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IoT Based Anti-Theft Detection and Alarm System Using NodeMCU and Blynk Application

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Abstract *- The purpose of building this system is to prevent the loss of property due to theft that we face in our daily lives. This system includes NodeMCU with Esp8266 Wi-Fi module based on microcontroller, PIR sensor to use the motion detection, ultrasonic sensor to know the distance from the obstacles, buzzer to use the alarm system, Blynk application to use the reporting message and light bulb to illuminate around the environments. When sensor detected the movement of objects, sends a message to phone, lights up the bulb, and then alert alarm because Esp8226 Wi-Fi module is connected to Blynk application. The problems found with existing systems were that they can only identify the intruder after the theft, or cannot distinguish between human and non-human objects. So, this system will be essential for every building because it is not just easy to use but is also inexpensive.*

Keywords: NodeMCU, IoT, Blynk application, PIR sensor, Ultrasonic sensor.

1. INTRODUCTION

In our country, there has been the loss of property every year due to thieves and strangers. Therefore, security is very important [1]. This system is intended to provide security in unsafe places. This is because it is to prevent the loss of important documents and property in offices, departments, classrooms, homes and buildings etc. The key to security is IoT system [2]. The Internet of Things (IoT) describes physical objects (or groups of such objects) with sensors, processing ability, software, and other technologies that connect and exchange data with other devices and systems over the Internet or other communications networks [3]. Internet of things has been considered a misnomer because devices do not need to be connected to the public internet, they only need to be connected to a network and be individually addressable [4]. Traditional fields of embedded systems, wireless sensor networks, control systems, automation (including home and building automation), independently and collectively enable the Internet of things [5]. In the consumer market, IoT technology is most synonymous with products pertaining to the concept of the "smart buildings", including devices and appliances (such as lighting fixtures, thermostats, home security systems, cameras, and other home appliances) [6]. Nowadays, people are creating everything using IoT system because of the advancement of IT technology [7]. The block diagram of anti-theft detection and alarm system is shown in Fig 1.

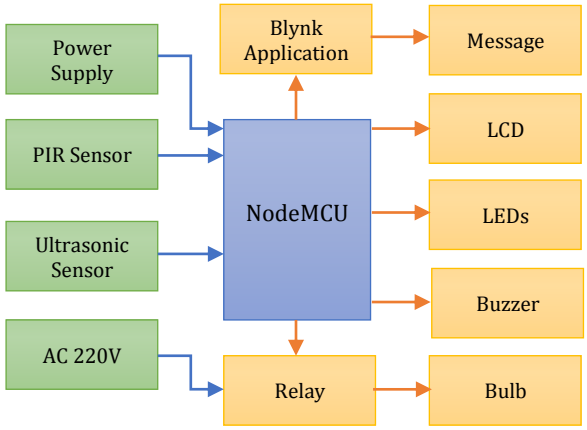

Fig-1: Block diagram of anti-theft detection and alarm system

2. METHODOLOGY

Basically, the design and development of this system are divided into two main parts: hardware architecture and software details. In the hardware architecture, the design of the circuit was constructed and the prototype of the system was built. While in the software development, the whole complete prototype was operated via programming codes.

2.1 Hardware Architecture

NodeMCU

NodeMCU is an open-source development board and firmware based in the widely used ESP8266 - 12E WiFi module as shown in Fig 2. It allows to program the ESP8266 WiFi module with the simple and powerful LUA

programming language or Arduino IDE [8]. With just a few lines of code can establish a WiFi connection and define input/output pins according to needs exactly like arduino, turning your ESP8266 into a web server and a lot more. It is the WiFi equivalent of ethernet module [9]. With its USB-TTL, the nodeMCU Dev board supports directly flashing from USB port. It combines features of WIFI accesspoint and station + microcontroller. These features make the NodeMCU extremly powerful tool for Wifi networking. It can be used as access point and/or NodeMCU Blynk application Relay Bulb Buzzer LCD Message Power Supply IR sensor PIR sensor 9V battery station, host a webserver or connect to internet to fetch or upload data [10].

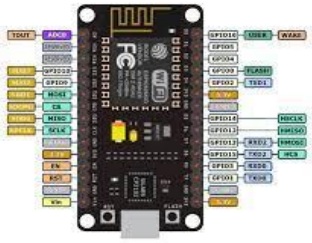

Fig-2: NodeMCU

Internet of things

The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction as shown in Fig 3. A thing in the internet of things can be a person with a heart monitor implant, an automically anti-theft detection and alarm system, an automobile that has built-in sensors to alert the driver when tire pressure is low or any other natural or man-made object that can be assigned an Internet Protocol (IP) address and is able to transfer data over a network. Increasingly, organizations in a variety of industries are using IoT to operate more efficiently, better understand customers to deliver enhanced customer service, improve decision-making and increase the value of the business [11].

Fig-3: Internet of Things

Blynk Application

Blynk was designed for the Internet of Things as shown in Fig 4. It can control hardware remotely, it can display sensor data, it can store data, visualize it and do many other cool things. There are three major components in the platform:

- Blynk App - allows to create amazing interfaces for researches using various widgets.
- Blynk Server - responsible for all the communications between the smartphone and hardware. Our Blynk Cloud can be used or your private Blynk server is locally run. It's open-source, could easily handle thousands of devices and can even be launched on a NodeMCU.
- Blynk Libraries - for all the popular hardware platforms - enable communication with the server and process all the incoming and outcoming commands.

Every time it is pressed a Button in the Blynk app, the message travels to space the Blynk Cloud, where it magically finds its way to hardware. It works the same in the opposite direction and everything happens in a Blynk of an eye.

Fig-4: Blynk Application

PIR Sensor

PIR sensors allow to sense motion, almost always used to detect whether a human has moved in or out of the sensors range as shown in Fig 5. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason, they are commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors. PIRs are basically made of a pyroelectric

sensor (which you can see below as the round metal can with a rectangular crystal in the center), which can detect levels of infrared radiation. Everything emits some low-level radiation, and the hotter something is, the more radiation is emitted. The sensor in a motion detector is actually split in two halves. The reason for that is that someone is looking to detect motion (change) not average IR levels. The two halves are wired up so that they cancel each other out. If one half sees more or less IR radiation than the other, the output will swing high or low.

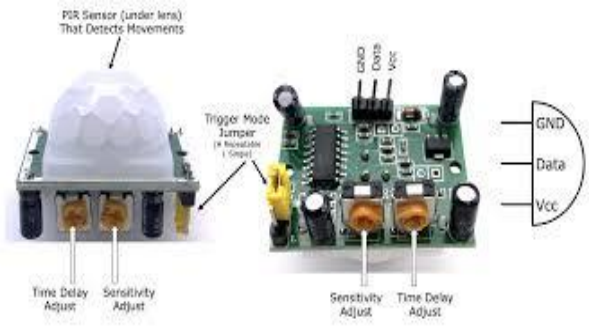

Fig-5: PIR Sensor

Ultrasonic Sensor

An ultrasonic sensor is an electronic device that measures the distance of target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal as shown in Fig 6. Ultrasonic waves travel faster than the speed of audible sound (i.e the sound that humans can hear). Ultrasonic sensors have two main components: the transmitter (which emits the sound using piezoelectric crystals) and the receiver (which encounters the sound after it has travelled to and from the target). In order to calculate the distance between the sensor and the object, the sensor measures the time it takes between the emission of the sound by the transmitter to its contact with the receiver.

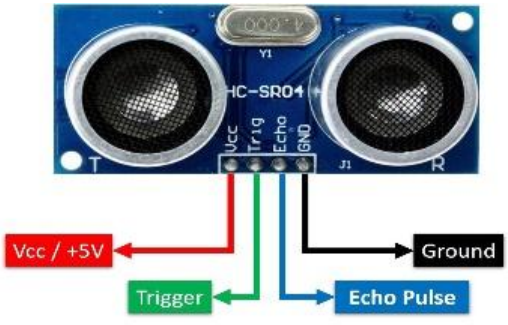

Fig-6: Ultrasonic Sensor

Arduino IDE

The Arduino IDE supports the languages C using special rules of code structuring as shown in Fig 7. It supplies a software library which provides common input and output procedures for wiring projects. It requires only two basic functions that is for starting the sketch and the main program loop. They are compiled and linked with a program stub main() into an executable cyclic executive program. Then, it employs the program to convert the executable code into a text file in hexadecimal encoding. That is text file is loaded into the microcontroller by a loader program in the board's firmware.

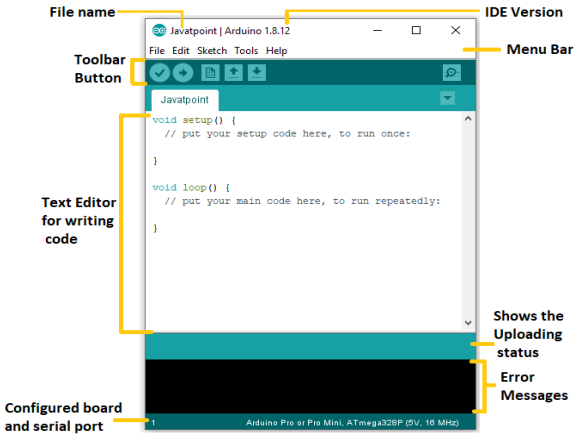

Fig-7: Arduino IDE

2.2 Software Architecture

In this work, the program is written in NodeMCU Lua program language. It must use Arduino software (IDE) version (1.8.19). This software is an open software. The code will be written on this software and it will be upload to NodeMCU board. The NodeMCU board always change to adapt to new needs and challenges and it's offer simple 8-bit boards to product for IoT applications, wearable, 3D printing and embedded environment. The program of microcontroller reads the program and sends the data to the indicator LCD display and Blynk application. Blynk is a platform with ios and android applications to control NodeMCU, Arduino, Rasberry Pi and the others over the internet. After connecting microcontroller USB via into computer, it will choose and port. Then it will compile and upload the program. The flowchart of the system is shown in Fig 8.

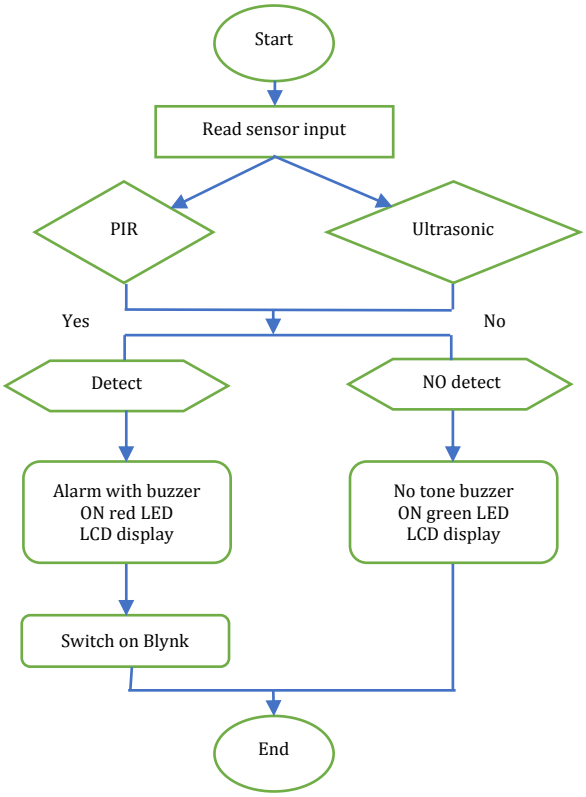

Fig-8: Flow chart of the system

3. OPERATING SYSTEM

This system includes NodeMCU Esp8266 Wi-Fi module, PIR sensor, Ultrasonic sensor, LCD, Buzzer, Blynk application, relay and bulb. NodeMCU is a board based on the microcontroller with the Wi-Fi module. The microcontroller will be commanded using Lua programming language. The Lua programming language must be written in Arduino IDE and then command the microcontroller on the NodeMCU. In this system, PIR sensor is used to detect the movement. PIR sensors have ranges of up to 3.3 meters (10 feet), and then Ultrasonic sensors are good for detection between 2cm-400cm (13 feet). In this work, Blynk application is used to send notifications on the phone when the movement occurs. At the same time, existence of the movements will be notified as well on the LCD display, even if a notification message is not received due to phone error. The buzzer will alert alarm as soon as the motion is detected. The Bulb connected to relay is used to detect the movement at night. The operating voltage of the NodeMCU is 3.3V, but the input voltage must be supplied between 4.4V and 10V. Therefore, 5V power supply must be set up to provide the required voltage. As soon as the sensors detect the movements, the data are sent to the microcontroller on the NodeMCU. The notification message is sent on the phone by the Blynk application after the microcontroller had registered the movements, and then the buzzer will also sound alarm and LCD also displays the movements, and the bulb will also light in this time. The completed circuit of the system is shown in Fig 9.

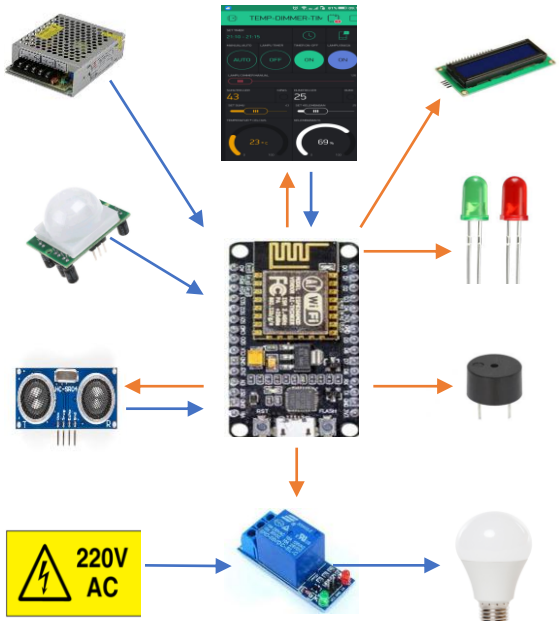

Fig-9: Completed circuit of the system

4. EXPERIMENTAL RESULTS

Three types of the organisms (human, cat, dog) are considered as an obstacle; as stated in previous section; due to their popularity in many applications. The obtained results for each organism are shown in tables and figures to clearly focus on the difference of two sensors to conclude the detection of movements.

Table-1: Experimental Results (human)

Sensors	Distances (cm)	Detection/ No detection
PIR	50	Detect
	100	Detect
	150	Detect
	200	Detect
	250	Detect
	300	Detect
	350	No detect
Ultrasonic	60	Detect
	120	Detect
	180	Detect
	240	Detect
	300	Detect
	380	Detect
	402	No detect

Fig-10: The condition that detected the human

Table-2: Experimental Results (cat)

Sensors	Distances (cm)	Detection/ No detection
PIR	50	Detect
	100	Detect
	150	Detect
	200	Detect
	250	Detect
	300	Detect
	350	No detect
Ultrasonic	60	Detect
	120	Detect
	180	Detect
	240	Detect
	300	Detect
	380	Detect
	402	No detect

Fig-11: The condition that detected the cat

Table-3: Experimental Results (dog)

Sensors	Distances (cm)	Detection/ No detection
PIR	50	Detect
	100	Detect
	150	Detect
	200	Detect
	250	Detect
	300	Detect
	350	No detect
Ultrasonic	60	Detect
	120	Detect
	180	Detect
	240	Detect
	300	Detect
	380	Detect
	402	No detect

Fig-12: The condition that detected the dog

5. CONCLUSION

The research on this system mainly focused on solving the security problems. It is hoped that it will help people across the country reduce theft. It has provided a novel wireless sensing system for the surveillance and detection of a human intruder as well as instant notification of the intrusion to prevent theft. This system is suitable for small personal area surveillance, i.e., offices, departments, classrooms, homes and buildings. The main advantage of the system is easy to use, low cost with high quality. New research challenges of security and privacy have arisen due to an increase in products that connect the cyber and physical worlds. It is expected that these research problems will be further resolved in the upcoming future.

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