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IoT Based Home Security: Experimental Prototype Case Study Using ESP32 And Arduino IoT Cloud

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Abstract: The prototype smart home security system experimented by using ESP32 micro-controller and the Arduino IoT Cloud platform. The system likely aims to provide real-time security monitoring, potentially including alerts for intruders. The cloud may be used to send data to a smartphone app for remote monitoring and control. The ESP32 micro-controller integrates Wi-Fi and Bluetooth connectivity, making it easy to connect to the internet and control remotely. The Arduino IOT cloud platform provides a simplified way to connect devices to the cloud, allowing for remote monitoring, control, and data logging comparing to other cloud platforms. The system uses PIR sensor to detect motion that could indicate a potential security breach. The project is a prototype, indicating that it is an experimental implementation of the smart home security system.

Index Terms **- PIR, Arduino IoT cloud, web interface, mobile-interface, sensitivity, time delay.**

I. INTRODUCTION

This case study explores an experimental smart home security prototype utilizing ESP32 micro-controller and the Arduino IoT Cloud platform for real-time data transmission and control. The goal is to demonstrate the feasibility and benefits of integrating these technologies for building a smart home security system. ESP32 boards, with their integrated Wi-Fi and Bluetooth capabilities, serve as the core of the security system. They are responsible for sensor data acquisition, processing, and communication with the Arduino IoT Cloud. This cloud platform provides a user-friendly interface for managing and monitoring the security system remotely. It allows for real-time data visualization, control, and alerts.

The prototype includes sensor for motion detection. The sensor is connected to the ESP32, and their data is transmitted to the Arduino IoT Cloud. Users can remotely monitor the security status and control certain aspects of the system, such as turning on/off alarms or adjusting sensor sensitivity, through the Arduino IoT Cloud dashboard. In case of security breaches, the system can trigger alerts (e.g., push notifications to a mobile app) and potentially activate an alarm. ESP32 and Arduino IoT Cloud are relatively inexpensive and widely available, making them a practical choice for home security projects.

The Arduino IDE and the Arduino IoT Cloud platform simplify the development process, allowing for rapid prototyping and deployment [1][2][3]. The system can be easily scaled to include more sensors and features as needed. This prototype aims to demonstrate the power and potential of using IoT technologies for building a smart home security system that is both effective and accessible.

II. Proposed System Components

2.1. ESP32 Micro Controller

The ESP32 (Fig.1) combines the micro-controller (CPU), memory, and peripherals into a single chip, simplifying design and reducing component count. Built-in Wi-Fi and Bluetooth (including Bluetooth Low Energy - BLE) enable wireless communication for connecting to networks, devices, and the cloud. The ESP32 finds use in a wide range of applications, including IoT devices, home automation, robotics, and educational projects [4] [5].

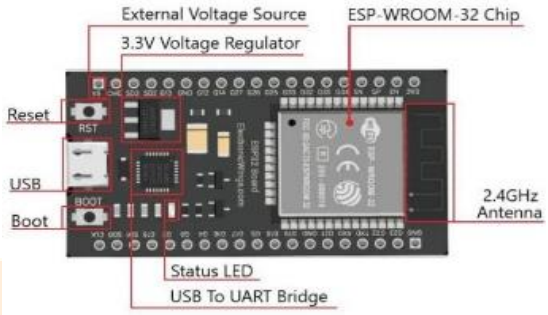

Fig. 1 ESP Micro-controller

The ESP32 is known for its low cost and low power consumption, making it suitable for battery-powered devices and cost-sensitive applications [6]. ESP32 modules and development boards provide easy access to the chip's features and capabilities, facilitating prototyping and development.

2.2. PIR Sensor Module

PIR sensors (Fig.2) are designed to detect infrared radiation [7] [8], which is the heat emitted by objects, including humans and animals. The sensor's key component is a pair of slots, each containing a material sensitive to infrared radiation. When a moving object enters the field of view, the infrared radiation changes, causing a differential change in the signal detected by the two slots. This differential change is processed, and the sensor generates an output signal to indicate motion has been detected. They can be part of alarm systems, triggering alarms when motion is detected within the protected area. They can be used to switch on lights automatically when motion is detected, saving energy.

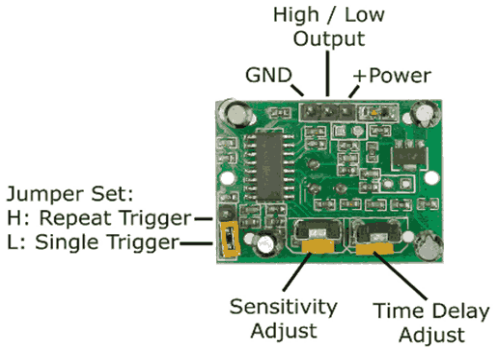

Fig. 2 PIR Sensor

They are also used in various other applications like automatic doors, toys, and more. In PIR (Passive Infrared) sensors, the trigger mode determines how the output reacts to motion detection. Single trigger mode (Fig. 3) outputs a high signal only once when motion is detected, then goes low after a delay, regardless of continued motion. Multiple (or repeatable) trigger mode (Fig. 4) keeps the output high as long as motion continues, resetting the delay with each new detection.

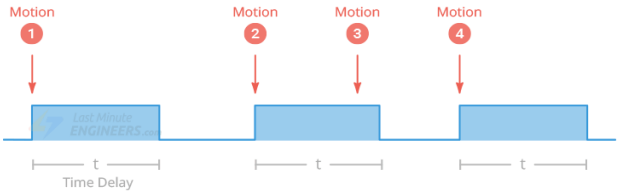

Fig. 3 PIR Single trigger

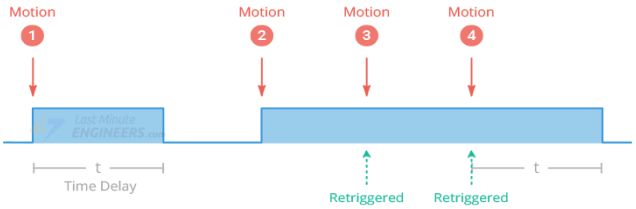

Fig. 4 PIR Sensor multiple triggers

2.3. Arduino IoT Cloud Platform

Arduino IoT Cloud is a platform that makes it easy to create, monitor, and manage connected IoT projects. It provides tools for programming Arduino boards, visualizing data, and controlling devices remotely, all from a web-based interface and a mobile app. A cloud service for synchronizing data from Arduino boards and other devices. A customizable dashboard for visualizing data from your IoT devices and controlling them. A companion app for controlling and monitoring your IoT projects from your mobile device. A REST API for automating tasks and integrating with other systems. The ability to update the firmware on your Arduino boards remotely. Arduino IoT Cloud handles the backend for you, so you can focus on your project. The platform can handle a wide range of IoT projects, from simple sensors to complex automation systems. The platform uses secure connections and encryption to protect your data.

2.4. IoT Cloud Remote App

The Arduino IoT Cloud Remote app [9] is a free mobile application that allows users to remotely monitor and control their projects from smartphones. It enables real-time data visualization and control of devices through custom dashboards, widgets, and features like push notifications. The dashboard created in the cloud platform can be used to visualize data and control devices.

III. PROPOSED SYSTEM WORKING

The block diagram IOT-based home security system as shown in Fig.5. The system would collect data from sensors, transmit it to the Arduino IoT Cloud, and allow the user to remotely view the data, adjust system settings, and control actuators based on the data received.

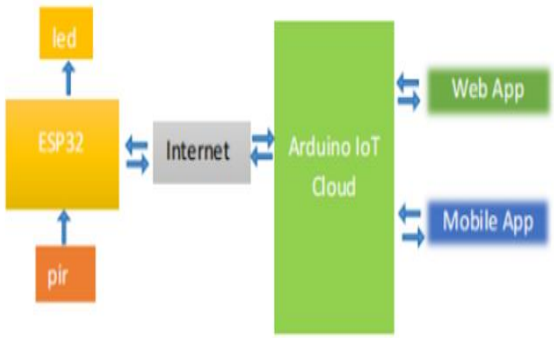

Fig. 5 IoT Based Home Security System

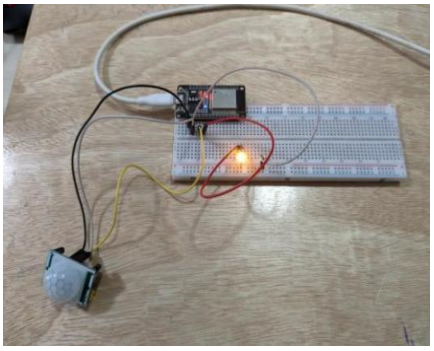

Fig. 6 Wiring of the System

The connections and execution of the system as shown in Fig. 6. At the site, if the sensor detects the human being, the LED will ON, otherwise OFF. The display of detection of human being is verified by the web-dashboard as well as mobile phone dashboard as shown in the Fig. 7 & Fig. 8.

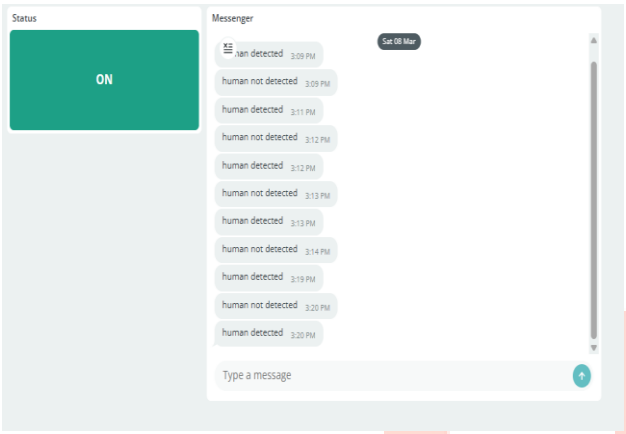

Fig. 7 Web – Dashboard

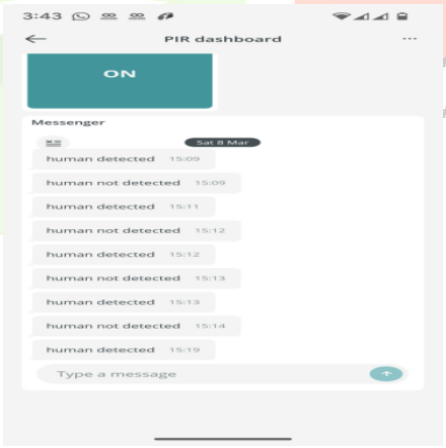

Fig. 8 Mobile Phone – Dashboard

The sensor distance sensitivity i.e., distance coverage and time delay sensitivity i.e., response duration has been verified by varying the sensor controls.

IV. SKETCH

```
#include "arduino_secrets.h"
#include "thingProperties.h"
#define pirpin 2
#define ledpin 4
void setup() {
   Serial.begin(9600);
   delay(1500);
   pinMode(pirpin,INPUT);
   pinMode(ledpin,OUTPUT);
   initProperties();
   ArduinoCloud.begin(ArduinoIoTPreferredConnection);
   setDebugMessageLevel(2);
   ArduinoCloud.printDebugInfo();
}
void loop(){
   ArduinoCloud.update();
   pirsensor=digitalRead(pirpin);
   if(pirsensor) {
      msg="human detected";
      digitalWrite(ledpin,HIGH);
      status=HIGH;
   } else {
      digitalWrite(ledpin,LOW);
      msg="human not detected";
      status=LOW;
   }
 }
void onStatusChange() {}
void onMsgChange() {}
```

V. RESULT AND DISCUSSION

An IoT-based home security system prototype utilizing ESP32 and Arduino IoT Cloud can effectively demonstrate the feasibility of remote monitoring and control, offering a secure and convenient solution for home automation. This case study could explore real-time data collection, alert systems, and potentially integrate with other home automation features, showcasing the capabilities of these technologies. The system could log data on the cloud, enabling analysis of security events and potential optimization of the system. The prototype could be designed to integrate with other smart home devices, creating a more comprehensive and interconnected security and automation system. The use of ESP32 and Arduino IoT Cloud can offer a cost-effective approach to building home security systems, making it accessible to a wider range of users.

VI. CONCLUSION AND FUTURE WORK

An IoT-based home security system, utilizing ESP32 and Arduino IOT Cloud, can effectively monitor a home and send alerts in case of intrusion. This approach provides convenience, enhanced security, and energy efficiency for the user. The system can send real-time data and alerts to the user's smartphone or computer, allowing them to monitor their home from anywhere. The development of home security systems based on IoT technology is expected to continue growing and offer more advanced features in the future. The user can then access the data and control the system via a web or mobile app. important to consider the security of the cloud platform and the network connection to ensure the system is reliable and secure. The prototype could be enhanced with features like voice control, facial recognition, and predictive security measures.

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