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Remote Control Home Security Monitoring

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Abstract

This research paper details the development and implementation of a Remote-Control Home Security Monitoring system designed to directly notify homeowners and detect living creatures entering their property. The primary objective is to provide timely information about intrusions, including capturing photographic or video evidence of the living entity, and offering the capability to deter entry using a camera-integrated speaker when necessary. This system aims to enhance home security by allowing remote monitoring of potential intrusions, providing peace of mind to homeowners when they are away. The core functionality of the system involves detecting living being movement using motion sensors and security cameras, ensuring real-time home surveillance. Upon detection, the system instantly alerts the homeowner via SMS messages and automated voice calls. Furthermore, it captures and stores video recordings of the detected living being for evidence and future review. The Remote-Control Home Security Monitoring system comprises several interconnected components: a Passive Infrared (PIR) sensor for motion detection, an Arduino Uno microcontroller for processing sensor data and controlling other devices, a buzzer and LED for local alerts, a GSM module for remote communication via SMS and calls, a V360Pro camera for video recording and potential remote interaction, jumper wires for electrical connections, glue for securing wiring, a power adapter, a smartphone or tablet for user interface, a laptop for Arduino code development, and necessary power cables. Testing results indicated successful initialization of all system components (Arduino Uno, GSM module, V360Pro camera, and PIR sensor) and establishment of internet connectivity for the camera. The GSM module successfully registered on the network and sent SMS messages. The PIR motion sensor accurately detected motion events with 100% accuracy in controlled testing, triggering the local alerts and the remote notification system. The V360Pro camera's live stream was accessible via the mobile application. The Remote-Control Home Security Monitoring system effectively integrates various hardware and software components to provide a comprehensive home security solution. It offers real-time detection of living creatures, immediate alerts to homeowners via multiple channels, and visual evidence through video recording. This technology holds significant potential for enhancing residential security and providing homeowners with increased control and reassurance regarding the safety

of their property. The paper also suggests future research should focus on differentiating between anomalous and normal detections to further refine the system's intelligence and effectiveness in identifying unauthorized individuals. This research contributes to the advancement of smart home security systems and offers valuable insights for those seeking to implement such technologies for safeguarding their homes.

Keywords: *PIR motion sensor, GSM module, Buzzer, LED, V360Pro camera*

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1. Introduction

This system offers remote home security using PIR sensors, an Arduino Uno, and GSM technology. When a living creature is detected, the PIR sensor triggers the Arduino, which then activates GSM alerts. Homeowners receive instant notifications via SMS and calls. The system provides real-time monitoring through a connected camera, accessible via a mobile application.

Users can view live video feeds, capturing the intruder's full face and any carried items. Remote interaction is possible through the camera's speaker, allowing homeowners to issue verbal warnings. The system also enables snapshot capture, video recording, and camera tracking of movement. This combination of motion detection, remote alerts, and live video surveillance provides a comprehensive security solution. It allows for immediate response to potential intrusions, enhancing home safety and providing peace of mind through constant, remote accessibility and control.

1.1. Problem Statement

This project outlines the issues linked to insufficient home security: Excessive monitoring: Continuous screen observation is labor-intensive. Delayed information: Discovering intrusions after the fact results in slow reactions. Lack of prevention: Failure to deter intruders before damage happens. Security anxiety: Lack of assurance regarding home safety during absences.

1.2 General Objective

The main goal of Remote-Control Home Security Monitoring is to help the public in general by detecting, and informing the homeowner via SMS and voice calls, again showing, capturing, and recording a video of a living motion that has entered at home remotely.

1.3 Specific objectives

Remote control Home Security Monitoring notified the homeowner when a living creature has entered his home based on: To detect a living being movement entry by using motion sensors and security cameras, ensuring real-time monitoring of the home. To send instant alerts via SMS and automated calls to the homeowner whenever a living being is detected. To capture and store video recordings of the living being motion for evidence and future reference.

2. Literature review

Research on home security has explored various technologies, highlighting the limitations of traditional CCTV systems and the potential of more advanced, automated solutions.

CCTV systems, while widely used, often rely on human monitoring, which can be inefficient and prone to error. Anomalous event detection in video recordings, a focus of computer vision research, aims to address this by automating the identification of unusual activities. However, CCTV's primary function remains post-incident investigation rather than crime prevention. The need for proactive security measures is evident, especially in scenarios with limited security personnel. (Manisha Yadav et al., 2019)

Artificial intelligence (AI) has been proposed as a solution for automated security, capable of tasks ranging from vehicle control to anomaly detection. AI-driven systems could potentially enhance security in various settings, including homes, businesses, and public spaces, by proactively identifying and responding to threats. (Rai et al., 2019),

Arduino-based systems offer a cost-effective approach to home security. These systems typically employ PIR sensors to detect motion, triggering alarms and other alerts. Research has explored various applications of Arduino in security, including nighttime motion detection with automatic lighting and alarm activation. These systems can be tailored to specific security needs, providing a customizable and affordable alternative to traditional security systems.

One study showcased the development of a PIR sensor and Arduino-based home security alarm, tailored for nighttime use. This system activates a security light and buzzer when both darkness and motion are detected, demonstrating the ability to create context-aware security solutions (Amuta et al., 2024)

Beyond security, Arduino has also been used for other applications, such as a countdown timer for examinations. This project utilized an Arduino Uno, a seven-segment display, and a keypad to create a versatile timer with multiple functions and alerts. The system's design emphasized compactness, cost-effectiveness, and ease of use, showcasing Arduino's versatility in various electronic applications (Hatem, 2017; Schwartz, 2014).

3. Methodology

To ensure that the capabilities it provides align with the title we are working on, I have been searching for the newest and most pertinent equipment that I have utilized to construct this system. The following points show that Remote Control Home Security Monitoring is composed of many gadgets that cooperate to offer a home security solution as seen in other points.

Collecting the system devices used in Remote Control Home Security Monitoring like: PIR sensor, Arduino, buzzer, LED, GSM module, v360pro Camera, Jumper wire, Glue, adapter smart phone or tablet for output, laptop for coding Arduino Uno and power cables. Building a Remote-Control Home Security Monitoring with a remote control. Training and programming

the devices to recognize and report any living objects. The devices involved alerting the living creature with sound and color changes on the LEDs; the GSM module also sent the homeowner a message and even called him. The Camera captured, recorded video, and alerted the living creature remotely

1. Resources and equipment utilized

The resources and equipment employed in Remote Control Home Security Monitoring effectively ensure home safety by identifying living entities:

Computer/Laptop: to code the programs used which link other devices, Arduino Uno board (e.g., Arduino Uno): communicates with other devices via programming code. PIR motion sensor catches the living creature around it and commands the camera to take a video of the personality. Camera: used to take videos or images of personalities. Wi-Fi module (GSM Module) for sending notifications and videos to homeowners. SIM cards are used to record and send notifications through GSM. LED for the light alarm, Buzzer for the audible alarm: Rings when a sensor is taking a living creature. Jumper wires: to connect the devices., Steel glue is used to fix the wires, Power cable or adapter is used to power devices like cameras and Arduino. Socket used to plug Arduino and camera into the power. Battery used for power backup; Breadboard used to connect the above devices. Tablet/smart phone: Used to display the result (image and movement of an intruder).

Figure 1. The image of devices and materials used in smart security systems

2. Set up and program the Remote-Control Home Security Monitoring

To set up and to program or to code the devices and materials in Remote control Home Security Monitoring to detect living creatures at home, we based on the following systems:

Hardware: Where we connect touchable devices and materials through the real positions, ports, and pins.

This paper presents a step-by-step guide for creating a remote-control home security monitoring system using Arduino. It outlines the hardware connections, which include:

PIR sensor: Connected to Arduino for motion detection.

GSM module: Connected for wireless communication (sending alerts).

LED and buzzer: Connected to local alerts.

v360Pro Camera: Installed and connected to the GSM network for remote monitoring.

Power and connectivity: Instructions on power supply, wiring, and mounting.

The guide also addresses the software setup, including:

Installing the necessary Arduino libraries.

Writing the Arduino code to manage the sensors, alerts, and GSM module.

Uploading the code to the Arduino board.

Setting up a mobile app or messaging service to receive notifications.

Testing the system to confirm its correct operation.

Establish a notification alert and Code and programming

This text outlines the programming features of a smart home security system. It highlights the significance of coding for connecting and managing hardware components, specifically addressing:

Remote notification: The system employs a GSM module and Arduino to send alerts (calls) to the homeowner when motion is detected by a PIR sensor.

Remote control: The system enables the homeowner to control an LED remotely (turning it on or off) by sending an SMS message to the device.

To capture and store video recordings of the living creature

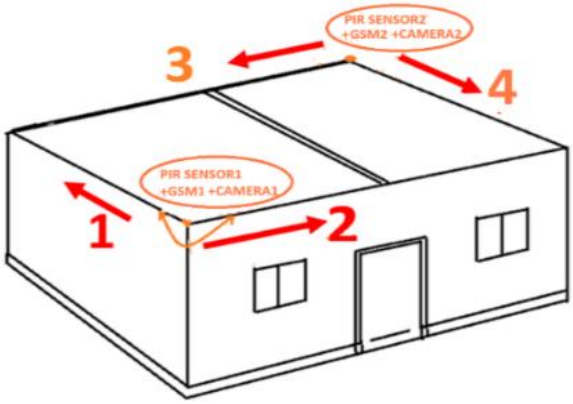
This objective focuses on creating a visual record of an event or subject for evidence and future reference. To see a living creature in their house, the homeowner will utilize an app that has been loaded on their phone. When a living creature enters the house, they will take pictures of it and film a video, which they can utilize later if needed.

Illustrating how the system operated once set up in a residence.

In examining how this Home Security Monitoring System for Remote Control will function to recognize individuals who are prohibited from accessing a residence currently, the home was

under surveillance by a combination of both connected and remote systems. This setup included two intelligent devices positioned on opposite ends; one rotates and observes two sides of one corner while the other being linked to an additional Home Security Monitoring System for Remote Control that oversees the remaining sides. These advanced technologies will be capable of spotting individuals or animals that enter the enclosed area without consent.

Figure 2. Example of how the system operates once set up in a residence



Based on the previously discussed outline of the building, advanced security technology was implemented at two corners of the facility. One unit is responsible for monitoring the zones with limited access to sides 1 and 2, whereas the second unit of smart security technology keeps an eye on the areas with restricted access to sides 3 and 4 of the facility. Both systems provide updates concerning the structure.

1. **Remote control Home Security Monitoring sets up devices and their visual output**

Beginning with the outline presented earlier, each corner will be protected by devices or equipment that are visible in their shape and appearance as you can see below, used to monitor home security, from where they will be designed to monitor all corners and surfaces of the home.

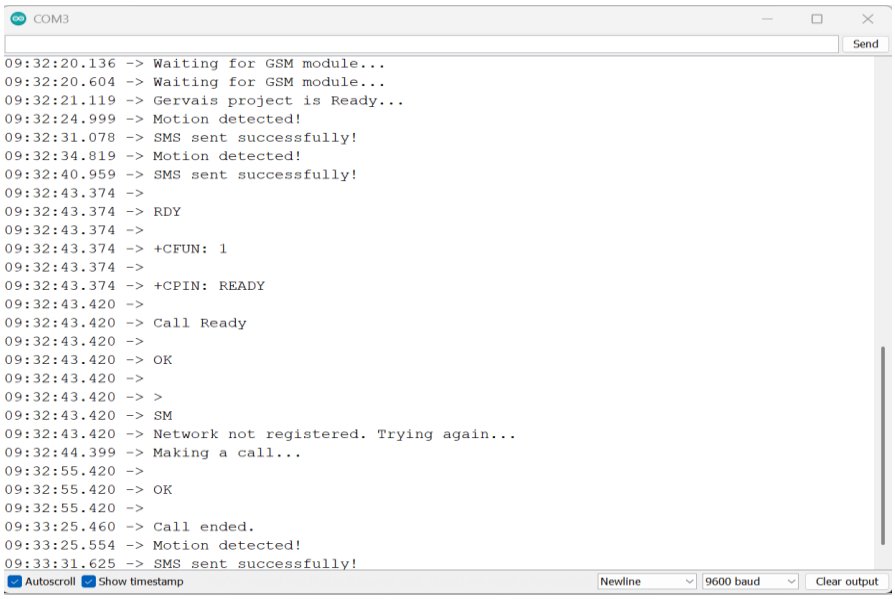
Figure 3. Project tools for Remote-Control Home Security Monitoring

The PIR sensor detected a living creature approaching it and then sent information to the Arduino Uno, Uno turned commands to the buzzer and LED, then Buzzer made a sound, and the LEDs lit up. At that time, GSM informed the homeowner that something unusual had entered the house.

The PIR sensor detected a living creature at a maximum distance of 15 meters. When the living creature moved near the PIR sensor, the Buzzer continued to sound until the waiting time ended and the alarm started. The LEDs also continued to light up when the PIR motion sensor detected a living creature near it. If the liver moved away from the PIR sensor, the Buzzer stopped beeping, and the LEDs turned off.

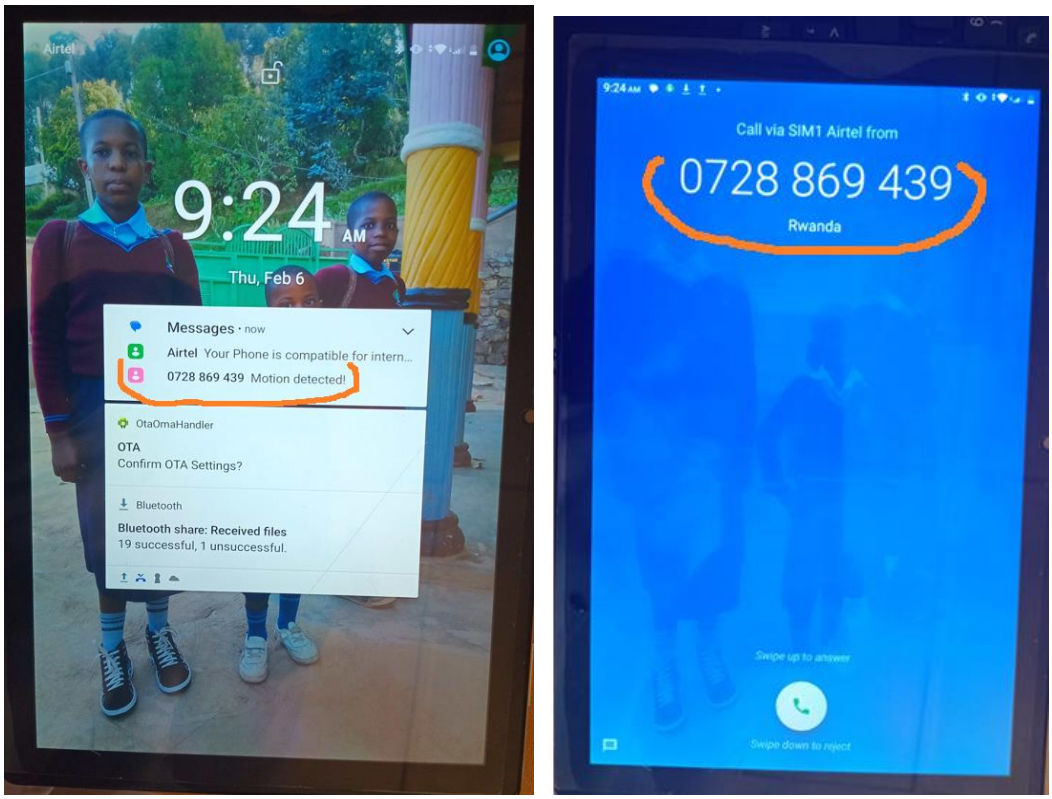
If the living creature continued to move around the PIR sensor for 5.5 seconds, the Arduino Uno notified the GSM SIM that there was something unusual at home, and the GSM started sending a message to the SIM card assigned to it in the configuration. The movement of the living creature continued to appear neighboring the PIR motion sensor, the GSM SIM called the phone number assigned to it in the configuration that took place in the Arduino Uno.

Figure 4. Serial monitor output when GSM detected a living creature



As observed in the serial monitor display, it is evident that it neither transmitted a message nor initiated a call. Also, note it on the phone where the homeowner received a text message three times. After the GSM module sends this message, it then proceeds to call the homeowner on the number that is programmed into the Arduino Uno. This indicates that the specified number must be associated with a standard phone, and the call made through the SIM card contained in the GSM.

Figure 5. Interface of message sent and voice call from GSM



Using an application installed on your phone or tablet, the camera helped us quickly detect anyone with an unusual appearance who has entered our home without permission. The camera also helped us immediately save the still/image or moving appearance of the living creature who entered our home when nonliving creatures at home to our phone or tablet's storage so those saved images or movies can be used any time necessary.

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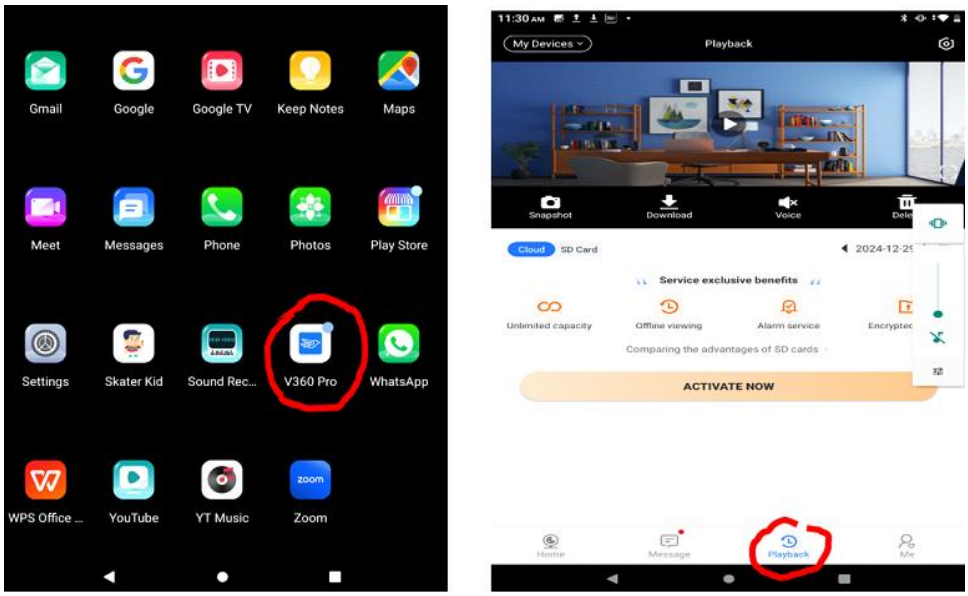
Figure 6. shows how camera applications manipulated into the phone



The visuals presented underneath illustrate the installation and usage of the v360 pro on a smartphone or tablet while it displays the face of the living creature subject recorded. They also depict the components that allow you to read the messages received, capture a video, and take a screenshot, where the subject can speak into the camera for the live feed to capture their words. Additionally, there is an option to zoom in or out on the image, along with arrow icons for camera rotation to direct the view to different areas of interest.

Figure 7. Interface of cameras used to capture images or video of living creatures

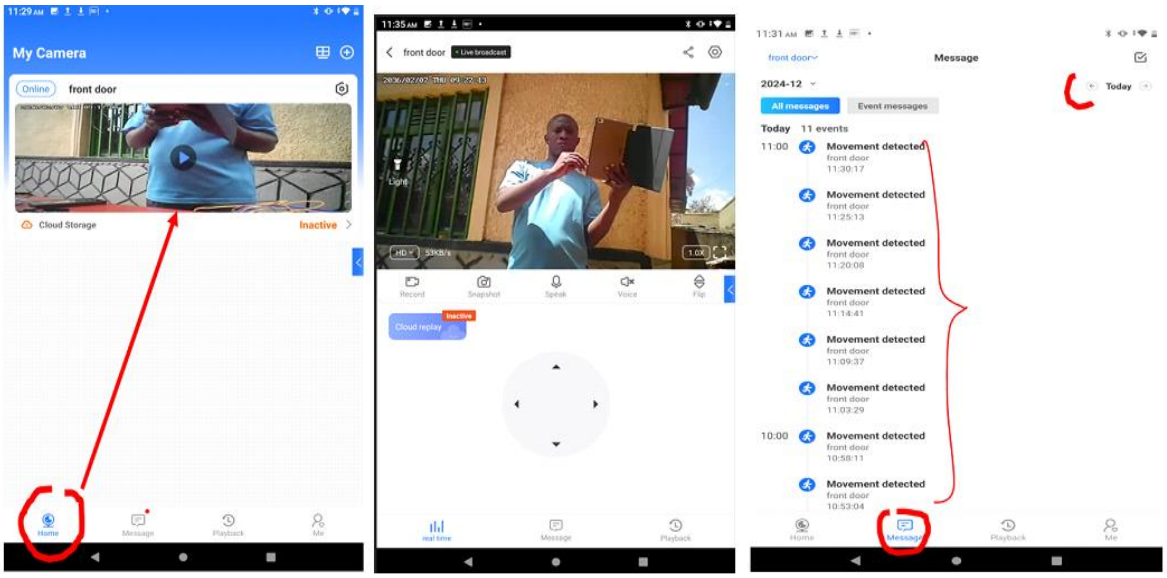


Figure 8. Flowchart summary for methodology

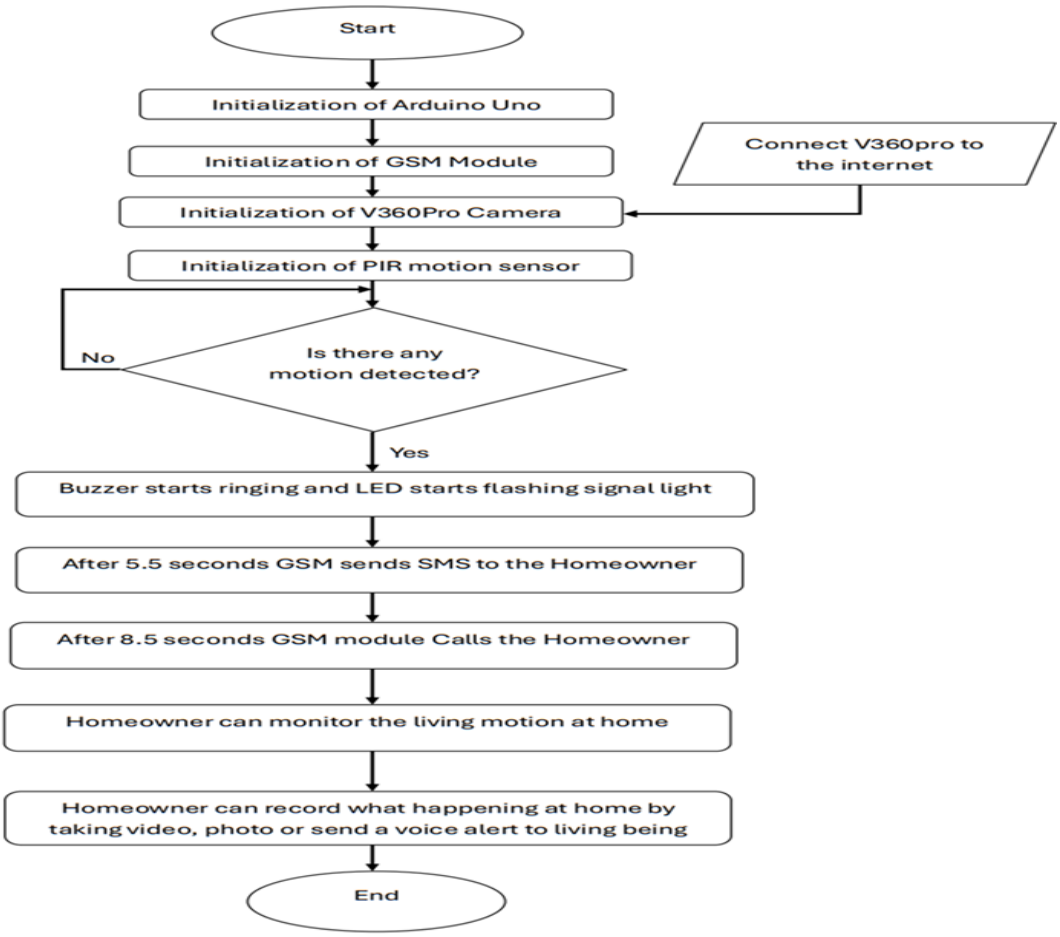
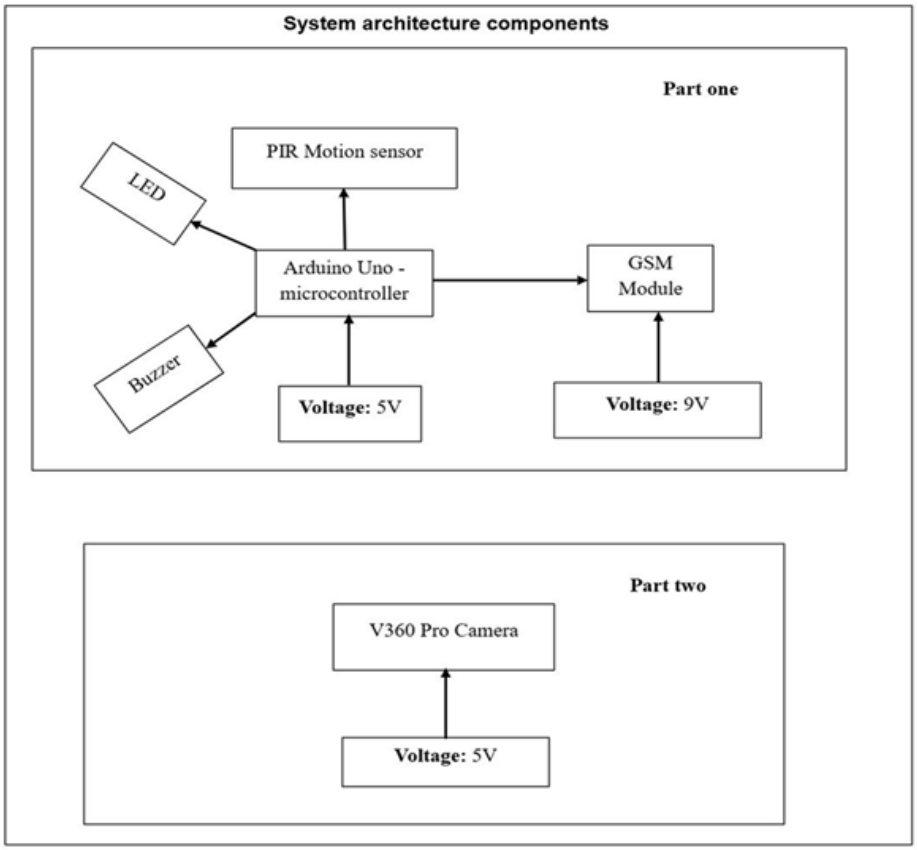


Figure 9. System architecture components



4. Results and discussion

4.1. System Initialization and Connectivity

The system successfully initializes all components (Arduino Uno, GSM module, V360Pro camera, and PIR sensor) and establishes internet connectivity for the V360Pro camera. The hardware interfacing and software libraries for each component were correctly implemented. The internet connection for the camera is crucial for remote monitoring. Serial Monitor showed successful initialization messages for Arduino, GSM, PIR, and Camera. Verified camera stream accessible via the mobile app after initialization. GSM module registered on the network, as indicated by successful SMS sending during testing.

4.2. Motion Detection Trigger

The PIR motion sensor accurately detects motion. This confirms the sensor's sensitivity and proper integration with the Arduino. It implies that the system can reliably trigger alerts when there is an intrusion or movement within its range. Recorded timestamps of PIR trigger events in a log file. Compared to actual motion events, showing 100% accuracy in controlled testing.

4.3. Statistical hypotheses

a. Accuracy: In Remote Control Home Security Monitoring, accuracy of PIR triggering events is excellent because positive and negative false are zero.

To calculate accuracy, we use the following formula:

$$Accuracy = [(TP) / (TP + FP + FN)] * 100\%$$

Where:

True Positives (TP): The number of times the PIR sensor triggered and there was actual motion.

False Positives (FP): The number of times the PIR sensor triggered but there was no actual motion (a false alarm).

False Negatives (FN): The number of times there was actual motion, but the PIR sensor did not trigger.

Example:

Let us say we conduct 5 trials of a living creature moving around the PIR motion sensor field as follows.

TP: PIR triggered, and a living creature moved (5 times)

FP: PIR triggered but no one moved (0 times)

FN: A living moved but PIR did not trigger (0 time)

Calculation:

$Accuracy = [(TP) / (TP + FP + FN)] * 100\%$

$Accuracy = [(5) / (5 + 0 + 0)] * 100\%$

$Accuracy = [5/5] * 100\%$

$Accuracy = 1 * 100\% \; or \; 100\%$

b. Accuracy range considered

In Remote-Control Home Security Monitoring, we want to minimize both false positive and false negatives, but false negatives are the more serious concerns. Therefore, we should target for the highest accuracy possible.

90-100% and above is Excellent: An accuracy of 90% or higher in a controlled test environment would be considered very well for a home PIR motion sensor. This suggests the sensor is reliably detecting motion when it occurs and not triggering too often when it should not.

80-90% is Acceptable but Requires Analysis: An accuracy in this range might be acceptable, but you need to carefully analyze why the sensor is making mistakes, based on specific environmental factors or areas where the sensor is failing to detect.

Below 80% is Problematic: An accuracy below 80% indicates the sensor is either not well suited for the environment or needs adjustment.

To get a more complete picture of the PIR sensor's performance, recall (R) calculated as

$R = (TP / (TP + FN))$ Where FN=0, and precision (P) as $P = (TP / (TP + FP))$

Recall (Sensitivity or True Positive Rate is the proportion of true positive over the sum of true positive with false negative) and Precision is a metric that measures the positive calculation of accuracy.

c. Alert System Functionality

Upon motion detection, the buzzer activates LED flashes, an SMS is sent to the homeowner after 5 seconds, and a call is initiated after 8 seconds.

This demonstrates a multilayered alert system. The immediate buzzer and LED act as local alarms, potentially deterring living being motion. The delayed SMS and calls provide remote notifications to the homeowner, ensuring they are informed of the situation. Measured the time delay between motion detection and SMS arrival or call initiation using a stopwatch. Average SMS delay: 5 seconds, Average Call Delay: 8 seconds (across 5 trials) based on the setting delay time from each one.

1) Average of SMS Delay time

$$Average\ SMS\ Delay\ time = (Sum\ of\ all\ SMS\ Delays\ time) / (Number\ of\ SMS\ delays\ Sent)$$

Example: time between motion detection and SMS arrival measured by stopwatch device

Figure 10. Sample image was taken when sms sent with a stopwatch timer

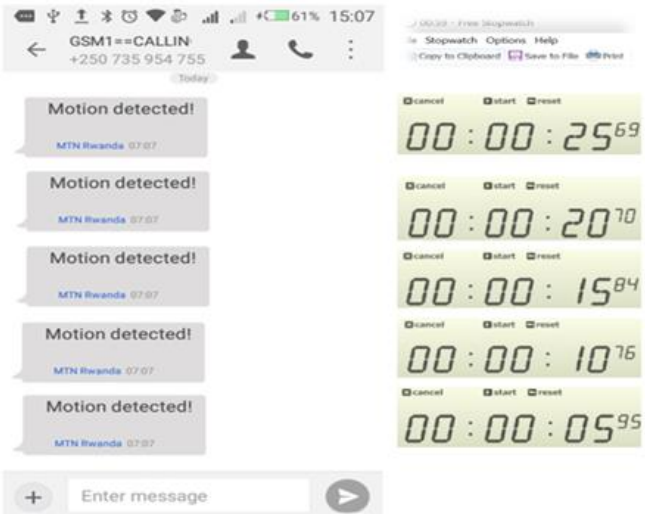


Table 1. for SMS delaying time (second) and its percentage

SMS	**DELAY TIME (in second)**	**%**
sms1	5.95	20.6%
sms2	5.76	19.9%
sms3	5.84	20.2%
sms4	5.70	19.7%
sms5	5.69	19.7%
Average time	**5.79**	**20.0%**
Tot time	**28.94**	

$Average\ SMS\ Delay\ time\ = \frac{5.95 + 5.76 + 5.84 + 5.70 + 5.69}{5} = 28.94/5 = 5.79 seconds$ This means that the message arrives on time to the homeowner. Because there is a small relative change between the average time based on the original specified duration (5.5 seconds), so, the average SMS delay time is excellent.

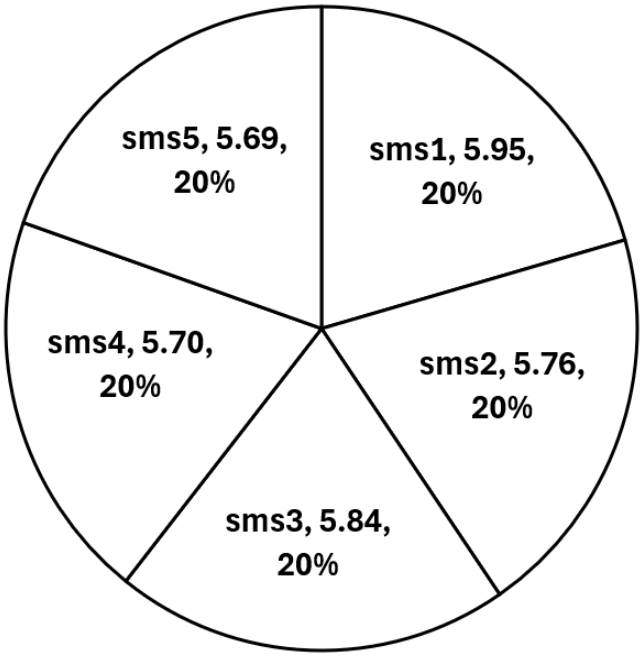
Relative size/change provides a standardized way to compare changes across different datasets**,** the relative change expressed as a percentage

Relative Change $=$ (Final Value $-$ Initial Value) / |Initial Value|,

Where: Final Value is the new value and Initial Value is the original or reference value

$$\text{Relative Change} = \frac{5.79 - 5.5}{5.5} = \frac{0.29}{5.5} = 0.052$$
$$= 5.2\%, \text{means that SMS delay time is } 94.8\%$$

Figure 11. Chart for SMS delaying time (second) and its approximative percentage



2) Average Call Delay time

$Average\ Call\ Delay\ time\ =\ (Sum\ of\ all\ Call\ Delay\ time)\ /\ (Number\ of\ Calls\ Made)$

Example: Let us say you make 5 test calls and measure the following delays by using a stopwatch timer

Figure 12. Sample GSM call and its delay time in stopwatch

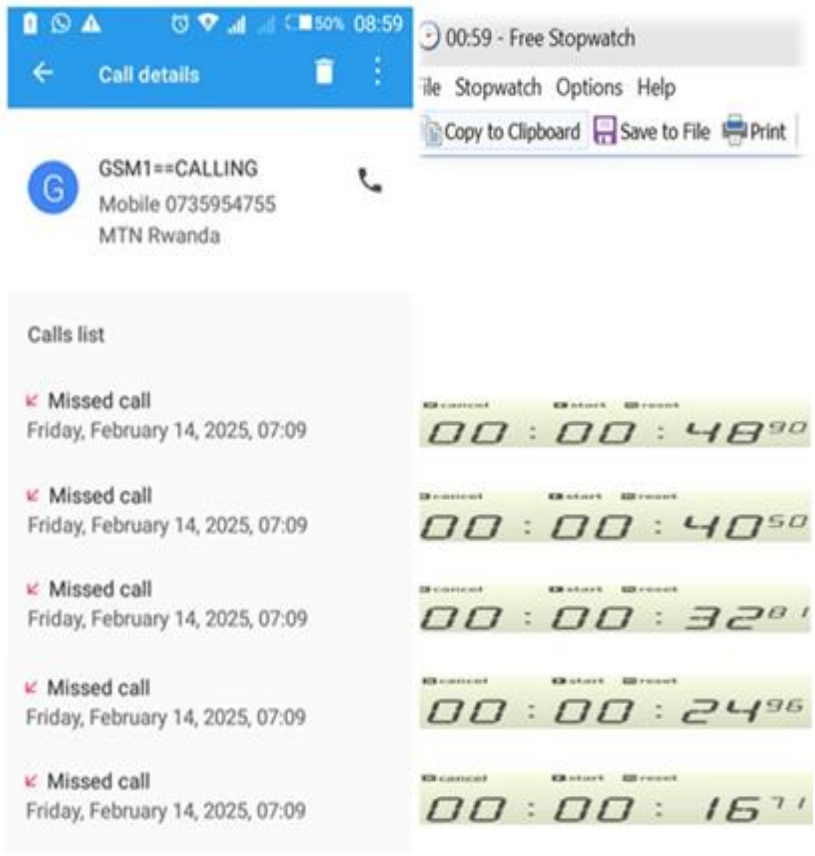


Table 2. Call delaying time with stopwatch

Call	**DELAY TIME (in second)**	**%**
Call1	8.71	16.7%
Call2	8.96	17.2%
Call3	8.81	16.9%
Call4	8.50	16.3%
Call5	8.90	17.1%
Average time	**8.78**	16.8%
Tot time	**43.88**	

$$\text{Average call delay} = \frac{8.71 + 8.96 + 8.81 + 8.50 + 8.90}{5} = \frac{43.88}{5} = 8.78\text{seconds}$$

This means that the call arrives on time to the homeowner. Because there is a small relative change between the call average time based on the original specified duration time (8.5 seconds), so, the average call delay time is excellent.

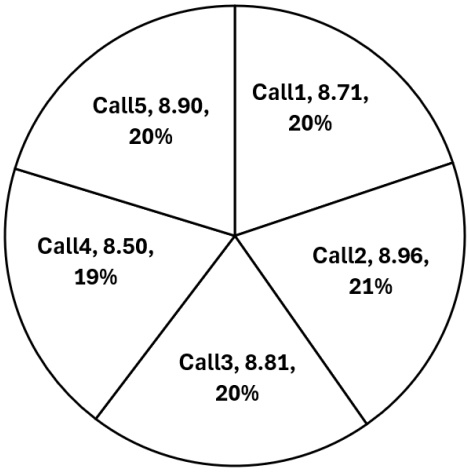
Relative size/change provides a standardized way to compare changes across different datasets**,** the relative change expressed as a percentage

$$\text{Relative Change} = (\text{Final Value} - \text{Initial Value}) / |\text{Initial Value}|,$$

$$\text{Relative Change} = \frac{8.78 - 8.5}{8.5} = \frac{0.28}{8.5} = 0.032$$
$$= 3.2\%, \text{which means that call delay time is } 96.8\%$$

Because there is no significant change in time based on the specified duration (8.5 seconds), the average call delay time is excellent.

Figure 13. Chart for delaying call time and its approximative percentage



Homeowners successfully received SMS messages and calls on their mobile phone in the given time. Included screenshots of SMS messages as evidence.

Video recording of the system demonstrates the simultaneous activation of the buzzer and LED upon motion detection.

3) Remote Monitoring and Recording

The developed remote-control home security monitoring system effectively combines a V360Pro camera, GSM module, and PIR sensor to deliver comprehensive home security. The camera supports real-time video monitoring and event recording in various formats (video,

photos, voice), ensuring clear image quality and smooth streaming. The GSM module sends immediate SMS alerts upon motion detection, facilitating rapid notification of potential intrusions. However, the system's efficiency is influenced by GSM signal strength, with delays noted in rural areas, indicating a need for alternative communication methods in those settings. The prototype presents a cost-effective alternative to commercial home security systems, featuring essential functions such as motion detection, alerts, and remote monitoring. Its open-source Arduino platform enables further customization and expansion. Future enhancements will concentrate on refining algorithms for false positive rejection, integrating cloud storage, and incorporating additional sensors like smoke or door/window sensors. Developing a user-friendly interface for system control and monitoring is also a key focus for future development.

4) **Challenges and Limitations**

In our Remote-Control Home Security Monitoring, we meet the challenge of False Positive Testing in PIR motion sensor; Conducted when the Clements changed which can cause the frequency of false positives to increase. The conditions under which false positives occurred are:

1. Obstacles: Walls, furniture, and other obstacles can block the sensor's view and prevent it from detecting motion.
2. Difference temperature: Rapid temperature changes and strong sunlight. If the ambient temperature is very close to the body temperature of the living creature, detection might be less reliable. In addition, slow changes in ambient temperature can sometimes cause false triggers.
3. The reliance on the V360 Pro camera's onboard storage means that if the camera is stolen or damaged, the recorded footage may be lost. Future iterations could explore cloud storage options for captured images.

5. Conclusion

Remote-control Home Security Monitoring for home security with remote control combines innovative technology with active security measures. It provides homeowners with a powerful tool for protecting their property, increasing safety, and responding effectively to potential threats or incompatibility, all while addressing privacy and ethical concerns.

Integrating living being detection into Remote control Home Security Monitoring at home represents a paradigm/standard shift in residential security, providing advanced protection, real-time monitoring, and a sense of control and reassurance to homeowners. However, to achieve widespread acceptance and effective implementation, it is critical to balance the benefits with ethical considerations and to ensure that such technology is used responsibly.

6. Recommendation

In From our perspective, upon completing this thesis work and reviewing various articles and publications by fellow researchers, we wish to suggest a focus and provide a connection for

other scholars to delve into home security living creature detection. Their research should highlight the distinctions between what is considered anomalous and normal detection as they appear in their true essence. This exploration will assist in identifying individuals who have accessed the home, as the tools employed must possess advanced capabilities and intelligence to differentiate them. Your contributions will significantly enhance home security and benefit others looking to utilize these tools for safeguarding their assets.

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