Motion Activated Smart Mirror – with Real Time Alerts and Notifications

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Abstract

Smart mirrors combine modern technology with traditional home furnishings, creating a harmonious blend of style and function. These cutting-edge gadgets are revitalizing spaces such as restrooms and dressing rooms, transforming them into interactive information hubs. By combining Telegram notifications with motion detection, the newly presented solution improves the functionality of the smart mirror using ESP8266 NodeMCU boards. The integrated solution uses motion sensors and the popular Telegram communication network to instantly notify users on their smartphones whenever motion is detected near the smart mirror. This innovative approach not only simplifies daily life but also enhances security by alerting users to any movement in front of the mirror, whether it's a family member or a potential intruder. The design and implementation process of this integration, along with its range of applications and implications, are thoroughly examined. From enhancing home automation to strengthening security measures, there are numerous ways to expand the capabilities of these cutting-edge devices and improve user experience by combining motion detection with Telegram notifications in smart mirrors.

Keywords: Smart mirror, motion detection, Telegram notifications, ESP8266 NodeMCU, IoT, home automation.

DOI: https://doi.org/10.36548/jsws.2024.2.006
Received: 12.04.2024, received in revised form: 04.05.2024, accepted: 16.05.2024, published: 29-05-2024

1. Introduction

Smart mirrors, which seamlessly integrate cutting-edge technology with traditional home fixtures, have revolutionized how we interact with everyday objects. By combining interactive elements powered by digital displays and sensors with the reflective surface of a traditional mirror, these innovative products offer a unique blend of functionality and aesthetics. Smart mirrors have outpaced their traditional counterparts by utilizing state-of-the-art technology to provide users with a versatile platform for interacting with their environment and accessing information. Traditionally, mirrors were only used to reflect physical appearance. However, with the advent of smart mirrors, a new era of functionality has begun, transforming mirrors into dynamic hubs of interaction and information rather than static objects. Smart mirrors can now provide a multitude of real-time information, from news headlines and health measurements to weather updates and calendar events, thanks to the integration of digital displays and sensors. With users able to easily access a wide range of information directly from their reflection, smart mirrors have become essential centers for daily tasks and decision-making. [1].

1.1 Telegram – Cloud based Messaging

Founded in 2013 by Pavel Durov and his brother Nikolai, Telegram is a cloud-based messaging service that is well-known for emphasizing privacy, security, and speed. Telegram provides end-to-end encryption for messages in transit and at-rest, guaranteeing the privacy and security of user communications. Its cloud-based infrastructure makes it easy to view media and messages on a variety of devices, facilitating synchronization and quick message delivery. Telegram also sets itself apart by enabling users to send anything up to 2 GB in size, which is a very useful tool for sharing bulky papers and media assets. Telegram is an essential communication tool for communities, corporations, and organizations. It supports group conversations with up to 200,000 people and public channels for broadcasting messages to large audiences. Additionally, a plethora of customization choices, including as themes, stickers, and custom chat backdrops, allow users to further customize their experience. Notably, Telegram's Bot API enables developers to create engaging bots that perform various functions on the network, send information, and automate operations, adding to its adaptability and user base's global appeal.

1.2 Telegram – Bot

Telegram bots are customized accounts run by software intended to easily communicate with users within the Telegram messaging network. They are driven by Telegram's Bot API. These bots include a plethora of functionality, such as automated responses to user inquiries, database and API connection, task automation for managing to-do lists and setting reminders, and entertainment elements like games, quizzes, and polls. Additionally, companies are using bots more and more for customer service, marketing, and sales initiatives. They do this by taking use of the bots' capacity to streamline transactions, promote products, and give tailored support. Telegram bots are extremely useful tools for developers, businesses, and users because of their efficiency and adaptability. They facilitate workflows, provide information, and improve user experiences across a variety of sectors and applications within the Telegram ecosystem.

1.3 ESP8266 NodeMCU

Built around the low-cost ESP8266 System-on-a-Chip (SoC), the NodeMCU (Node MicroController Unit) is an open-source software and hardware development environment. The Espressif Systems-designed and -produced ESP8266 has all of the essential components of a computer, including networking (WiFi), CPU, RAM, and even a contemporary operating system and SDK. This makes it a fantastic option for any form of Internet of Things (IoT) project. There are multiple package styles available for the NodeMCU. All of the designs share the same ESP8266 base core. The typical 30-pin arrangement has been retained in designs that are based on the architecture. It's crucial to be aware that while some designs employ the more typical narrow (0.9″) footprint, others use a wide (1.1″) footprint.

1.4 Arduino IDE

An open-source software platform called the Arduino Integrated Development Environment (IDE) is used to program Arduino microcontrollers [2]. It offers a flexible setting for creating, assembling, and uploading code to Arduino boards. Because it is open-source, anyone can examine, alter, and distribute it as needed because anyone can freely access the source code. Its compatibility with Linux, macOS, and Windows operating systems guarantees accessibility for a broad user base. In the help of features like syntax highlighting, autoindentation, and code completion in the code editor, novices can quickly become proficient in programming Arduino boards thanks to an intuitive interface.

1.5 Internet of Things

The Internet of Things, or IoT, is a network of real-world objects like cars, appliances, and devices that have sensors and connectivity built in to share data online. Its main goal is to facilitate autonomous communication between devices in order to improve efficiency and decision-making. Data processing and storage, user interfaces, security measures, and sensors for data collection are important components. IoT applications cover areas like healthcare, agriculture, transportation, and manufacturing, transforming operations and providing new opportunities. Smart industrial sensors, fitness trackers, and thermostats are a few examples. All things considered, IoT offers revolutionary innovation, global connectivity, and efficiency that will change the way we interact with our surroundings.

2. Related Work

In homes, passive infrared (PIR) sensors are frequently used for motion detection because of their sensitivity to variations in the infrared radiation emitted by moving objects, such as human bodies. These sensors are coupled with Arduino microcontrollers, like the Arduino UNO, to construct programmable platforms that can operate related actuators, like as relays, for light automation. When a PIR sensor senses motion, it typically sends a high signal to the Arduino, which turns on a relay to turn on the lights in the room. The Arduino is frequently configured to switch off the lights after a predetermined amount of time when motion stops in order to ensure energy savings.

Programming the Arduino UNO board involves utilising the Arduino IDE and the C coding language to interface with the ATMEGA328 microcontroller, which is the central component of the circuit. A bell, SIM module, and PIR sensor are examples of integrated sensors and modules. When a person is detected, the SIM module triggers a signal alert and sends the user a message. A camera also records video of the surroundings, which is then uploaded to a server and made available to users. This project investigates the integration of an Arduino microcontroller with a Human Movement Sensor to flash an LED and start recording video on an Android smartphone as well as a local computer [3].

Through the use of infrared radiation and a PIR sensor, the system detects intruders and, upon detection, generates an electrical signal. The purpose of amplifying this signal is to turn on a webcam and lighting system. When an intruder comes within the sensor's detecting range, the programme automatically detects it, takes a picture, and stores it on a micro-SD card. As soon as the intruder exits the detection area, the webcam turns off. This economical and energy-efficient security system works within the PIR sensor's 10-meter detecting range [4].

Through the use of an internet-connected computing device, the system processes sensor data using an Arduino Uno microcontroller to enable remote monitoring and control of linked devices. Using the Message Queuing Telemetry Transport (MQTT) protocol, the Arduino Uno connects to an ESP8266 Wi-Fi module, which serves as a node for communication between the cloud and the sensors. The cloud computing infrastructure is provided by Amazon Elastic Compute Cloud (EC2), which offers scalability and dependability. The cloud interface used to store and retrieve data from Internet of Things (IoT) devices is called ThingSpeak. With the help of the system's numerous dispersed sensors, each devoted to a particular task, users may monitor and manage devices from a distance using a portable mobile phone that serves as a router [5].

The system uses a ZigBee-based Wireless Sensor Network (WSN) to monitor many parameters and incorporates a Passive Infrared (PIR) sensor for motion detection, which is confirmed by an IP camera. When an alert generation system detects an incursion, a GSM SIM900A module powers the system and delivers text notifications to users. An ESP8266 12E Wi-Fi module allows users to access the ThingSpeak server for data storage and retrieval, while an IP camera for surveillance purposes provides real-time feeds for intrusion verification [6].

The central component of the suggested smart mirror architecture is a Raspberry Pi 3, a low-powered minicomputer. This Raspberry Pi model uses 700mA and has 512MB SDRAM. It runs on the Linux operating system. The mirror uses an LCD screen covered by a two-way acrylic mirror that, when powered, acts as a display and, when not, as a standard mirror. The smart mirror is an internet-connected device that shows pertinent information to the user, like local time and date, trending headlines, weather updates, and Google calendar appointments. This Internet of Things (IoT) technology gives users customisable, real-time information by retrieving updated data from websites, including RSS feeds [7].

A Raspberry Pi microcontroller, a two-way mirror, and a display device that shows off real-time news and weather updates are all included in this Internet of things smart mirror. It lets users customise the layout and content, but it needs an internet connection to retrieve data. Because of the system's scalability and updateability, it may be updated with new features and software, although implementing it requires knowledge of both hardware and software development [8]. As a multipurpose personal assistant, the smart mirror shows the time, the weather, the news, and allows email handling via a graphical keyboard. Another variation concentrates on smart home communications, augmenting security via facial recognition and sounding alarms for faces that are not identified. This mirror uses a Raspberry Pi or an Arduino UNO to demonstrate a variety of features, including speech recognition and Wi-Fi. Finally, a virtual fashion adviser mirror that offers individualised fashion advice through simple 2D visualisations uses augmented reality and gesture detection to suggest outfits [9]. An ARM processor and a Smart Mirror with a face-recognition camera are integrated in the suggested system. It keeps 100 photos for each user in grayscale for identification using live streaming images. Personalised messages and information are displayed to authorised users via the system, which uses a CNN-based algorithm for facial detection. Unauthorised users are presented with a typical mirror image. Real-time updates, including news, weather predictions, and user-specific information, are provided by the ARM CPU over an interface with a Wi-Fi module [10].

3. Proposed Work

The goal of the proposed work is to combine the Telegram messaging network and the ESP8266 microcontroller to create a novel motion detection system. The motion detection technology within the smart mirror will be covertly installed so that it can function effectively without detracting from the mirror's attractiveness or reflective qualities. All of the motion data will be recorded and processed by the ESP8266, which is equipped with a PIR sensor. The system will make use of the ESP8266, an affordable and effective microcontroller with Wi-Fi capability that can be used for Internet of Things (IoT) applications. To detect motion, it will connect the microcontroller to a passive infrared (PIR) motion sensor [11]. In order to enable instantaneous communication and notifications, a Telegram bot will be developed to function as a mediator between the user's Telegram account and the ESP8266. When the PIR sensor detects motion, this bot will allow the ESP8266 to deliver warning messages straight to the user's Telegram account via HTTPS calls to the Telegram Bot API. Instant notifications will be sent to users via the Telegram Messenger programme, which can be accessed on desktops (PC, Mac, and Linux) and smartphones (Android and iPhone) as long as they are online. Numerous benefits come with the integration with Telegram, such as its cross-platform interoperability, cloud-based infrastructure that guarantees dependable message delivery, and its user-friendly interface that is free of ads, all of which contribute to a seamless and improved user experience [12-14].

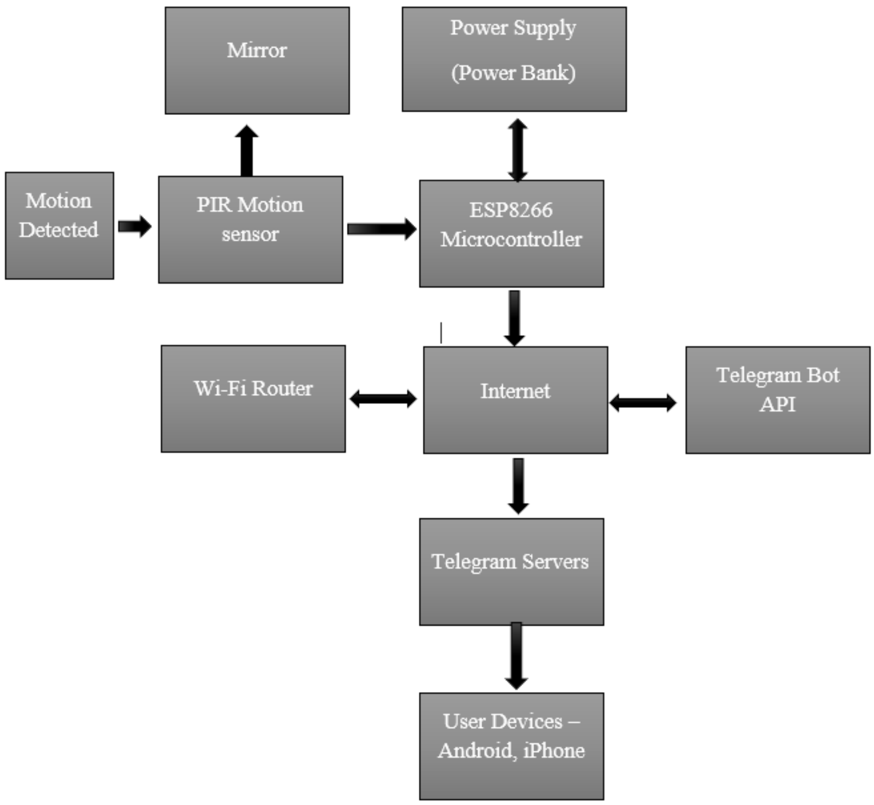


Figure 1. Work Design

Figure 1 explains the working flow of the smart mirror. The motion detection system uses an ESP8266 microcontroller connected to a secretly installed PIR motion sensor within a smart mirror. When motion is detected, the ESP8266 sends an HTTPS request with the motion data to the Telegram Bot API. The bot processes this data and sends a notification to the user's Telegram account. Users receive real-time alerts on their Telegram app across various devices, ensuring immediate and reliable notifications. This setup offers a cost-effective, user-friendly solution for enhanced security and convenience using IoT and messaging technology.

The overall goal of this suggested system is to offer a low-cost, effective, and user-friendly solution for motion detection and notification in real-time by utilising the flexibility of the Telegram messaging platform and the capabilities of the ESP8266 microcontroller [15].

4. Experimental Analysis

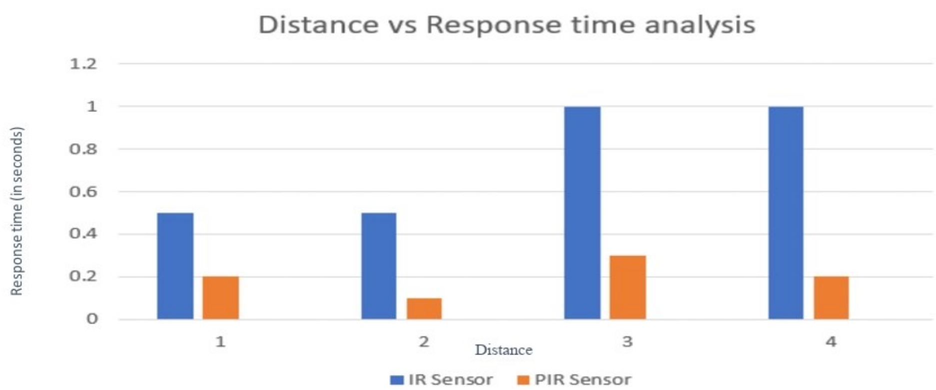
Experimental analysis reveals the comparative response times of PIR and IR sensors, demonstrating PIR sensors' consistent and rapid reaction to motion events across distances. This feature underscores their practicality and suitability for applications like automated lighting or security systems. Additionally, PIR sensors offer energy efficiency, as depicted in the circuit diagram (Figure 3). The warning message delivery process is illustrated in Figure 4, while the final setup of the smart mirror, complete with the PIR sensor for motion detection, is showcased in Figure 5.

4.1 Choosing the Sensor – PIR vs IR Sensor

This section involves the comparison between the PIR and the IR sensor which enabled to select a better sensor for this project.

The appropriate x and y axes are shown in the accompanying graph,

- The X-axis, which indicates distance or motion intensity, shows the different ranges of distance or intensity from the sensor.
- The Response Time (Y-axis) graph shows how long it takes for each type of sensor to detect motion at various distances (in meters) or intensities.



Distance

Figure 2. Comparison between PIR and IR Sensor

In the Comparative Sensor Response Times section, we look closely at the response characteristics of two different types of sensors: passive infrared (PIR) and infrared (IR). The primary focus is on how quickly they detect motion occurrences. This analysis investigates the consistency and quickness of detection over a range of distances and motion intensities. By examining these factors, we acquire useful insights into each sensor type's utility and efficacy for motion detection applications. We hope to determine which sensor type performs best under a variety of environmental situations, allowing us to make the best sensor selection for certain use cases.

Figure 2 explains that PIR sensors consistently react to motion events faster than IR sensors, regardless of the distance or intensity of the motion, as seen by the graph comparing the two types of sensors' response times. This feature highlights their supremacy in terms of practicality, guaranteeing prompt detection that is essential for applications such as automated lighting or security systems. So we have chosen PIR Sensor for this project.

Furthermore, PIR sensors are a better option than IR sensors for energy-conscious installations due to their passive sensing method and economical energy use. In general, the graph supports the use of PIR sensors due to their dependability, energy economy, and quick reaction time in motion detection situations.

4.2 Circuit Integration

This section provides a detailed analysis of the connection setup between the ESP8266 microcontroller and the Passive Infrared (PIR) sensor, explaining each step of the wiring and setting procedure. We have thoroughly specified the layout of wires and components to provide clarity during the integration phase. Our goal is to provide a clear knowledge of how the circuit is smoothly integrated into the mirror structure, ensuring maximum functionality for motion detection.

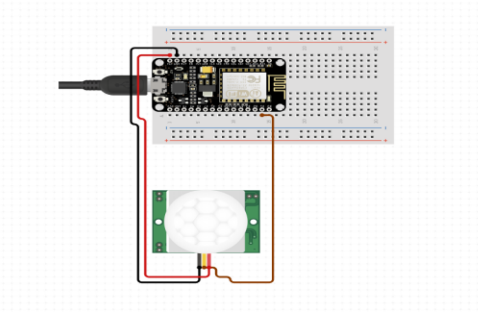


Figure 3. Circuit Diagram

Figure 3 explains the connections between different components. Esp8266 is connected to PIR sensor via board connection using jumper wires, this circuit will be integrated with mirror.

4.3 Final Setup of the Smart Mirror

When a person stands in the room where the smart mirror is placed, the PIR sensor which is integrated with the mirror will detects motion and through HTTPS calls to the Telegram Bot API, the owner will receive the warning message in their mobile phone.

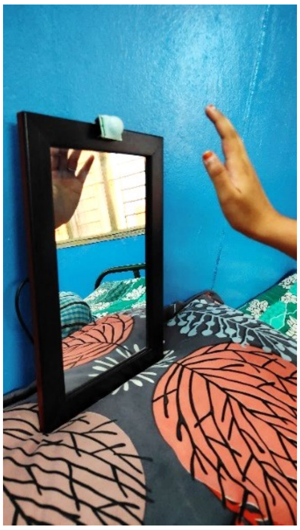


Figure 4.1. Final Setup of the smart Mirror- The Front side

Figure 4.2. Final Setup of the Smart Mirror-Rear Side of the Mirror

The Figure 4.1 and Figure 4.2 is the final setup of the smart mirror with the PIR sensor placed in the smart mirror to detect movement.

4.4 Results and Discussion

In this section, we explore the operational details of the Passive Infrared (PIR) sensor-assisted motion detection mechanism. The PIR sensor detects minute movements within its detection range thanks to its excellent detecting abilities. As clearly depicted in the above Figure 4.2, when a hand or any other object moves within the sensor's range, the PIR sensor sends a signal to the ESP8266 microcontroller. The smart mirror, equipped with this sensor, thus effectively detects motion. The ESP8266 board, connected to the Telegram API via a generated token, processes this signal and initiates an HTTPS call to the Telegram Bot API,which in turn sends the Notification message to the user device. This method guarantees smooth communication and facilitates real-time alerts to users' mobile devices

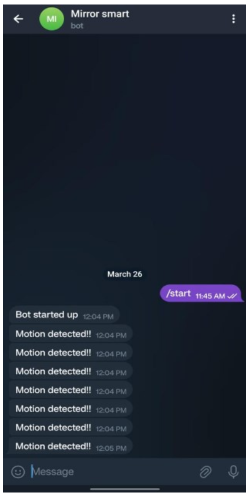


Figure 5. Warning Message Received from Smart Mirror

Figure 5 clearly shows the warning message sent by the telegram bot. The bot is activated by a start message. It also intimates once the bot is started up. Once the motion is detected it seamlessly send the warning message to the user via the bot.

4.5 Comparison of Motion Events vs. Notifications

This data offers information about how well the system is working, such as how frequently motion events are found and how often users are notified when they do. By examining these data, one can assess how well the motion detection system informs users of motion events that have been identified. To improve system performance and user experience, additional analysis might look at trends, patterns, or correlations between motion events and notifications issued

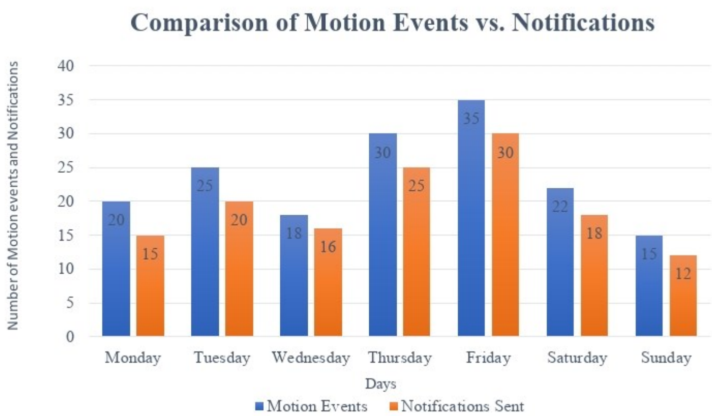


Figure 6. Notifications vs. Motion

The daily count of motion events observed and messages issued by the system are shown in the Figure 6. It provides a numerical evaluation of the system's operation, allowing for an examination of how well it notifies users of observed motion in a timely manner. Through close examination of data trends and patterns, possible enhancements to improve system performance and user experience can be found.

5. Conclusion and Future Work

In conclusion, the proposed smart mirror system offers a practical, affordable, and user-friendly solution for real-time motion detection and alerting by effectively integrating the ESP8266 microcontroller with the Telegram messaging platform. Through the integration of the PIR motion sensor and Telegram bot, the system guarantees timely alert delivery to users on multiple devices, taking advantage of Telegram's dependable cloud-based infrastructure and cross-platform interoperability. With the use of well-known messaging platforms and IoT technology, this creative system shows how to improve user experience and offer smooth motion detection capabilities. The objective of the future work on the suggested motion detection system incorporated into the smart mirror is to show the temperature and time in real time on the display. Furthermore, a Telegram bot will automatically upload the images, time, and temperature data, to the owner's Telegram account when motion is detected. The system will take pictures, store them on an SD card, and send the images to the owner. By giving consumers instant access to crucial information and enhancing security by enabling them to track possible motion occurrences in real-time, these improvements will give users a more engaging experience.

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