IMPLEMENTATION AND VERIFICATION OF CROWD CONTROL USING UART PROTOCOL

[1]P.ADI SIVASANKARACHARI, [2]G.SIVA, [3]SK ABDUL JABEV, [4]CHANDALA YEJRA, [5]K.NARENDRA, [6]V.NAGESH

[1]ASSOCIATE PROFESSOR, DEPT OF ECE, Dr.SAMUEL GEORGE INSTITUTE OF ENGINEERING AND TECHNOLOGY, MARKAPUR

[2,3,4,5,6]U.G STUDENT, DEPT OF ECE, Dr.SAMUEL GEORGE INSTITUTE OF ENGINEERING AND TECHNOLOGY, MARKAPUR

ABSTRACT

This project aims to develop a crowd management system for areas with frequent mass gatherings, utilizing two IR sensors to track the number of people entering and leaving. If the room exceeds the allowed limit, a buzzer will sound to alert event management or security, with the current count displayed on an LCD. The system also integrates RFID technology to verify whether a person is permitted to enter, triggering the buzzer if access is denied. The digital crowd indicator was designed using Verilog HDL on Xilinx ISE.

INTRODUCTION

Large crowds frequently gather in public spaces during certain seasons, making effective crowd management crucial to prevent disasters like stampedes, confusion, and pandemic outbreaks. To address this, a smart and efficient computer vision-based framework with a simple interface is proposed, consisting of three layers: sensor, management, and interface. The sensor layer tracks the number of people entering a space, the management layer ensures occupancy limits are not exceeded, and the interface layer alerts security when limits are reached, suitable for rooms, shops, lifts, and similar spaces. Historically, crowds have been seen as entities with unpredictable behaviors distinct from individual actions, often leading to tragic incidents like the stampede at a Hindu festival in India, where poor crowd control caused over 100 deaths. While traditionally considered a domain of social sciences, engineers contribute valuable insights from field theory and flow dynamics, offering technological solutions through image processing and computer vision. Despite the widespread use of CCTV in busy areas, monitoring challenges remain, with limited staff unable to watch all cameras continuously, leading to delayed or missed detections. To overcome these limitations, it is essential to develop automated crowd monitoring systems that utilize existing CCTV infrastructure to prevent accidents and ensure public safety.

LITERATURE SURVEY

Researchers like S. Hashish and M. Ahmed (2015) have explored using sensor-enabled smartphones as crowd-sensing tags in large gatherings, though challenges such as inconsistent internet access and

diverse device platforms persist. Embracing the Smart City paradigm, crowd sensing can assist in monitoring issues like air pollution and urban crowd management, with users collaboratively collecting and transmitting data to centralized servers, as noted by D.C. Duives et al. (2020). Traditional crowd monitoring relied heavily on CCTV, but advancements in data fusion now allow more accurate crowd estimations by integrating multiple sensor inputs, supporting timely decision-making (Sebastian Bek and Eduardo Monari, 2015). Crowd counting techniques have evolved, focusing on region or line of interest tracking, while dynamic flow analysis is now considered vital for risk assessment to distinguish between safe and critical crowding situations. Furthermore, Rosario Fedele and Massimo Merenda (2017) highlighted the role of IoT and recommender systems, powered by machine learning and deep learning, in smart city emergency management, optimizing services like evacuation routes using algorithms such as Dijkstra's and A*. Similarly, Marwa F. Mohamed et al. (2018) proposed an IoT-based crowd management framework involving multi-layered sensing, networking, and application systems that collect crowd data, assist in decision-making, and enhance user interaction with multilingual, user-friendly interfaces to control and guide crowd movements effectively.

EXISTING SYSTEM

We can seamlessly monitor crowded areas that may pose risks of stampedes or riots by automatically estimating crowd density. The system captures snapshots of the crowd as frames, selects any frame, and calculates the crowd density. If the density crosses a predefined threshold, an alert is triggered, either through an audio signal or an LED indicator. This approach enables efficient crowd control in highly congested areas without the need for manual monitoring.

PROPOSED SYSTEM

This project aims to detect and respond to overcrowding at an early stage, helping assess the effectiveness of crowd safety measures by monitoring the total number of people to ensure safe venue capacity, tracking distribution to prevent local overcrowding, and identifying potential crowd issues to avoid public disorder. A crowd control system is designed using UART (Universal Asynchronous Receiver-Transmitter) with IR sensors, LEDs, fingerprint modules, and buzzers in a VLSI (Very Large Scale Integration) framework, enabling real-time monitoring and control for applications like managing foot traffic, monitoring building occupancy, and maintaining social distancing, while enhancing system performance, reliability, and power efficiency.

APPLICATIONS

1. **Public Events & Gatherings:** Manages crowd density at stadiums, concerts, and exhibitions to prevent overcrowding and ensure safety.
2. **Smart Public Infrastructure:** Regulates the flow of people at railway stations, airports, and bus terminals to maintain smooth and organized movement.
3. **Industrial Safety:** Monitors access to factory floors and

warehouses, ensuring that only authorized personnel enter restricted areas.

4. **Shopping Malls & Commercial Centers:**
   Tracks customer entry and exit to support effective crowd management and enhance security.
5. **Educational Institutes:** Implements RFID-based attendance systems and restricted access control for schools, colleges, and universities.
6. **Hospital Management:** Manages access to sensitive areas like ICUs, operating theaters, and emergency wards to maintain patient safety and security.

ADVANTAGES

1. **Automated Crowd Management** – Utilizes Verilog-based hardware design to regulate human movement efficiently.
2. **Real-Time Security Alerts** – Sensors immediately detect breaches or fire hazards and trigger instant notifications.
3. **Optimized Energy Usage** – LDRs, LEDs, and fans activate only when necessary, minimizing power consumption.
4. **RFID-Based Access Control** – Restricts entry to authorized personnel through RFID authentication.
5. **Live Digital Updates** – A 16x2 LCD display provides real-time information on crowd density and movement.
6. **Scalable and Modular Design** – Easily expandable to larger areas and compatible with IoT-based monitoring systems.
7. **High-Speed Processing** – Verilog implementation on FPGAs or ASICs ensures rapid and efficient system performance.

FUTURE SCOPE

The system leverages IoT-based monitoring with cloud integration to enable remote access and real-time analytics, ensuring efficient management of environments. AI-powered crowd behavior prediction models are employed to forecast overcrowding and potential security threats proactively. Mobile app integration provides real-time notifications and enables dynamic access control directly through users' devices. To enhance security, facial recognition and biometric access systems are implemented, addressing vulnerabilities associated with traditional RFID methods. For large-scale event monitoring, autonomous drones assist in crowd surveillance, offering real-time aerial insights. Edge computing is utilized to process sensor data locally, significantly reducing latency and improving response times. Additionally, the integration of 5G technology and wireless sensor networks (WSN) ensures ultra-fast data transmission, enabling seamless and reliable connectivity across all components.

CONCLUSION

The Crowd Control Management System, developed using Verilog and integrated with various sensors, offers an efficient, automated, and intelligent solution for managing human traffic in public spaces, industrial zones, and restricted areas. By leveraging real-time monitoring and automated control mechanisms, the system significantly enhances security, optimizes energy usage, and improves emergency

response capabilities. The hardware-level implementation using Verilog ensures high-speed processing and reliability, making the system highly suitable for demanding real-time applications.

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