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Literature Survey: Workers Monitoring And Safety Assurance Bot In Oil Refinery Using Esp32 Cam

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Abstract: Ensuring the safety and productivity of workers in hazardous environments, such as oil refineries, is a critical challenge. This project proposes the development of a Workers Monitoring and Safety Assurance Bot using an ESP32-CAM module. The bot integrates real-time video surveillance, environmental monitoring, and safety alert systems to enhance worker safety and operational efficiency. Equipped with sensors to detect hazardous gases, temperature fluctuations, and motion anomalies, the system provides live video feeds and alerts to a central monitoring hub. By leveraging low-cost, high-efficiency IoT technology, this solution aims to mitigate risks, ensure compliance with safety regulations, and improve incident response times. The implementation is scalable and adaptable to various industrial safety requirements, making it a versatile tool for modern refineries

INTRODUCTION

The oil refining industry is one of the most hazardous sectors, characterized by the presence of flammable substances, toxic gases, and high-temperature operations. Worker safety is paramount, as even minor lapses can lead to catastrophic incidents, endangering lives and causing significant economic and environmental damages. Conventional safety measures, while effective,often lack the real-time adaptability needed to prevent accidents in dynamic industrial environments.Recent advancements in Internet of Things (IoT) technologies offer promising opportunities to enhance industrial safety. The ESP32-CAM, a low-cost microcontroller with integrated camera and Wi-Fi capabilities, serves as an ideal platform for developing real-time monitoring systems. This project leverages the ESP32-CAM to create a multi-functional bot capable of monitoring worker activity, detecting hazardous conditions, and transmitting data to a centralized system for immediate action.

LITERATURE REVIEW

V. S. Kadiriboiena [1] et.al. Manual Control via IoT Technology: An Android smartphone application is used to control the robot's movement, allowing for real-time navigation and surveillance. The robot is integrated with metal sensors to detect metal bombs and other hazardous materials The system is designed to provide man-free operations, reducing the risk to human soldiers.

The paper by V. S. Kadiriboiena et al presents a surveillance system that utilizes IoT technology to control a robot remotely via an Android smartphone application, aimed at enhancing safety in hazardous environments. The robot is equipped with metal detection sensors to identify explosives like landmines and bombs, reducing the need for human intervention in dangerous areas. The system is designed for real-time navigation, automation of risky tasks and multifunctional applications such as monitoring pipeline leaks, ensuring coal mine safety, and conducting surveillance in war zones. By minimising human exposure to danger, the system improves safety, lowers costs through the use of accessible technology, and offers versatile, real-time intelligence for effective decision-making in various high-risk operations.

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H. Lee and S. Park [2]. Incorporate reinforcement learning (RL) techniques using Unity ML-Agents to train surveillance bots in a simulated 3D environment. This approach allows the bots to learn optimal navigation and decision-making strategies through trial and error interactions

H. Lee and S. Park propose a system combining Deep Reinforcement Learning (DRL) and real-time Human-Computer Interaction (HCI) feedback to train surveillance drones in a 3D simulated environment using Unity ML-Agents. The methodology integrates DRL for autonomous navigation and obstacle avoidance, a sensing-aware nonlinear control system for optimized trajectory planning based on real-time sensor inputs, and HCI feedback to allow human intervention during novel or complex scenarios. The system architecture fuses DRL with sensor-driven navigation while enabling manual control via a keyboard interface. Tested in a Unity 3D simulation, the system demonstrates improved navigation, adaptability to unforeseen challenges, and a user-friendly interface for real-time monitoring and control, showcasing its potential for effective and flexible autonomous surveillance applications.

B. Das and K. K. Halder [3]. This paper introduces an approach for real-time tracking and monitoring by recognizing the faces of individuals and collecting the data with the corresponding time on a spreadsheet. In this proposal, image capturing was carried out by ESP32-Cam development board created by Espressif System.

B. Das and K. K. Halder present a framework, SWM4.0, that leverages Industry4.0 (I4.0) technologies to enhance Smart Waste Management (SWM) by integrating sustainable practices and advanced technological solutions across individuals, cities, enterprises, and factories. The methodology includes a systematic literature review, evaluation of existing solutions, and the design of a unified framework focusing on smart people, cities, enterprises, and factories. The implementation organizes I4.0 technologies into waste management workflows, addressing data-driven collection, sorting, and recycling, and linking existing solutions with scalable interfaces. The framework aims to optimize resource recovery and reduce environmental impact while promoting scalability and adaptability across.various.sectors.

V. Moorthy [4] et.al. Smart Cameras for Object Detection: The bot is equipped with smart cameras that utilize advanced object detection algorithms, including YOLOv7, to identify and track objects and human intruders in real-time. Simultaneous Localization and Mapping (SLAM): The bot employs SLAM techniques, specifically the Bug2 algorithm, to navigate autonomously and avoid obstacles.

V. Moorthy et al., propose a method integrating advanced object detection and autonomous navigation for real-time applications. Smart cameras equipped with YOLOv7 algorithms enable the detection and tracking of objects and intruders, while Simultaneous Localization and Mapping (SLAM) using the Bug2 algorithm ensures obstacle avoidance and autonomous navigation. The study also enhances image segmentation by improving the two-phase Mumford-Shah (MS) model through a weighted combination of anisotropic and isotropic Total Variation (TV) norms for refined boundary regularization. Using the Difference-of-Convex Algorithm (DCA) and the Primal Dual Hybrid Gradient (i.e PDHG) method, the approach achieves efficient computation and higher segmentation accuracy, making it effective for large-scale image processing tasks.

Okokpujie.K [5] et.al. The system is designed to detect motion using a Pyroelectric Infrared (PIR) sensor and to alert users via SMS through a GSM feedback mechanism, facilitated by the Internet of Things (IoT) through the TWILIO API [8-10], employing the ESP32 microcontroller in conjunction with an OV2640 (OV) Camera.

Okokpujie K. et al., present a low-cost, IoT-enabled surveillance system aimed at improving security in low-income areas with limited infrastructure. The system integrates an ESP32 microcontroller, an OV2640 camera for video capture, and a motion-activated Pyroelectric Infrared (PIR) sensor to optimize energy usage. Utilizing IoT protocols and the TWILIO API, the system enables real-time motion detection, remote monitoring, and SMS alerts via a GSM feedback mechanism. Designed for cost-effectiveness and scalability, the system supports live video feeds and remote accessibility, making it a practical solution for enhancing security in underserved urban areas.

Manoj Purohit [6] et.al. Image-based sensing is a powerful source of information for a wide range of applications such as surveillance, monitoring, and automation. The volume of data collected by surveillance devices is enormous; therefore, images are processed to extract application-driven data.

Manoj Purohit et al., propose an advanced image-based sensing system designed to address the limitations of conventional surveillance systems under varying illumination conditions. By integrating high dynamic range image sensors and developing real-time illumination adjustment algorithms, the system enhances object detection and scene analysis in diverse lighting environments. The methodology focuses on dynamic adaptation to fluctuating light levels, ensuring consistent image quality and accurate data extraction. Tested in natural settings, this approach improves the reliability and adaptability of surveillance systems, making them suitable for indoor and outdoor applications and boosting their effectiveness in security and monitoring tasks.

B. N. Rohith [7]. Sensor Integration: The robot is equipped with various sensors, including a microphone, smoke sensor, temperature sensor, and humidity sensor. The system uses the sensor data and video feed to identify potential threats and alert the user in real-time

B. N. Rohith presents a cost-effective surveillance system combining Computer Vision and IoT for monitoring forests and large farms. Utilizing an ESP32-CAM board for video capture, the system transmits real-time feeds to a server, where Computer Vision algorithms detect humans, animals, and objects. Deployed on a wheeled robot for mobility, the system integrates various sensors, including a microphone, smoke sensor, temperature sensor, and humidity sensor, to enhance threat detection. Alerts are sent to users upon detecting anomalies, enabling real-time situational awareness. The mobile design allows coverage of large, remote areas, offering a versatile and affordable solution for efficient surveillance and monitoring.

Tao Yu [8] et.al. real-time high-resolution video surveillance systems using unmanned aerial vehicles (UAVs) with high mobilities of UAVs and high qualities of videos which can improve the surveillance performance and evolve the system, especially for artificial intelligence (AI)-based monitoring systems.

Tao Yu et al., explore the use of unmanned aerial vehicles (UAVs) for real-time, high-resolution video surveillance, emphasizing their high mobility and ability to capture high-quality videos, which enhance AI-based monitoring systems. By integrating Computer Vision and IoT technologies, the system processes video feeds from UAVs to detect humans, animals, and objects in real time using server-based algorithms. Designed for flexible deployment, the UAVs improve surveillance coverage over large and remote areas, outperforming traditional static systems. This approach highlights the advantages of real-time monitoring, adaptability, and cost-effective deployment, making it ideal for applications in diverse environments like forests and farms.

Vanita Jain [9] et.al. a novel approach to develop an intelligent automated real-time surveillance system based solely on efficient tracking and facial recognition.

Vanita Jain et al., propose an intelligent, automated real-time surveillance system utilizing UAVs with mmWave communication for transmitting uncompressed 4K video feeds with low latency. The system offloads AI-based video analysis tasks to ground stations, improving energy efficiency and allowing UAVs to focus on capturing high-resolution data. The optimized system architecture integrates mmWave modules for high-speed data transfer and seamless AI integration at ground stations. This approach delivers superior video quality, reduces UAV power consumption, and ensures efficient, real-time surveillance, making it highly effective for advanced monitoring applications.

Hsing Cheng Chang [10] et.al. This paper aims to develop an intelligent autonomous surveillance system for the safety of indoor environments with the integration of techniques such as sensory information fusion, internet of things (IoT), and artificial intelligence(AI) and presenting the implementation and integration of several autonomous navigation and surveillance functions on a multisensor mobile robot for robotic site monitoring tasks.

Hsing-Cheng Chang et al., introduce an intelligent autonomous surveillance system for indoor safety, integrating sensory information fusion, IoT, and AI. The system employs an Autonomous Surveillance Vehicle (ASV) equipped with sensors to monitor temperature, CO levels, LPG concentration, flame detection, and movement, enabling real-time hazard detection. AI models process sensory data to generate actionable insights, while IoT connectivity facilitates centralized data analysis and decision-making. Designed for efficiency and autonomy, the ASV ensures continuous monitoring of indoor environments, enhancing safety by identifying and responding to potential risks such as fires, gas leaks, and other environmental hazards.

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Tanin Sultana [11] et.al. The system, consisting of edge-fog computational layers, will aid in crime prevention and predict crime events in a smart home environment (SHE) and includes more intelligence and services in the future for other video surveillance applications by utilizing its efficient workload management ability.

Tanin Sultana et al., propose a smart surveillance system designed for crime prevention and prediction within smart home environments (SHE), utilizing edge-fog computational layers for efficient workload management. The system integrates advanced video surveillance techniques to enhance security by predicting potential crime events and offering intelligent services. The study emphasizes the system's capability to handle complex data and computational tasks, improving surveillance effectiveness and enabling future expansions for various applications in smart homes. The design aims to increase the efficiency and responsiveness of surveillance systems, ultimately contributing to safer and more intelligent environments.

Yasuhisa Hirata [12] et.al. refers to research that focuses on developing robotic systems to assist nursing staff in healthcare environments. Specifically, the paper is about designing and implementing a control architecture for delivery robots to support tasks such as transporting medical supplies, medications, or equipment.

Yasuhisa Hirata et al., focus on developing robotic systems to assist nursing staff in healthcare environments by automating delivery tasks such as transporting medical supplies, medications, and equipment. The proposed system features a control architecture for autonomous robots, integrating task prioritization algorithms, advanced sensors, and mapping technologies for safe and efficient navigation in hospital settings. Tested in real-world hospital environments, the robots reduce the logistical burden on nursing staff, ensure timely delivery of critical items, and streamline hospital workflows. The scalable design adapts to various delivery needs, enhancing operational efficiency and patient care.

CONCLUSION

The Workers Monitoring and Safety Assurance Bot using the ESP32-CAM offers a robust, cost-effective solution to address the critical safety challenges in oil refineries. By combining real-time video surveillance with environmental monitoring and alert systems, the bot significantly enhances situational awareness and enables rapid response to potential hazards.The integration of IoT technology not only improves safetycompliance but also reduces operational downtime and mitigates risks associated with industrial accidents.The modularity and scalability of the proposed system make it adaptable to various industrial scenarios, ensuring its relevance beyond oil refineries.Future enhancements could include advanced AI algorithms for predictive analysis and machine learning to optimize safety protocols further. This project demonstrates the transformative potential of IoT solutions in creating safer, more efficient industrial environments, laying the groundwork for continued innovation in worker safety technologies.

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