

DESIGN OF IOT BASED LOW COST RODENT REPELLING DEVICE USING ULTRASONIC FREQUENCY

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Abstract—Rat is one of the most common rodent species around the world. Even-though it is small in size it causes several damages. Many people have problem with rats in agricultural fields, storage areas, households, offices, home appliances and even in automobiles. They eat the crop, contaminate the stored food and spread dangerous diseases to people and livestock. They cause damages to wires and other parts in automobile and household appliances. Even it causes damages to paper works in offices, cloth materials in textile industries etc. This project aims to create an ultrasonic repelling device using Arduino and IR sensor, and also a buzzer is added to warn the user about the intruding of rats. The Prototype detect the rat using IR sensor and scare the rats away by emitting a high frequency ultrasonic wave and also an intrusion is notified to the user mobile through WIFI module. The whole prototype is enabled through the mobile application only whenever we required.

Keywords—Rat, Infrared sensor, Ultrasonic frequency, Notification

I. INTRODUCTION

Rats are the most destructive pest all over the world in various fields. Increasing rat population is one of the major reasons for reduced crop yields and causes farmers to suffer heavy losses because they started to invade the field even from the initial stage and it continues to destruct it till the end. Farmers mostly uses a trapping technique which involve manual labor and it is very expensive [1]. Rat not only destroy the agricultural field, it also invade the storage areas once the yields of the agriculture are harvested and stored. This is the main issues in most of the government food storage warehouses because they store vast amount of food items for public distribution system (PDS) and also to help people during natural calamities. Rats can consume the stored food items and also contaminate the goods with their urine and feces [2]. The damages caused by rats not only limited to agriculture, it can also affect the Human health in various ways. Rat bite or scratches even their uring and dropping can cause several bacterial and some viral infection to Humans. They are known to spread over 35 diseases and the most common and dangerous diseases include salmonella,

hantavirus, tularemia, choriomeningitis (LCMV), leptospirosis and lymphocytic [3]. Another major problem caused by rats are in the automobiles and household appliances. Rats mostly during their breeding and reproduction season choose automobile engines and home appliances as their nest because of their internal compact structures. Generally the teeth of the rats are constantly growing which they get rid of them by grinding their teeth by chewing anything on regular basis. So when they are inside the engines or appliances, it starts to chew on the wires in order to get rid of the pain because of the growth in teeth and also to keep their teeth in great shape [4]. The damages caused by rat on agricultural field area easily found because of the open field area. But the damages caused in automobile parts and appliances are bit hard to notify because of their moulded designs. They can only be found when there is any technical issues appear when they are powered up. Sometimes those little damages they done in electrical wires can led to malfunctioning or even complete damage to the appliances and also it even led to the electrical sparking which in turn cause fire. In whatever causes, the damages they create can bring greater suffer to the Human beings. This project aimed to design a low cost IOT based repelling device which scares the rat away by generating a high frequency ultrasonic wave and also a notification is send to the user mobile about the intrusion of rat. This prototype is mostly used during night time because the rodent activity are high during that time. The device generates the high frequency wave only after a motion is detected and the whole set up is enabled and disabled through the mobile app whenever it required which reduces power consumption because it will not generate ultrasonic sound continuously.

II. LITERATURE SURVEY

Budi A et al., [3], proposes a system that pulls bells producing sound to repel birds and controls the buzzer to repel rice field pests, birds and mouse using the Arduino ATmega 2560 which will regulate the performance of sensors and servo motors as a mechanical system

Ross et al., [9], proposes a system called, RatSpy, a visual, low-power bait station monitoring system which wirelessly reports both on bait station levels and intruders entering the bait station to a

custom designed cloud platform which reducing manual labour, improving scalability and data about the pest in field .

M. A. M. Fisol and W. M. Jubadi , [4] , proposes an ultrasonic repelling device has been developed to solve the problem in controlling the population of rats and scared them away from entering paddy field by using Passive Infrared Sensor (PIR) to detect the motion of rat and then emits high frequency ultrasonic wave to expel intruding rats away.

C. Cambra et al., [2] , proposes the design of a smart IoT communication system for detecting rodents . The movements of rodents and the trapping estimation for periodical dates on each company or selected area can be remotely monitored by accessing to the multimedia platform through mobile phone or via computer Matikainen-Ankney et al., [6] , present a simple PIR-based activity logger, the rodent activity detector (RAD) which is a low cost and simple design , ideal for activity monitoring in high-throughput experiments and multi-site studies

III. PROPOSED WORK

The proposed project senses the motion of rodents using a PIR sensor , and once the motion is detected it starts generating high frequency ultrasonic wave of about 65 KHZ which disturbs and scares the rat away and also a notification is send to the mobile once the motion is detected . In addition to the ultrasonic frequency generator , an active buzzer is also used to produces a warning sound to alert the user about the intrusion of rodents .The prototype uses NodeMCU WIFI module which sends notification to the user mobile once motion is detected . In this project , even though the supply is given to the whole hardware setup initially , it is in idle state until it was enabled through the mobile app which reduces both the power consumption and an unwanted motion detection of humans in that area . once the humans are settled for night time sleep , the prototype is enabled , it started to sense the area for any motion detection.

A. Overall system setup

The overall system setup is shown in Figure 1.



Fig (1).Overall system setup

B. Block diagram

Figure 2 shows the block diagram of IOT based repelling device which consists of NodeMCU , Arduino Nano , PIR sensor and Buzzer modules .

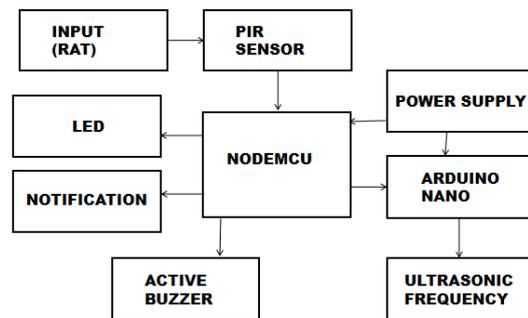


Fig (2) . Overall Block Diagram

C. Block Diagram Description

NodeMCU is an open-source IoT platform , which is a Microcontroller unit with WIFI capability . Here PIR sensor,LED , active buzzer all are connected to the NodeMCU . And another microcontroller unit Arduino Nano is also used which is attached to PIR sensor . Passive buzzer module is attached to the Arduino Nano . In this setup even though a power supply is given , sensor does not start sensing until it will be enabled through the mobile app which reduces the power consumption . Once the setup is enabled , PIR starts to sense the surrounding area for any motion of rodents . when rodent comes into the FoV of the sensor , passive buzzer attached to the Arduino Nano started to generate high frequency ultrasonic frequency which disturb the rodent and scare away it . And also once the motion is detected ,

Microcontroller	32-bit ESP-8266
Clock frequency	80 MHz
Internal RAM	128KB
Flash	4MB
Operating voltage	3V to 3.6V
Digital IO Pins	11
Analog in pins	1

NodeMCU send a notification to the mobile app and an active buzzer produce beep sound to alert the user .

This project uses passive buzzer module to generate High frequency ultrasonic frequency . We can't produce ultrasonic frequency using NodeMCU so Arduino Nano is used to generate the desired frequency using passive buzzer module . Once the motion is detected , NodeMCU sends a trigger signal to the Arduino Nano which in turn using passive buzzer module generate an high frequency ultrasonic

Microcontroller	ATmega328
Clock frequency	16 MHz
SRAM	2KB
Flash	32 KB (2KB for Bootloader)
EEPROM	1KB
Operating voltage	7 V to 12 V
Digital IO Pins	22 (6 PWM)
Analog in pins	8

frequency to scare the rat away from that surroundings .

IV. HARDWARE AND SOFTWARE COMPONENTS

The Hardware components used are :

- Generic ESP8266 NodeMCU
- Arduino Nano
- PIR sensor
- Passive buzzer module
- Active Buzzer Module
- LED
- 12V Power supply

The software tools used are :

- Arduino IDE
- Blynk

VI. NodeMCU

NodeMCU is an open source firmware and IoT platform which is built around a very inexpensive System-on-a-Chip (SoC) called the ESP8266 . It integrates 802.11b/g/n HT40 Wi-Fi transceiver so NodeMCU not only connect to the internet , it can also set up a network of its own which allows other devices to connect to directly.The NodeMCU ESP8266 development board comes with the ESP-12E module containing ESP8266 chip having Tensilica Xtensa 32-bit LX106 RISC microprocessor. This microprocessor supports RTOS and operates at 80MHz to 160 MHz adjustable clock frequency . NodeMCU does not have a DC power jack and it can be powered using Micro USB jack and Vin pin8 (External Supply Pin) .It is programmed using Arduino IDE which is an Integrated Development Environment that runs both offline and online .Table 1 shows the specifications of NodeMCU.

Table 1. NodeMCU Specifications

VII. Arduino Nano

The Arduino Nano is a small , complete , and breadboard-friendly board based on the ATmega328 microcontroller . Arduino Nano is the smaller version of Arduino UNO hence both has the same functionalities . It is programmed using Arduino IDE which is an Integrated Development Environment that runs both offline and online.

Table 2. Arduino Nano Specifications

VIII. PIR Sensor

Passive infrared sensor is an electronic sensor which detects the infrared radiation (IR) in its surrounding environment . It uses a pair of pyroelectric sensors which trigger the PIR when the signal difference between these two sensors changes . Most common PIR sensors are comes with fresnel lenses in front of pyroelectric sensors in order improve the field of view of PIR sensor . It has 3 pins : vcc , ground and high/low output . There is an adjustment setup for time delay and sensitivity . It can be powered by supplying an voltage of 5-12 v . The effective range of PIR sensor is about 10 meters (30 feet)

Table 3. Ranges of PIR Sensors

IX. Passive Buzzer Module

Passive buzzer is an electromagnetic speaker which generates a sound signal of different frequencies . Unlike active buzzer , passive buzzer need AC signal to produce sound . Arduino uses tone() function which act as a signal source to generate the sound signal of desired frequency . The sound of the passive buzzer is controlled by varying the input signal . It has 3 pins : Vcc , Ground and I/O . The operating voltage is ranges from 3.3 to 5 Volts .

X. Active Buzzer Module

Active buzzer module is an audio signalling device which consist of piezo-electric buzzer . It has an in-built oscillating source so when a DC voltage is supplied , it generates a single tone independently using an internal oscillator . when the signal is high it produces a sound of approximately 2.5khz . Active buzzer is different from passive buzzer by means of generating a single tone only . It has 3 pins : Vcc , Ground and I/O . The operating voltage of the active buzzer module is 3.3 to 5 volts .

XI. 12 v Power Supply

Arduino Nano is connected to the 12v power supply and through which all other components are powered up . PIR sensor , active buzzer module , passive buzzer module all works on above 5v and hence they can be powered using Arduino Nano 5v output pin . NodeMCU's operating voltage is between 3 v to 3.6 v , since it has an in-built voltage-regulator NodeMCU is also given 5v supply from the Arduino Nano which in turn bring down to 3.3 v by the voltage regulator .

XII. Arduino IDE

To program both the NodeMCU and Arduino Nano , we use Arduino IDE software. The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus.

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension “.ino”. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

Before uploading the sketch, the correct items are selected from the Tools > Board and Tools > Port menus. On Windows, it's probably COM1 or COM2 (for a serial board) or COM4, COM5, COM7, or higher (for a USB board). After the correct serial port and the board is selected, the upload button in the toolbar is pressed. The Arduino software will display a message when the upload is complete, or show an error.

Libraries provide extra functionality for use in sketches, e.g. working with hardware or manipulating data. To use a library in a

SENSOR	MINIMUM RANGE	MAXIMUM RANGE
Indoor passive infrared	25 cm	20 m
Indoor curtain type	25 cm	20 m
Outdoor passive infrared	10 m	150 m
Outdoor passive infrared Curtain detector	10 m	150 m

sketch, the Sketch > Import Library menu is selected. This will insert one or more #include statements at the top of the sketch and compile the library with your sketch. Because libraries are uploaded to the board with your sketch, they increase the amount of space it takes up. If a sketch no longer needs a library, simply delete its #include statements from the top of your code. There is a list of libraries in the reference. Some libraries are included with the Arduino software. Others can be downloaded from a variety of sources or through the Library Manager..

XIII. Blynk

Blynk is a hardware-agnostic IoT platform with white-label mobile apps, private clouds, device management, data analytics, and machine learning. Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, visualize it and do many other cool things. Blynk easily connects 400+ hardware models like Arduino, ESP8266, ESP32, Raspberry Pi and similar MCUs and drag-n-drop IOT mobile apps for iOS and Android in 5 minutes .

V. RESULTS AND DISCUSSIONS

- Until the whole setup is powered up , it is in offline mode. Figure 3 show the offline mode of blynk app

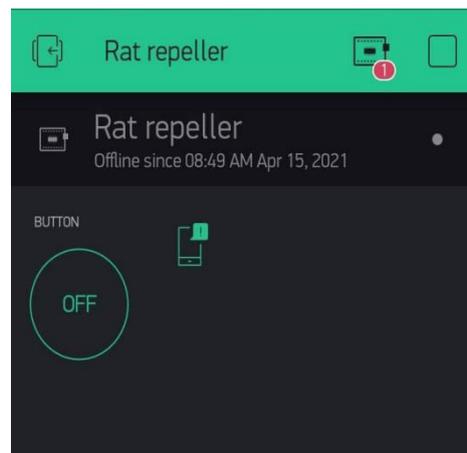


Fig (3) . Offline mode

- Once the setup is powered up , it comes to online mode and NodeMCU connects with the Blynk server . Figure 4 shows the online mode of the blynk app



Fig (4) . Online mode

- Even though Setup is in online mode , it does not start sensing until it is enabled through blynk app
- Once it is enabled , it started to sense the surrounding area for rodent activity and notify when the motion is detected . Figure 5 shows the notification in blynk app when the motion is detected

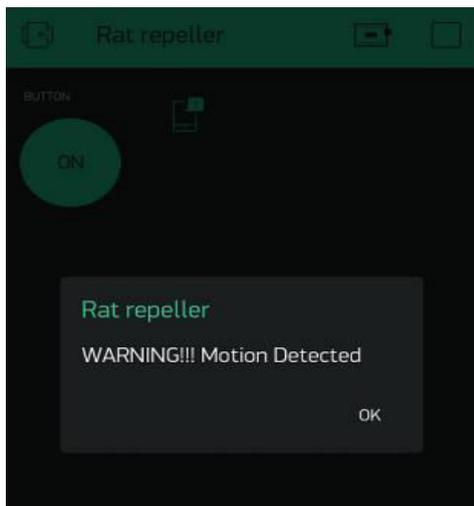


Fig (5) . Motion Notification

VI. CONCLUSION

This work presents the Design of IOT based rodent repelling device in which high frequency ultrasonic sound is produced to scare the rat away from the surrounding area . It reduces the power consumption by enabling the system only when it is required rather than continuous ultrasonic frequency generation like in existing system . And also it send a notification to the mobile about the intrusion of rat . The results are promising since it can be activated

only when it is required and also it can generate ultrasonic frequency only when the motion is detected .

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