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INTELLIGENT WILD ANIMAL SAFETY FENCE WITH REAL-TIME MONITORING AND ALERT SYSTEM

M. S. N. Ismail@Marzuki*[1], Z. S. Samsolanuar[1], W. A. K. Wan Chek[1], A. I. Mod Arifin[1], H. H. Abu Bakar[1] and M. F. Mohd Zin[1]
[1] Faculty of Electrical Engineering, Universiti Teknologi Mara, Cawangan Terengganu Kampus Dungun, 23000, Dungun, Terengganu, Malaysia.
corresponding: saifulnajib@uitm.edu.my

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Abstract— Human-wildlife conflict (HWC) poses risks to human safety, crops, and wildlife, especially in rural areas. This project proposes a Wild Animal Safety Fence, an automated IoT-based system to deter wildlife entry into restricted areas. Using PIR sensors and a Piezoelectric Accelerometer (SW-420) for motion and vibration detection, with an Arduino UNO R3 and NodeMCU (ESP8266), it sends real-time alerts via the Blynk app. Upon detection, a spotlight and alarm activate while notifying users. This system aims to protect humans and wildlife, offering a humane, cost-effective, and scalable solution by integrating IoT with conventional deterrents to manage HWC effectively.

I. Introduction

Wild animals are vital for ecological balance; however, their encroachment into human areas has increased human-wildlife conflict (HWC) incidents [1-2]. Urban expansion into natural habitats has heightened interactions, threatening human safety, causing property damage, and harming wildlife, necessitating an effective, humane solution. Traditional deterrents like electric fences and manual monitoring have limitations as electric fences may harm animals, require maintenance, and are costly, while manual monitoring is inefficient in large rural areas [3-4]. Conventional fences also lack real-time alerts during wildlife intrusions.

This project proposes the Wild Animal Safety Fence, a smart IoT-integrated deterrent system using PIR motion sensors [5] and a Piezoelectric Accelerometer (SW-420) for detecting movement and vibrations. It triggers spotlights and alarms while sending real-time alerts via NodeMCU (ESP8266) and the Blynk app [6]. Leveraging sensor technology and IoT connectivity, the system offers an automated, energy-efficient, humane method to reduce HWC, aiding agricultural protection, rural safety, and environmental conservation [7].

II. Methodology

The project involved selecting Arduino Uno R3, NodeMCU (ESP8266), PIR sensors, and the Blynk IoT app, programmed using Arduino IDE with prior C++ research for component compatibility [8]. After the hardware assembly, the microcontrollers were coded to process sensor inputs and trigger alerts. The circuit was tested for accurate motion detection and response. A PCB was designed using Proteus software [9] and fabricated at the UiTM Dungun PCB lab. Final testing confirmed system functionality, with the circuit secured within the prototype. This structured approach enabled the successful development of the automated Wild Animal Safety Fence with real-time monitoring and alerts.

A. System Design and Integration

The system uses a PIR sensor for motion detection and an SW-420 accelerometer for vibration detection, triggering the spotlight, alarm, emergency light, and mobile alerts when activity is detected.

B. Project Flowchart

The flowchart in Figure 1 illustrates the sequence of operations in an automated alert system, integrating motion and vibration sensors with microcontrollers for real-time monitoring and response.

The process begins at the Start point, initiating the system's readiness to detect disturbances. Two types of sensors are employed: the PIR motion sensor and the SW-420 vibration sensor. If the motion sensor detects movement, it sends a signal to the Arduino microcontroller, which then activates two responses: turning on the spotlight to illuminate the area and triggering the emergency light and alarm to provide visual and auditory warnings.

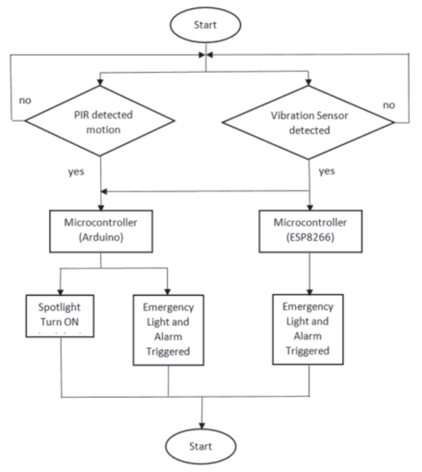

Figure 1: Flowchart of the Wild Animal Safety Fence

Simultaneously, if the vibration sensor detects physical disturbances, it transmits a signal to the ESP8266 microcontroller, which processes the input and sends a notification to the user's phone via a wireless network. Both detection pathways converge at the end point, ensuring that all necessary alerts have been activated. This structured approach enhances security by combining on-site visual and audible alerts with remote notifications, ensuring immediate awareness and response to potential threats.

III. Results and Discussion

The development of the Wild Animal Safety Fence successfully meets its objective of designing and constructing a smart monitoring system to prevent animal intrusion. This system utilizes a motion sensor as its primary input. When a wild animal approaches the fenced area, the sensor detects its presence and transmits the data to the Arduino UNO microcontroller. In response, the system activates its first output, illuminating the fence lights, as shown in the corresponding figure. The bright lighting serves a dual purpose which are deterring the approaching animal and providing enhanced visibility for individuals within the protected area to observe the animal outside the fence.

A. Hardware Implementation

Figure 2 showcases the electronic circuit assembled on a breadboard, consisting of multiple interconnected components such as a relay module, microcontroller, LEDs, and jumper wires. The illuminated LED and active relay module indicate that the circuit is powered and functioning. This setup represents the initial hardware testing phase, where the connections and coding logic are verified before integrating the system into the final prototype.

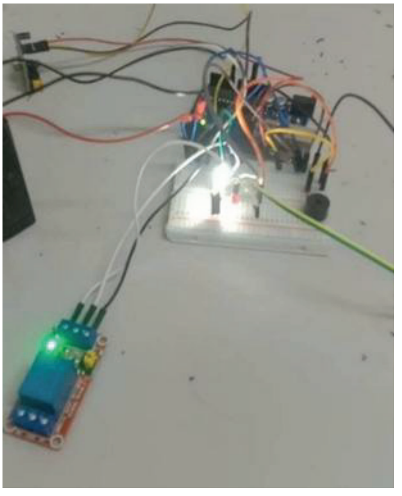

Figure 2: Hardware Implementation of the circuit

Figure 3(a) illustrates a 3D model of the circuit design, developed using TinkerCAD to visualize the arrangement of components before physical assembly. It features an Arduino microcontroller, a PIR motion sensor, and LED indicators representing system alerts. This virtual design ensures proper component placement and circuit functionality before implementation.

Meanwhile, Figure 3(b) presents the physical prototype, constructed using a cardboard enclosure to house the internal components securely. The exterior features a PIR motion sensor, an LED indicator, and an emergency alert system, designed to detect motion and trigger the appropriate response. The white circular element likely represents an output device, activated when an intrusion is detected. This prototype serves as a functional demonstration of the proposed system in real-world applications.

(a) (b)

Figure 3: (a) The 3D Model of the Circuit Design, (b) Prototype Implementation of the Wild Animal Safety Fence

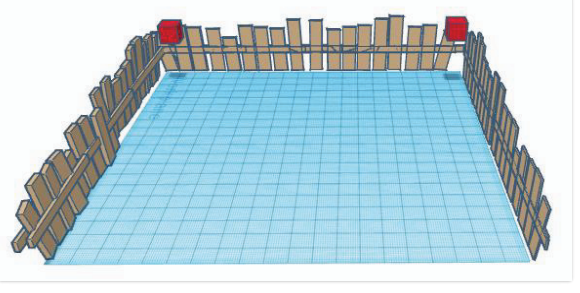

Figure 4: Hardware Implementation of the Circuit

Figure 4 illustrates the prototype positioning within a simulated environment using TinkerCAD. The design represents a fenced area equipped with security components, strategically placed to detect intrusions. The red devices mounted on the fence corners likely symbolize alarm indicators or sensors, which play a crucial role in the detection and alert system. This simulation serves as a preliminary model to ensure the effective placement of components before constructing the physical prototype, minimizing design errors and optimizing system performance.

B. Data Analysis

Figure 5 showcases the notification interface when the vibration sensor (SW-420) is triggered within the system. The detection occurs when vibrations are sensed on the fence, indicating possible movement or interference, such as the presence of a wild animal. The system is designed to process this data using two microcontrollers: Arduino Uno R3 and NodeMCU (ESP8266). Upon activation, the Arduino Uno R3 initiates two primary responses:

- Emergency light activation to ensure immediate visibility of the disturbance.
- Alarm triggering to alert individuals nearby to potential threats.

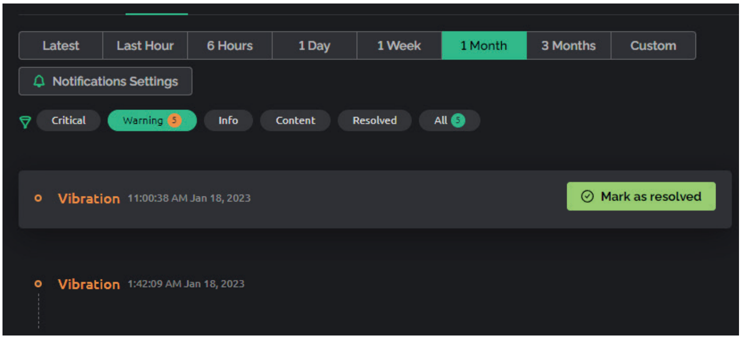

Figure 5: The Notification Interface

Simultaneously, the NodeMCU (ESP8266) processes the event by sending a notification to the user's smartphone via the Blynk application, as depicted in the figure. This feature allows remote monitoring, ensuring that users stay informed about any suspicious activity around the fenced area. The integration of these components provides an effective real-time monitoring system, enhancing security and awareness.

To evaluate the effectiveness of the PIR sensor, a series of tests were conducted to determine its detection range and wide-angle coverage. These tests were essential to ensure the sensor's suitability for the project and to verify whether its performance aligned with the expected results. The first test focused on measuring the detection range of the PIR sensor. The results in Table 1 indicate that the sensor could detect movement at distances of 50 cm, 100 cm, 150 cm, 200 cm, 250 cm, and 300 cm, confirming that it remained responsive up to 3 meters.

Table 1: Range Test for PIR Sensor

No.	Detection Range (cm)	Detect (Yes/No)
1	50	Yes
2	100	Yes
3	150	Yes
4	200	Yes
5	250	Yes
6	300	Yes

Table 2: Detection Wide Angle for PIR Sensor

No.	Detection Wide Angle (°)	Detect (Yes/No)
1	90	Yes
2	180	Yes
3	270	No
4	360	No

The second test assessed the wide-angle detection capability of the PIR sensor. The findings in Table 2 showed that the sensor successfully detected motion at 90° and 180°. However, when tested at 270° and 360°, it failed to detect any movement, indicating that its maximum effective coverage angle is 180°. From these results, it can be concluded that the PIR sensor is suitable for the project, as it offers a detection range of more than 3 meters and a wide-angle coverage of 180°, making it reliable for motion-sensing applications.

IV. Conclusion and Recommendations

In conclusion, the Wild Animal Safety Fence serves as an effective alert and safety system designed to prevent wild animal encroachments. This system integrates two microcontrollers, Arduino UNO R3 and Node MCU, to ensure efficient monitoring and notification. By utilizing real-time alerts, property owners can be immediately informed of any disturbances through notifications on their mobile devices. This project is highly beneficial as it helps reduce the risk of human-wildlife conflicts while also preventing potential property damage. The implementation of this system is expected to enhance safety measures and provide significant advantages to communities facing frequent wild animal intrusions.

To enhance this project's effectiveness, several improvements can be made. Adding a camera module would enable real-time video monitoring, allowing users to visually inspect activity around the fence. Utilizing NodeMCU's IoT functionality, a remote-control system via a mobile app can be implemented, improving usability and accessibility. Additionally, upgrading the alert system by replacing the piezo buzzer and red LED with a louder alarm and brighter emergency lights would ensure alerts are more noticeable. Although these enhancements may increase costs, they would significantly improve the system's reliability and efficiency, making it a more robust, practical, and user-friendly safety solution for preventing wildlife intrusions effectively while maintaining ease of monitoring and control.

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VI. References

[1] G. Bhushal, B. Wolde, and P. Lal, "Human-wildlife conflict and the likelihood of reporting losses in Nepal," *Trees, Forests and People*, vol. 15, 2024.

[2] D. Oman Zumo, "Human-Wildlife Conflicts in Africa: A Preliminary Review," *International Journal of Environmental Sciences*, vol. 13, no. 1, pp. 6-14, 2024.

[3] S. J. Cabral de Mel et al., "Current and Future Approaches to Mitigate Conflict between Humans and Asian Elephants: The Potential Use of Aversive Geofencing Devices," *Animals*, vol. 12, no. 21, 2022.

[4] J. Schillings, C. Holohan, F. Lively, G. Arnott, and T. Russell, "The potential of virtual fencing technology to facilitate sustainable livestock grazing management," *Animal*, vol. 18, no. 8, 2024.

[5] S. A. Akinwumi, A. C. Ezenwosu, T. V. Omotosho, O. O. Adewoyin, T. A. Adagunodo, and K. D. Oyeyemi, "Arduino Based Security System using Passive Infrared (PIR) Motion Sensor," in *IOP Conference Series: Earth and Environmental Science*, vol. 655, 2021.

[6] M. A. Hailan, B. M. Albaker, and M. S. Alwan, "Transformation to a smart factory using NodeMCU with Blynk platform," *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 30, no. 1, pp. 237-245, 2023.

[7] Abel Uzoka, Emmanuel Cadet, and Pascal Ugochukwu Ojukwu, "The role of telecommunications in enabling Internet of Things (IoT) connectivity and applications," *Comprehensive Research and Reviews in Science and Technology*, vol. 2, no. 2, pp. 055-073, 2024.

[8] G. P. Fernandez and C. Cossio-Mercado, "AeIE: A Versatile Tool for Teaching Programming and Robotics Using Arduino," in Proceedings 2024, *50th Latin American Computing Conference, CLEI 2024*, pp. 1-10, 2024.

[9] M. T. Khatun et al., "Study of CNC System for PCB Design using Proteus," *International Journal of Advanced Trends in Computer Science and Engineering*, vol. 10, no. 1, pp. 101-105, 2021.