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YOLO-BASED ABNORMAL BEHAVIOR DETECTION SYSTEM FOR ELDERLY HEALTHCARE MONITORING

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***Abstract*- The YOLO-Based Abnormal Behavior Detection System for Elderly Healthcare Monitoring presents an intelligent and predictive approach to enhancing the safety and well-being of elderly individuals. The system integrates computer vision, machine learning, and embedded sensing technologies to monitor both physical activity and physiological parameters in real time. Using a Python-based embedded processor, the YOLO (You Only Look Once) algorithm analyzes live video captured via a USB web camera to detect abnormal behaviors such as falls, sudden collapses, or prolonged inactivity. Machine learning models further process the collected behavioral and physiological data to predict potential health risks and emergencies before they occur. Simultaneously, an Arduino microcontroller interfaces with heartbeat and temperature sensors to continuously track vital signs. Upon detection of unusual activity, critical health conditions, or predicted emergencies, the system triggers a buzzer for immediate local alerts and transmits notifications to caregivers or family members through a GSM module. Powered by a regulated 12V supply and interconnected via secure connectors, this system offers a reliable, real-time, and predictive monitoring solution. By combining behavioral analysis, vital sign monitoring, and machine learning-based predictions, the system enables proactive interventions, reducing emergency response time and improving elderly care management**

***Keywords*— Arduino, GSM, Fall Detection, Temperature Sensor, Heart Beat Sensor**

I. INTRODUCTION

In The rapid growth of the aging population has created a significant demand for advanced healthcare monitoring systems. Elderly individuals often face health risks such as falls, sudden medical emergencies, and abnormal behavioral patterns, which require continuous supervision. Traditional monitoring methods, including manual caregiving and wearable devices, are often limited by high cost, user discomfort, and lack of real-time responsiveness. Therefore, there is a growing need for intelligent, automated, and non-intrusive monitoring solutions.

Recent advancements in Artificial Intelligence (AI) and Computer Vision have enabled the development of smart healthcare systems capable of analyzing human activities in real time. In particular, deep learning-based object detection models such as YOLO (You Only Look Once) have shown remarkable performance in detecting and tracking human movements with high accuracy and speed. These models are well-suited for real-time applications due to their ability to process video streams efficiently.

This paper proposes a YOLO-based abnormal behavior detection system designed specifically for elderly healthcare monitoring. The system utilizes video input to identify critical events such as falls, unusual inactivity, or irregular movements. Upon detecting such events, the system can generate immediate alerts to caregivers, ensuring timely assistance and improving patient safety.To enhance real-world applicability, the proposed system integrates hardware components such as an Arduino microcontroller, which enables instant alert generation and emergency response mechanisms. This combination of software intelligence and hardware support creates a reliable and efficient monitoring solution.In recent years, the global population of elderly people has been increasing rapidly.

With aging, individuals become more vulnerable to health issues such as falls, mobility problems, and sudden medical emergencies. Continuous monitoring is essential to ensure their safety and well-being, especially for those living alone. Traditional monitoring methods rely on caregivers or wearable devices. However, these methods have limitations such as discomfort, dependency on human attention, and chances of device failure.The system is designed to automatically detect critical situations such as falls, unusual inactivity, and irregular movements by analyzing visual data in real time. Upon detection of any abnormal event, the system immediately generates alerts to caregivers, ensuring quick response and reducing the risk of severe consequences. Furthermore, the integration of an Arduino microcontroller enhances the system by enabling real-time hardware-based alert mechanisms such as alarms and emergency notifications. This combination of software intelligence and hardware support makes the system highly efficient and practical for real-world deployment.

II.PROBLEM STATEMENT

Women The increasing elderly population has led to a growing need for continuous and reliable healthcare monitoring systems. Elderly individuals are highly susceptible to falls, sudden medical emergencies, and abnormal behavioral patterns, which often go unnoticed due to the lack of constant supervision. Traditional monitoring methods, such as manual caregiving and wearable devices, are either inefficient, intrusive, or unable to provide real-time alerts. Therefore, there is a need to develop an intelligent, automated, and non-intrusive system capable of detecting abnormal behaviors in real time and providing immediate alerts to ensure timely assistance and improved safety for elderly individuals.

Elderly people living alone face significant risks due to delayed response during critical situations such as falls or unusual inactivity. Existing systems based on wearable sensors depend heavily on user compliance and may fail if the device is not worn properly. Similarly, manual monitoring is labor-intensive and not feasible for continuous observation. Although some vision-based systems exist, they often lack real-time performance, accuracy, or efficient alert mechanisms.

The main challenge lies in developing a system that can accurately detect abnormal behaviors in real time while being cost-effective, reliable, and easy to deploy. Additionally, the system should be capable of generating immediate alerts and integrating with hardware components for practical implementation. Addressing these challenges requires the use of advanced deep learning techniques such as YOLO for fast and accurate detection, along with embedded systems like Arduino for real-time response and alert generation. The proposed solution aims to overcome these limitations by providing an automated, efficient, and scalable elderly monitoring system.

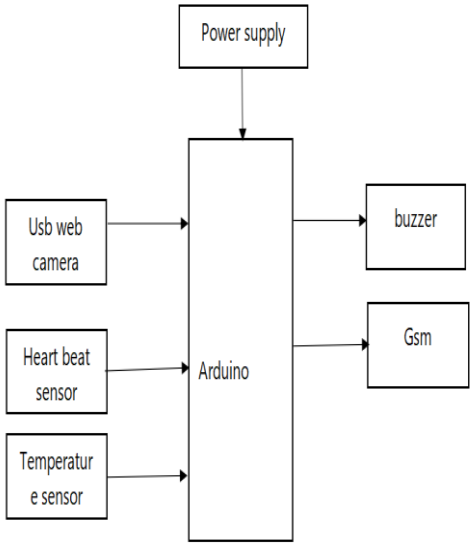

Figure 1: Block diagram of our project

III. ARDUINO BOARD

ArduinoArduino Uno is a very valuable addition in the electronics that consists of USB interface, 14 digital I/O pins, 6 analog pins, and Atmega328 microcontroller. It also supports serial communication using Tx and Rx pins.

There are many versions of Arduino boards introduced in the market like Arduino Uno, Arduino Due, Arduino Leonardo, Arduino Mega, however, most common versions are Arduino Uno and Arduino Mega. If you are planning to create a project relating to digital electronics, embedded system, robotics, or IoT, then using Arduino Uno would be the best, easy and most economical option.It's an open-source physical processing stage focused around a straightforward microcontroller board, and an environment for composing programs for the board. Arduino can be utilized to create interactive items, taking inputs from a diverse collection of switches or sensors, and controlling an assortment of lights,engines, and other physical outputs. Arduino activities can be remaining solitary, or they can be associated with programs running on your machine (e.g. Flash, Processing and Maxmsp.) The board can be amassed by hand or bought preassembled; the open-source IDE can be downloaded free of charge.

Figure 2: Top View of ARDUINO UNO Board

This board comes with all the features required to run the controller and can be directly connected to the computer through USB cable that is used to transfer the code to the controller using IDE (Integrated Development Environment) software, mainly developed to program Arduino. IDE is equally compatible with Windows, MAC or Linux Systems, however, Windows is preferable to use. Programming languages like C and C++ are used in IDE.

Apart from USB, battery or AC to DC adopter can also be used to power the board.

Arduino Uno boards are quite similar to other boards in Arduino family in terms of use and functionality, however, Uno boards don't come with FTDI USB to Serial driver chip.

There are many versions of Uno boards available, however, Arduino Nano V3 and Arduino Uno are the most official versions that come with Atmega328 8-bit AVR Atmel microcontroller where RAM memory is 32KB.

When nature and functionality of the task go complex, Mirco SD card can be added in the boards to make them store more information.

There are several I/O digital and analog pins placed on the board which operates at 5V. These pins come with standard operating ratings ranging between 20mA to 40mA. Internal pull-up resistors are used in the board that limits the current exceeding from the given operating conditions. However, too much increase in current makes these resisters useless and damages the device.

IV. TECHNICAL SPECIFICATIONS OF ARDUINO

Input Voltage (limits): 6-20V

- Digital I/O Pins 14 (of which 6 provide PWM output)
- Analog Input Pins 6
- DC Current per I/O Pin 40 mA
- DC Current for 3.3V Pin 50 mA
- Flash Memory
- 32 KB of which 0.5 KB used by
- bootloader
- SRAM 2 KB

- EEPROM 1 KB
- Clock Speed 16 MHz

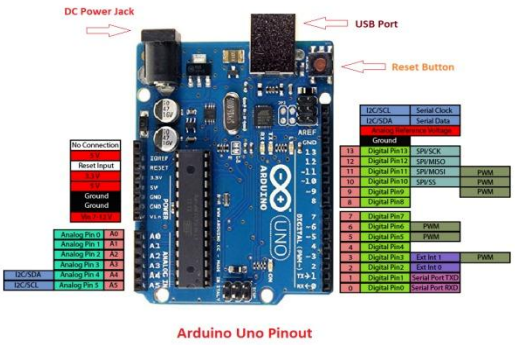

Figure 3: Technical Specifications of ARDUINO Board

V.BASIC CONCEPT OF GSM MODULE

A GSM modem is a device which can be either a mobile phone or a modem device which can be used to make a computer or any other processor communicate over a network. A GSM modem requires a SIM card to be operated and operates over a network range subscribed by the network operator. It can be connected to a computer through serial, USB or Bluetooth connection.A GSM modem can also be a standard GSM mobile phone with the appropriate cable and software driver to connect to a serial port or USB port on your computer. GSM modem is usually preferable to a GSM mobile phone. The GSM modem has wide range of applications in transaction terminals, supply chain management, security applications, weather stations and GPRS mode remote data logging.

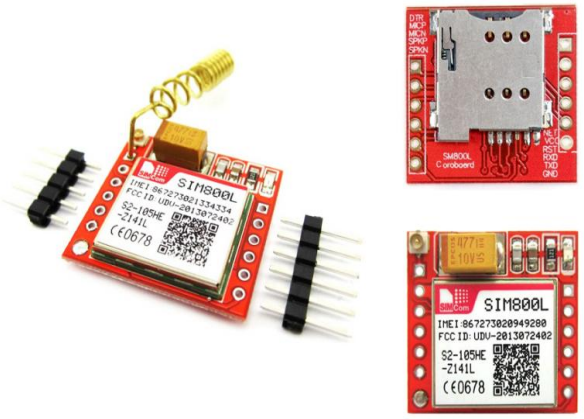

Figure 4: Transform Information through GSM

It requires a **SIM (Subscriber Identity Module)** card just like mobile phones to activate communication with the network. Also they have **IMEI** (International Mobile Equipment Identity) number similar to mobile phones for their identification. A GSM/GPRS MODEM can perform the following operations:

1. Receive, send or delete SMS messages in a SIM.
2. Read, add, search phonebook entries of the SIM.
3. Make, Receive, or reject a voice call.

The MODEM needs **AT commands**, for interacting with processor or controller, which are communicated through serial communication. These commands are sent by the

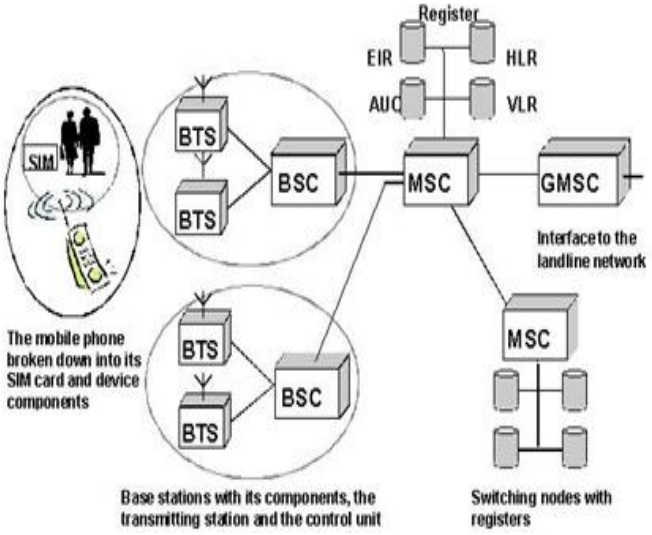

Figure 5: GSM Architecture

GSM (Global System for Mobile Communication) enables the system to send **instant SMS alerts** to caregivers when abnormal behavior (like a fall) is detected. This ensures quick response during emergencies.Unlike IoT-based systems, GSM does not require Wi-Fi or internet. It works using mobilenetworks, uninterrupted communication.**Real-Time Notifications** The GSM module sends alerts in real-time, reducing delay in communication and helping caregivers take immediate action.n the proposed elderly healthcare monitoring system, the GSM (Global System for Mobile Communication) module serves as a key communication component that enables real-time transmission of alerts and emergency notifications. GSM is a widely used digital cellular technology that operates over mobile networks, allowing devices to send and receive data such as SMS messages and voice calls. In this system, the GSM module is interfaced with the Arduino microcontroller, which receives signals from the YOLO-based abnormal behavior detection system. When an abnormal event such as a fall, prolonged inactivity, or unusual movement is detected, Arduino triggers the GSM module to send an automated SMS or initiate a call to pre-stored emergency contacts, including caregivers or family members.The GSM module communicates using AT commands, which are simple text-based instructions used to control operations like sending messages, dialing numbers, and checking network status. One of the major advantages of GSM is that it does not require an internet connection, making it highly reliable in areas with limited or no Wi-Fi access. Additionally, GSM provides wide network coverage, low operational cost, and easy integration with embedded systems, making it ideal for healthcare monitoring applications. It also supports SIM-based communication, ensuring secure and direct connectivity. By incorporating GSM technology, the system ensures timely communication, quick emergency response, and enhanced safety for elderly individuals, especially those living alone.

Figure 7: Project Prototype with all components connected with the

device

VI. Results and Discussion

The proposed YOLO-Based Abnormal Behavior Detection System for Elderly Healthcare Monitoring was successfully implemented and tested under real-time conditions. The system was able to accurately detect the presence of a person and monitor their movements using live video input from a web camera. It effectively identified abnormal behaviors such as falls and prolonged inactivity with good accuracy. Upon detecting such events, the system generated immediate alerts, ensuring timely response from caregivers. The results demonstrate that the system is reliable, efficient, and capable of continuous monitoring without the need for wearable devices. Overall, the project proves that integrating computer vision and real-time detection techniques can significantly enhance elderly safety and healthcare monitoring.

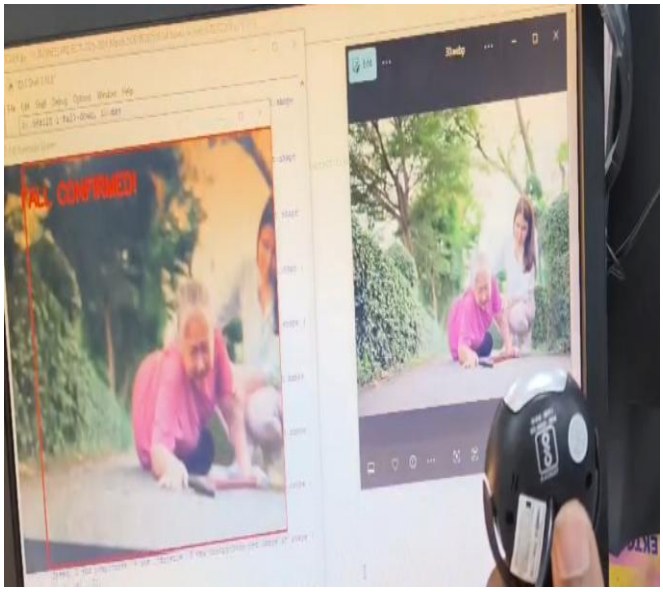

Figure 6: Fall detection

Figure 7: Display Health Alert

VII. Conclusion

The YOLO-Based Abnormal Behavior Detection System for Elderly Healthcare Monitoring provides an efficient and reliable method for ensuring the safety of elderly individuals through continuous monitoring. By leveraging the YOLO algorithm, the system achieves real-time detection of human activities with high speed and accuracy, making it suitable for practical healthcare applications.Through the implementation of real-time video analysis, the system demonstrates how intelligent algorithms can interpret human behavior and respond to critical situations effectively. The ability to detect incidents such as falls or irregular movement patterns plays a crucial role in preventing severe health consequences by enabling quicker intervention. This makes the system highly beneficial in both home environments and healthcarefacilities.YOLO-based abnormal behavior detection system for elderly healthcare monitoring has been proposed and analyzed to address the growing need for continuous and reliable supervision of elderly individuals. With the increasing aging population and the associated health risks such as falls, sudden illness, and irregular behavioral patterns, there is a strong demand for intelligent systems that can provide real-time monitoring and immediate assistance. Traditional methods, including manual caregiving and wearable devices, often fail to deliver efficient, comfortable, and continuous monitoring, highlighting the necessity for an automated and non-intrusive solution.The proposed system leverages the power of deep learning and computer vision, particularly the YOLO (You Only Look Once) algorithm, to detect abnormal behaviors accurately and in real time through video analysis. The ability of YOLO to perform fast and efficient object detection makes it highly suitable for real-world healthcare applications where quick response is critical. By continuously analyzing video input, the system can identify events such as falls, unusual inactivity, or abnormal movements, thereby enabling early intervention and reducing the risk of severe consequences. To enhance the practical implementation of the system, hardware components such as the Arduino microcontroller and GSM module have been integrated. Arduino plays a crucial role in converting detection results into immediate physical actions, such as triggering alarms or activating alert systems. Meanwhile, the GSM module ensures reliable communication by sending instant notifications or emergency alerts to caregivers, family members, or medical personnel. This combination of software intelligence and hardware support makes the system highly effective, responsive, and suitable for deployment in real-life scenarios.Furthermore, the proposed system offers several advantages, including cost-effectiveness, ease of use, real-time performance, and non-intrusive monitoring, which significantly improve the quality of life for elderly individuals while reducing the burden on caregivers. Despite its effectiveness, certain challenges remain, such as privacy concerns related to video surveillance, dependency on camera placement, and the need for large and diverse datasets to improve model accuracy. Future work can focus on addressing these limitations by incorporating privacy-preserving techniques, multimodal data integration, and edge computing for enhanced performance and security. In conclusion, the proposed YOLO-based elderly monitoring system represents a significant step toward the development of smart healthcare solutions. By

combining advanced deep learning techniques with embedded hardware components, the system provides a reliable, efficient, and scalable approach to ensuring the safety and well-being of elderly individuals. This work contributes to the advancement of intelligent healthcare technologies and supports the creation of safer and smarter living environments for the aging population.

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