:

Simultaneously, the Arduino Uno orchestrates the activation of the window reactivity system. This involves the use of rotatory actuators, specifically servo motors, integrated with the window panes. These robust actuators initiate controlled movements, precisely lowering the window panes to create a designated emergency exit route. This synchronized response ensures that the emergency exit mechanism is readily accessible and efficiently deployed.

Emergency Escape Mechanism:

The automated descent of window panes provides an immediate and accessible escape route for passengers during emergencies, complementing the alarming system's swift response. This innovative feature facilitates a rapid evacuation process, allowing passengers to exit through the lowered windows. Crucially, in the event of the back emergency door becoming jammed due to a collision on that side, the window reactivity system serves as a vital alternative exit, ensuring passenger safety even in challenging situations. This adaptive feature enhances the system's effectiveness, providing a reliable means of escape during real-time emergencies.

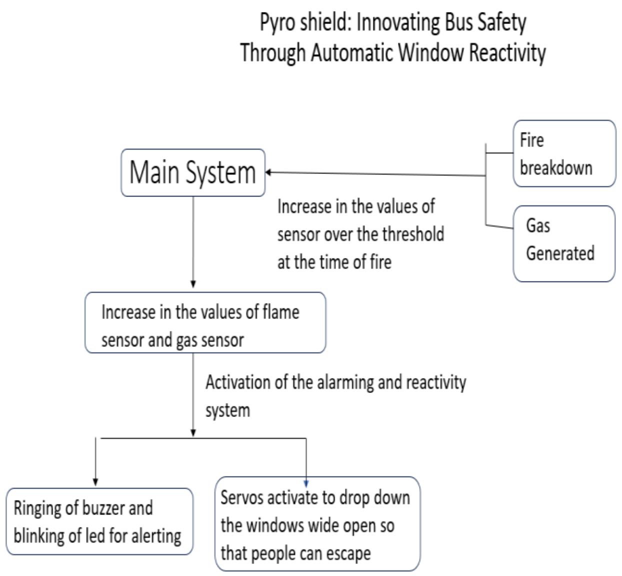
User Notification and Information:

Complementing the alarming system is a user-friendly LCD display that provides real-time information about the detected threat. This display also instructs passengers on the emergency exit process, ensuring clear communication during high-stress situations. This inclusion of clear visual and audible signals further enhances passenger awareness, enabling them to respond appropriately and evacuate through the lowered windows with confidence.

System Reset:

After addressing a threat or resolving an emergency, the system resets, either manually or automatically. The window panes return to their original position, deactivating alarming components. This reset readies the system for subsequent incidents. In the rare event of a fully engulfed bus, rendering it irreparable, a reset may be unnecessary. However, if the system aids passenger escape and a fire is manually extinguished before total destruction, the window panes can be manually restored based on bus conditions, ensuring adaptability for future use.

1.4 System Architecture



III. RESULTS AND DISCUSSION

Actual Model of System:

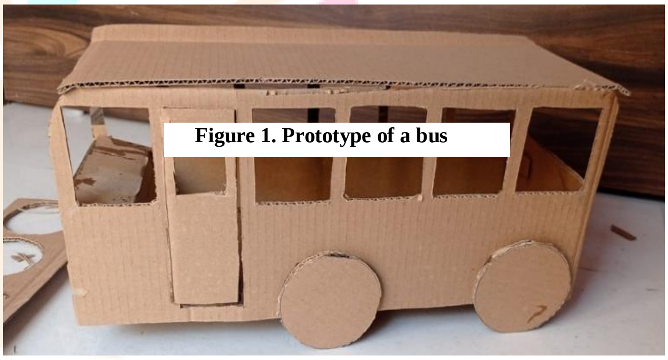


Figure 1. Prototype of a bus

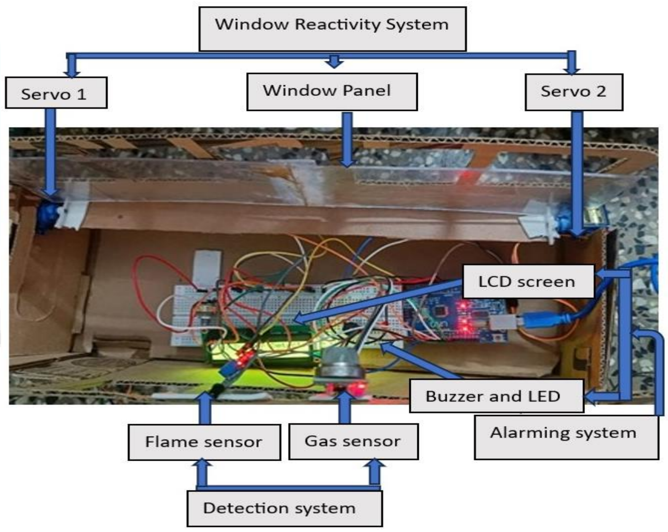
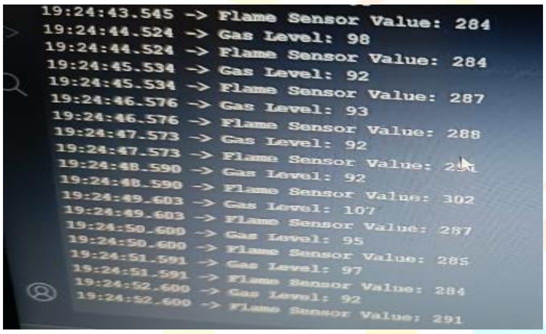


Figure 1. showcases a cardboard protype of a bus, providing a tangible representation of our system's integration into real-world applications.while Figure 2, illustrates the seamless integration of various components in the Pyroshield system for enhanced safety functionality.

Gas-Free Scenario: Prototype Operation:

x

Figure 3. Normal Operating Conditions



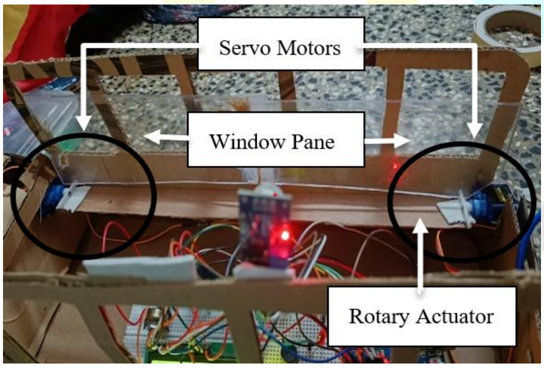


Figure 4. Window Reactivity system in normal operating conditions

In Figure 3, the prototype bus demonstrates normal operating conditions with the gas sensor and flame sensor fitted, as the LCD screen displays 'No Danger Detected'. Figure 4 details the system's response to normal gas and flame values, elucidating the window reactivity system where the rotary actuator holding the bus's glass is intricately illustrated.

Gas Detection Scenario: User Alert is Prototype Operation:

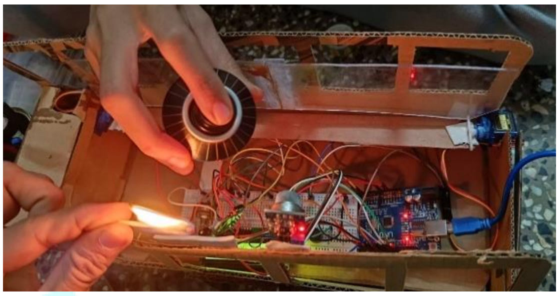


Figure 5. Gas Detection Scenario

Figure 5, illustrates a deliberate scenario in the prototype version, where gas and flame are intentionally introduced to the gas sensors, simulating an after-detection scenario to showcase the system's response in challenging conditions.

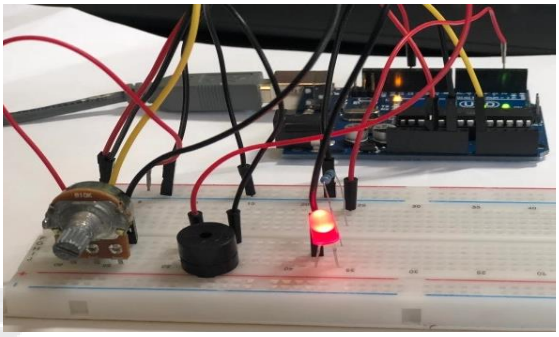


Figure 6. User Alert in Prototype Operation

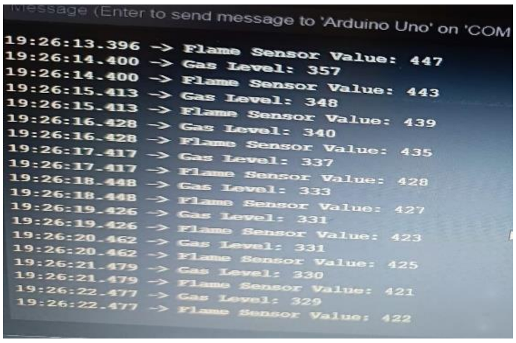


Figure 7. Window Reactivity system in Gas detection Scenario

In Figure 6, the after-detection scenario unfolds as the LCD displays a 'Danger Detected!' message, accompanied by a glowing LED light and a beeping buzzer. Moving to Figure 7, the system responds to elevated gas and flame levels surpassing sensor thresholds. Simultaneously, the window reactivity system advances, depicting the next step where the rotary actuator, responsible for holding the glass, initiates the downward motion, causing the glass to fall.

CONCLUSION

In conclusion, Pyroshield is a project made for the safety of the passengers travelling in buses. As AC buses have intact glass windows which have no movement, Pyroshield will give it a movement in emergency situation. Basically, the motive of the project is to open all the ways through windows at the time of fire and help passengers to escape out of the bus. Alarming system integrated with the reactivity system will give passengers a idea of the crises and aware them in advance to prevent panic suddenly. Overall, Pyroshield enhances safety, operational efficiency, and better control over emergencies, ultimately preserving human lives.

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REFERENCES

1. J. Mitrovics, H. Ulmer, G. Noetzel, U. Weimar and W. Gopel, F.:Design of a hybrid modular sensor system for gas and odor analysis, Proceedings of International Solid State Sensors and Actuators Conference (Transducers '97) Vol. 2, 1355-1358 (1997).
2. R. L. Shepherd, W. S. Yerazunis, K. T. Lau and D. Diamond, F.:Low-Cost Surface-Mount LED Gas Sensor, IEEE Sensors Journal 6(4), 861-866 (2006).
3. Jung Hoon Park, G. H. Choi, T. S. Yoon and J. B. Park, F.:A sensorless safety power window control system in automotive application. 2008 International Conference on Control, Automation and Systems, 1457-1461 (2008).
4. Ramya, V & Palaniappan, Balasubramaniam. F.: Embedded system for Hazardous Gas detection and Alerting. International Journal of Distributed and Parallel systems. International Journal of Distributed and Parellel Systems (IJDPS) 3(3), 287-300 (2012).
5. Shrivastava, A., Prabhaker, R., Kumar, R. and Verma, R., F.: GSM based gas leakage detection system. International Journal of Technical Research and Applications 1(2), 42-45(2013).
6. F. Stazi, F. Naspi, G. Ulpiani, C. D. Perna, F.: Indoor air quality and thermal comfort optimization in classrooms developing an automatic system for windows opening and closing, Energy and Buildings Vol. 139, 732-746 (2017).
7. F. Li, E. Lee, B. Zhou, J. Liu, Y. Zhu, F.: Effects of the window openings on the micro-environmental condition in a school bus, Atmospheric Environment Vol. 167, 434-443 (2017).
8. R. K. Kodali, R. N. V. Greeshma, K. P. Nimmanapalli and Y. K. Y. Borra, F.:IOT Based Industrial Plant Safety Gas Leakage Detection System, *2018 4th International Conference on Computing Communication and Automation (ICCCA)*, 1-5 (2018).
9. A. Samiha, F. H. Sarker, R. N. K. Chowdhury, A. K. M. R. R. Habib and R. Rahman, F.:Ogrodut: GSM based Gas Leakage Detection and Ventilation System using Arduino and Servo Motor, 2019 International Energy and Sustainability Conference (IESC), 1-6 (2019).
10. Kinnera Bharath Kumar Sai, S. Mukherjee, H. P. Sultana, F.: Low Cost IoT Based Air Quality Monitoring Setup Using Arduino and MQ Series Sensors With Dataset Analysis, Procedia Computer Science Vol. 165, 322-327 (2019).

11. Z. Sun, S. Wei and X. Zhang, F.:Intelligent Window Control System Design Based on Single Chip Microcomputer. *2020 IEEE International Conference on Progress in Informatics and Computing (PIC)*, 300-303 (2020)
12. R. K. Megalingam, A. Hegde Kota, V. K. Tejaswi P. and M. Doriginti, F.:IoT Based Controller for Smart Windows, *2020 IEEE International Students' Conference on Electrical, Electronics and Computer Science (SCEECS)*, 1-5 (2020)
13. H. Tai, S. Wang, Z. Duan, Y. Jiang, F.: Evolution of breath analysis based on humidity and gas sensors: Potential and challenges, Sensors and Actuators B: Chemical Vol. 318, 128104 (2020).
14. Khan MM. F.: Sensor-Based Gas Leakage Detector System. *Engineering Proceedings* 2(1), 28 (2020).
15. P. W. Tein, S. Wei, T. Liu, J. Calautit, J. Darkwa, C. Wood, F.:A deep Learning approach towards the detection and recognition of opening of windows for effective management of building ventilation heat losses and reducing space heating demand, Renewable Energy Vol. 177, 603-625 (2021)
16. J. B. Sanger, L. Sitanayah and I. Ahmad, F.:A Sensor-based Garbage Gas Detection System. *2021 IEEE 11th Annual Computing and Communication Workshop and Conference (CCWC)*, 1347-1353 (2021).
17. S. I. Nahid, F.:Development of a Smart Automatic Gas Leakage Detector and Alarming System, 2021 IEEE 12th Annual Information Technology, Electronics and Mobile Communication Conference (IEMCON), 0789-0795 (2021).
18. P. Naveen, K. R. Teja, K. S. Reddy, S. M. Sam, M. D. Kumar and M. Saravanan, F.:A Comprehensive Review on Gas Leakage Monitoring and Alerting System using IoT Devices, *2022 International Conference on Computer, Power and Communications (ICCPC)*, 242-246 (2022)
19. Z. Tasnim, S. Das, R. Islam, J. Biswas, F. M. J. M. Shamrat and A. Khater, F.:Sensor based Smart Automated Gas Leakage Detection and Prevention System, *2022 6th International Conference on Trends in Electronics and Informatics (ICOEI)*, 460-466 (2022) .
20. Y. Niu, Y. Zhou, D. Du, X. Ouyang, Z. Yang, W. Lan, F. Fan, S. Zhao, Y. Liu, S. Chen, J. Li, Q. Xu, F.:Energy Saving and Energy Generation Smart Window with Active Control and Antifreezing Functions, Advanced Science 9(6), 2105184 (2022)
21. S. Corzo, D. Ramajo, S. Idelsohn, F.: Study of ventilation and virus propagation in an urban bus induced by the HVAC and by opening of windows, Computer Methods in Applied Mechanics and Engineering Vol. 401, 115387 (2022).
22. S. Banka, B. Kanchanapalli, B. Annam, A. Akula, S. Thirukkovalluru, S. Jarpula, F.:A Novel Method for Fire Detection and Alarming Notification using IoT Technology, 2023 Second International Conference on Electronics and Renewable Systems (ICEARS), 560-565 (2023).