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Industrial Forklift Alert & Anti-Collision System

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Abstract- ***Forklift-related accidents are a major concern in industrial environments, especially in areas with shared pathways, blind spots, and high noise levels. These incidents often result in serious injuries or fatalities and disrupt operations. To address this issue, this project presents an "Industrial Forklift Alert and Anti-Collision System" designed to enhance workplace safety. The system uses photoelectric sensors to detect the presence of forklifts in real time. When a forklift is detected, a two-tier tower lamp provides visual alerts: a red light signals danger and instructs workers to stop, while a green light indicates safe conditions for movement. This simple, color-coded system ensures quick understanding and is especially effective in noisy environments where audio alerts may be missed. The system is fully automatic, cost-effective, and scalable, making it suitable for deployment across multiple zones in a facility. It improves safety by reducing the risk of collisions between forklifts and workers, promotes a culture of safety, and supports compliance with industrial safety standards such as OSHA. Initial trials have shown that the system significantly reduces accident risks, improves worker awareness, and minimizes downtime and injury-related costs. This project offers a practical and impactful solution for real-time hazard detection and safer forklift traffic management in industrial settings.***

I. INTRODUCTION

In today's fast-paced industrial environment, efficiency, speed, and safety are the three pillars that define operational success. Among the many machines that contribute to industrial productivity, forklifts stand out as one of the most essential tools used across a wide range of sectors. From warehouses and manufacturing plants to logistics centers and construction sites, forklifts play a crucial role in lifting, transporting, stacking, and organizing materials. Their ability to handle heavy loads with precision significantly reduces manual labor and enhances workflow efficiency.

However, despite their advantages, forklifts are also associated with serious safety risks. Their continuous movement, heavy load capacity, and operation in shared spaces with workers make them one of the leading causes of industrial accidents. The challenge lies in balancing their operational importance with the need to ensure a safe working environment.

The Industrial Forklift Alert System and Anti-Collision System has been developed to address this critical concern. This system is designed to provide real-time monitoring and alert mechanisms that help prevent accidents involving forklifts and workers. By integrating sensor-based detection with visual and audible warning systems, it creates a safer and more controlled industrial workspace.

II. LITERATURE REVIEW

In modern industrial environments, ensuring the safety of workers around moving machinery such as forklifts has become a critical priority, leading to the adoption of multiple preventive systems and safety practices. One commonly used method is the pedestrian alert system (PAS), which operates on the principle of proximity sensing. In this system, workers are required to wear electronic tags that

communicate with a control unit installed on the forklift. When a worker enters a predefined detection range—typically between 0.5 meters and 7.5 meters depending on the type of antenna used—the system alerts the forklift operator through visual signals such as flashing lights and audible warnings like piezo alarms. This technology helps in identifying nearby personnel and reducing the risk of collisions. However, the effectiveness of PAS is limited to its detection range and depends on workers consistently wearing the electronic tags. In addition to technological solutions, many industries implement physical and procedural safety measures to minimize interaction between forklifts and pedestrians. For instance, separate pathways are often designated for forklifts and workers to ensure complete segregation of movement. In situations where shared spaces are unavoidable, clearly marked pedestrian routes and designated crossing zones are provided using painted lines, warning signs, and sometimes physical barriers, which are considered more effective in preventing accidental entry into hazardous zones. Barriers and separators are also used to maintain distance between pathways, but even with these precautions, workers must remain highly alert while crossing forklift routes, as any direct contact can lead to serious injuries. Furthermore, in noisy industrial environments where the sound of forklift horns may not be easily heard, coloured warning lamps are installed on vehicles to improve visibility; however, these visual indicators may not be sufficient in areas with blind corners or obstructed views. Therefore, safety in such environments relies not only on systems and infrastructure but also heavily on worker awareness and training. Comprehensive safety training programs are essential for all employees, ensuring they understand workplace hazards, follow standard safety protocols, and use personal protective equipment (PPE) appropriately. Workers must also be educated on handling emergency situations, such as operating fire extinguishers during fire incidents. Proper maintenance of equipment and cleanliness of the work environment further contribute to accident prevention by reducing the likelihood of malfunctions and improving overall visibility and organization. Additionally, workers should promptly report any equipment issues or unsafe conditions to the maintenance team to prevent potential hazards. Avoiding loose clothing around rotating machinery is another important precaution to prevent entanglement injuries. Overall, while systems like PAS and visual warning mechanisms provide technological support, a combination of physical infrastructure, strict adherence to safety guidelines, and continuous worker training is essential to create a safe and efficient industrial workplace.

The topic of forklift safety and collision prevention has been widely studied in industrial engineering and safety management fields. Various organizations, researchers, and standards bodies have contributed to improving workplace safety through guidelines, technologies, and automated systems. This literature review discusses key contributions from safety standards like OSHA and ISO, along with research studies on automation and sensor-based collision avoidance systems.

III. SYSTEM SPECIFICATION

The Industrial Forklift Alert and Anti-Collision System is designed to improve safety in industrial environments where forklifts and workers operate in the same area. The system detects the movement of forklifts using photoelectric sensors and provides immediate visual and audible alerts to prevent accidents.

The system mainly works on the principle of object detection and signal processing, where sensors identify the presence of a forklift and trigger warning devices such as tower lamps and hooters. The system is simple, reliable, and suitable for real-time industrial applications.

As shown in the block diagram (page 21), the system consists of different modules that work together to perform detection, processing, and alert generation.

System Architecture

The system architecture is divided into the following main blocks:

1. Power Supply Unit (SMPS)
2. Photoelectric Sensors
3. Detection Logic Unit
4. Timer Relay (NO/NC Contacts)
5. Finder relay SPDT

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6. Output Devices (Tower Lamp and Hooter)
7. Electrical wirings/ connectors.

Each block performs a specific function and is connected sequentially to ensure smooth operation.

IV. BLOCK DIAGRAM

As alert system senses the presence of forklift vehicle at entry side and exit side of the site and shows red and green light on tower lamp respectively.

The block diagram represents the overall working of the Industrial Forklift Alert System and Anti-Collision System. It shows how different components such as the SMPS, photoelectric sensors, detection logic, timer circuit, and output devices (tower lamp and hooter) are connected and interact with each other to provide safety alerts in an industrial environment. The main objective of this system is to detect the presence of a forklift in a specific area and give clear visual and audible warnings to workers in order to prevent accidents.

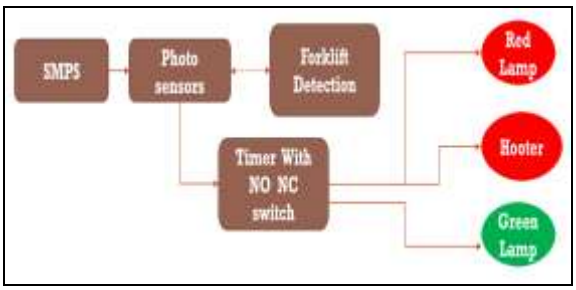

Fig. Block Diagram of System

Working of the System In the forward direction, the forklift enters the monitored area through the entry side. When it passes the entry sensor, the sensor sends a signal to the detection logic. The system recognizes the presence of the forklift and activates the timer circuit. The timer then switches the output to the warning state:

- Red lamp turns ON
- Hooter is activated
- Green lamp turns OFF

This indicates that the area is not safe and workers should not enter.

As the forklift moves forward and reaches the exit side, it triggers the exit sensor. This signal is used to reset the system. The timer and relay switch back to normal condition:

- Red lamp turns OFF
- Hooter stops
- Green lamp turns ON

This indicates that the forklift has left the area and it is now safe for workers.

Importance of Each Block
Each block in the diagram has a specific role:

- SMPS: Provides stable power supply
- Sensors: Detect forklift movement
- Detection Logic: Processes sensor signals
- Timer/Relay: Controls switching and timing
- Output Devices: Provide warning signals

The proper coordination of all these blocks ensures smooth and effective system operation.

V. CIRCUIT DIAGRAM

In industrial environments, safety and awareness are extremely important, especially in areas where heavy machinery like forklifts are used. Accidents can occur if proper warning systems are not installed. The circuit shown in the diagram is designed to provide a visual and audible alert whenever a forklift enters or exits a specific zone. This system uses sensors, a timer, relay, and signaling devices such as a tower lamp and hooter. The main objective of this circuit is to detect the presence of a forklift at the entry and exit points and generate a warning signal to nearby workers. The system also ensures that the alert does not remain active unnecessarily by using a timer and reset mechanism.

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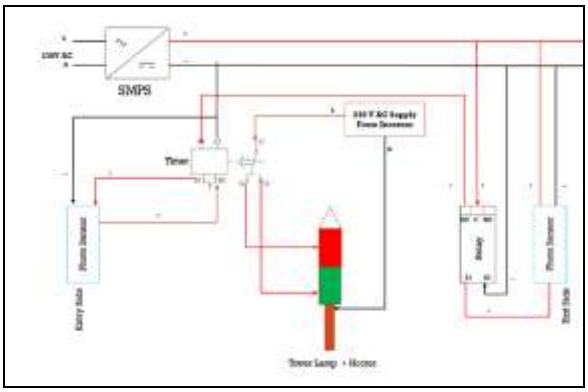

Fig. Circuit Diagram

This system has several advantages:

1. Improved Safety

Workers are alerted about forklift movement in advance

2. Automatic Operation

No manual intervention is required

3. Reliable Detection

Photoelectric sensors provide accurate sensing

4. Controlled Alarm Duration

Timer ensures proper alert timing

5. Efficient Reset Mechanism

Relay allows quick system reset

6. Dual Indication

Visual (lamp) and audible (hooter) signals improve effectiveness

VI. RESULT OVERVIEW

There are two output signals from four input sensors depending on the position of the forklift vehicle. When forklift vehicle enters the site red light turns on and green light turns off by the sensing from entry side photoelectric sensors. Now workers have to stop from crossing the gang way. When forklift vehicle leaves the site green light turns on and red light turns off by the sensing from exit side photoelectric sensors. Now workers can be able to cross the gang way.

Sensor is having 5 meter distance range to sense the forklift moving from the forklift gangway. When the sensor sense the forklift green light turns into red light & hooter also sounds, it has a timer with setting for 10 sec time (its calculated time from forklift passing speed from zebra crossing). Or when forklift goes in front of exit sensor the system will gets reset automatically to its normal position.

a) At entry side:

The entry of the vehicle is given as:

Output of the system is given as:

Fig. Red Light Is On

b) At exit side:

The exit of the vehicle is given as:

Fig. Exit Of Forklift Vehicle

Output of the system is given as:

VII. CONCLUSION

The Industrial Forklift Alert and Anti-Collision System provides an effective solution for improving workplace safety in environments where forklifts and pedestrians operate together. By integrating photoelectric sensors, timer relays, and visual and audible warning mechanisms, the system enables real-time hazard detection and automatic alert generation. Its simple architecture, low implementation cost, and reliable operation make it suitable for industrial deployment. Although limitations exist regarding detection range and coverage area, the system successfully demonstrates how automation can reduce accident risks and improve safety awareness. Future enhancements can further increase system intelligence, scalability, and operational efficiency.

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