DTMF Controlled Fire Fighting Robot

Sarath V. Warrier
Vineeth V.
Joshua Antony Sebastian
Arjun S.
Department of Electronics and Communication
Marian Engineering College

Ajana A.
Asst. Professor
Department of Electronics and Communication
Marian Engineering College

***Abstract*-Generally, robots are programmed to perform specific tasks which humans cannot. To increase the use of robots where conditions are not certain such as fire fighting or rescue operations, robots can be made which follow the instruction of human operator and perform the task. In this way decisions are taken according to the working conditions by the operator and the task is performed by the robots. Thus, we can use these robots to perform those tasks that may be harmful for humans. This project describes about the DTMF controlled robot which can be controlled to function as a fire extinguisher. It consists of mainly two parts, one is transmitter part and another is receiver part. Here RF transceiver for communication between the devices. The transmitter will transmit the signal and the receiver will receive the signal and make the robot move in respective direction. Here, the program is designed by using Embedded C programming.**

1. INTRODUCTION

In recent years, robotics is a current emerging technology in the field of science. A number of universities in the world are developing new things in this field. Robotics is the new booming field, which will be of great use to society in the coming years. Though robots can be a replacement to humans, they still need to be controlled by humans itself. Robots can be wired or wireless, both having a controller device. Both have pros and cons associated with them. Beyond controlling the robotic system through physical devices, recent method of DTMF control has become very popular. The main purpose of using DTMF is that it provides a more natural way of controlling and provides a rich and intuitive form of interaction with the robotic system. These days many types of wireless robots are being developed and are put to varied applications and uses. DTMF controls are easier and with the help of wireless communication, it is easier to interact with the robot in a friendly way. The robot moves depending on the codes pressed from a distance. The objective of this paper is to build a wireless DTMF control robot using Microcontroller, RF transceiver module.

Here our robot is designed to be The Fire Fighting Robot, which will search for a fire in a small floor plan of a house of the specific dimensions using a camera attached, extinguish the fire with the help of the fire extinguisher and returns back to its operator.

The fire fighting robot designed by us is an amateur attempt at creating a moving machine, to aid us in fighting the emergency of fire. When fire occurs in buildings, factories or any other closed spaces, fighting it is quite risky for us as one may get trapped in such closed spaces. In such cases, a robot, on the lines as designed by us, can be very efficiently used for fire fighting, with least risky human intervention.

The fire fighting robot made under this project can move in both forward and reverse directions and can turn in both left and right directions. The movement of the robot is controlled by using mobile phones, i.e., using a radio link. Thus we can operate the robot over a very long distance and there is no need for humans to go even near the area on fire. We use a smoke/fire sensor for the detection of fire. It is a highly sensitive device and is capable of detecting small fires too. The robot accommodates a fire extinguisher on itself to extinguish fire. It has a sense of vision by means of a camera and we can view whatever the robot "sees" on any monitor such as a laptop.

Thus, this robot can move around the place of fire, view the conditions and give us with the exact situation at the place on fire. Then it can be suitably moved around fire, its movements being controlled using the cell phone. It extinguishes fire by triggering the fire extinguisher. Thus, the fire fighting robot provides a safe means to fight fire, without any risk to human life.

Also our robot switches of the main supply one the robot is powered up. As many fire tends to get worse with the availability of high current. Also a message will be send to the owner and the fire safety department of the city, alerting them with the address.

2. PROPOSED METHOD

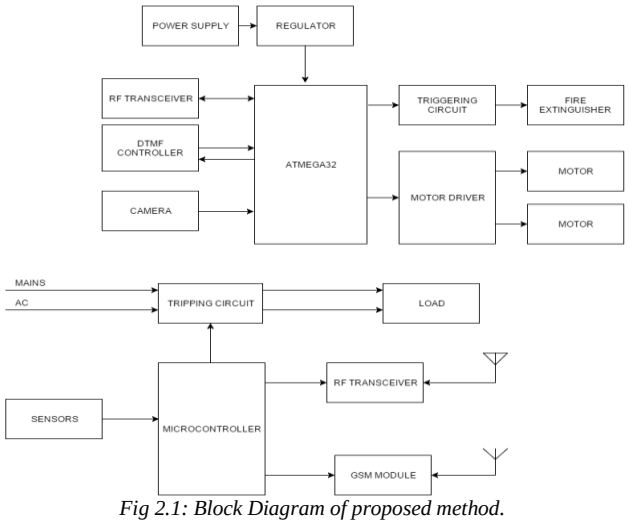

Fig 2.1: Block Diagram of proposed method.

A. *ATMEGA 32*

A microcontroller is a small computer on a single integrated circuit containing a processor core, memory, and programmable input peripherals. Program memory in the form of Ferroelectric RAM, NOR flash or OTP ROM is also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications.

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems.

Some microcontrollers may use four-bit words and operate at clock rate frequencies as low as 4 kHz, for low power consumption (single-digit mill watts or microwatts). They will generally have the ability to retain functionality while waiting for an event such as a button press or other interrupt; power consumption while sleeping (CPU clock and most peripherals off) may be just nano watts, making many of them well suited for long lasting battery applications. Other microcontrollers may serve performance-critical roles, where they may need to act more like a digital signal processor (DSP), with higher clock speeds and power consumption.

While some embedded systems are very sophisticated, many have minimal requirements for memory and program length, with no operating system, and low software complexity. Typical input and output devices include switches, relays, solenoids, LEDs, small or custom LCD displays, radio frequency devices, and sensors for data such as temperature, humidity, light level etc. Embedded systems usually have no keyboard, screen, disks, printers, or other recognizable I/O devices of a personal computer, and may lack human interaction devices of any kind. Micro-controllers may not implement an external address or data bus as they integrate RAM and non-volatile memory on the same chip as the CPU. Using fewer pins, the chip can be placed in a much smaller, cheaper package.

Integrating the memory and other peripherals on a single chip and testing them as a unit increases the cost of that chip, but often results in decreased net cost of the embedded system as a whole. Even if the cost of a CPU that has integrated peripherals is slightly more than the cost of a CPU and external peripherals, having fewer chips typically allows a smaller and cheaper circuit board, and reduces the labor required to assemble and test the circuit board, in addition to tending to decrease the defect rate for the finished assembly.

A micro-controller is a single integrated circuit, commonly with the following features:

- Central processing unit - ranging from small and simple 4-bit processors to complex 32- or 64-bit processors
- Volatile memory (RAM) for data storage
- ROM, EPROM, EEPROM or Flash memory for program and operating parameter storage
- Discrete input and output bits, allowing control or detection of the logic state of an individual package pin
- Serial input/output such as serial ports (UARTs)
- Other serial communications interfaces like I²C, Serial Peripheral Interface and Controller Area Network for system interconnect
- Peripherals such as timers, event counters, PWM generators, and watchdog
- Clock generator - often an oscillator for a quartz timing crystal, resonator or RC circuit
- Many include analog-to-digital converters, some include digital-to-analog converters
- In-circuit programming and debugging support

The microcontroller used here is ATMEGA 32 by ATMEL. The ATMEL AVR ATMEGA is a High-performance, Low-power 8-bit Microcontroller based on the advanced RISC Architecture. By executing powerful instructions in a single clock cycle, the ATMEGA 32 achieves throughputs of up to 16 MIPS at 16MHz, allowing the system designer to optimize powerful consumption versus processing speed. It has 32Kbytes of In-System Self-programmable Flash program memory with 1024 bytes of EEPROM, 2 Kbytes Internal SRAM. It uses JTAG (IEEE std. 1149.1 Compliant) Interface. The ATMEL AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

B. *Power Supply*

Rechargeable batteries were the power supply of choice for the robot. Combined with basic line regulation rechargeable batteries provide clean, reliable power, and allowed reuse of the batteries when depleted. The selection between different types of batteries was made based on size and power requirements. Due to our size constraints, anything larger than AA size batteries would be too large for the robot. However, the batteries must offer enough charge capacity to power the robot for a reasonable amount of time. Starting with the minimum voltage requirements of our linear regulators and working our way down to the current requirements of the motors, we determined our power requirements to include a 7 Volt supply capable of

providing at least 1 Amp of peak current, and 500mA of continuous current

C. ZIGBEE Transceiver

Zigbee is an IEEE 802.15.4-based specification for a suite of high-level communication protocols used to create personal area networks with small, low-power digital radios.

The technology defined by the Zigbee specification is intended to be simpler and less expensive than other wireless personal area networks (WPANs), such as Bluetooth or Wi-Fi. Applications include wireless light switches, electrical meters with in-home-displays, traffic management systems, and other consumer and industrial equipment that require short-range low-rate wireless data transfer.

Its low power consumption limits transmission distances to 10–100 meters line-of-sight, depending on power output and environmental characteristics. Zigbee devices can transmit data over long distances by passing data through a mesh network of intermediate devices to reach more distant ones. Zigbee is typically used in low data rate applications that require long battery life and secure networking (Zigbee networks are secured by 128 bit symmetric encryption keys.) Zigbee has a defined rate of 250 Kbit/s, best suited for intermittent data transmissions from a sensor or input device. Zigbee was conceived in 1998, standardized in 2003, and revised in 2006. The name refers to the waggle dance of honey bees after their return to the beehive.

This transceiver is easy to install, since only one module needs t be hard wired to the control processor. Additional “repeater” modules can be added by simply powering them from any electrical outlet within communication range of other modules. The transceiver units will then create a self-healing “mesh” network which adapts to changes or problems with the communication path.

Features of Zigbee:

- Enables bi-directional Zigbee communication.
- Wireless Zigbee communication range between ZM-24 modules up to 100 feet.
- Connects to central processor from up to 1000 feet away using standard Cat5 cable.
- Create a self-healing mesh network by adding modules configured in “repeater “mode.
- Utilizes IEEE802.1504 wireless Zigbee communication at 2.4 GHz.
- Durable plastic enclosure and adjustable antenna.
- Receives power from an RTI control processor or from the included power supply.
- Easy mounting with a detachable wall bracket.

D. Motor Driver

L293D is a typical Motor driver or Motor Driver IC which is used to drive DC on either direction. It is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC. Dual H-bridge Motor Driver integrated circuit (IC).The L293d can drive small and quiet big motors as well.

It works on the concept of H-bridge. H-bridge is a circuit which allows the high voltage to be flown in either direction. As you know voltage should change its direction to able to rotate the motor in clockwise or anticlockwise direction, hence H-bridge IC are ideal for driving a DC motor using micro-controller

In a single L293d IC there are two H-Bridge circuit inside it which can rotate two dc motor independently. Due to its size it is very much used in robotic application for controlling DC motors. There are two Enable pins on L293d. Pin 1 and pin 9, for being able to drive the motor, the pin 1 and 9 need to be high. For driving the motor with left H-bridge you need to enable pin 1 to high. And for right H-Bridge you need to make the pin 9 to high. If anyone of the either pin1 or pin9 goes low then the motor in the corresponding section will suspend working. It’s like a switch. The 4 input pins for this L293d, pin 2, 7 on the left and pin 15, 10 on the right as shown on the pin diagram. Left input pins will regulate the rotation of motor connected on the left side and right input for motor on the right hand side. The motors are rotated on the basis of the inputs provided at the input pins as LOGIC 1 or LOGIC 0. In simple you need to provide Logic 0 or 1 across the input pins for rotating the motor.

E. Motors

Motors used here is 60RPM 12V DC geared motors. It is very easy to use and available in standard size. It has nut and threads on shaft to easily connect and internal threaded shaft for easily connecting it to wheel.
Features:

- 60RPM 12V DC motors with Gearbox.
- 6mm shaft diameter with internal hole.
- 125gm weight.
- Same size motor available in various rpm.
- 2Kgcm torque
- No load current=60mA (MAX), Load Current=300mA (Max).

F. Camera

In order to give a sense of vision to our robot we will be equipping it with a camera module. The camera is wirelessly connected to a laptop through which the operator can have an idea where the rover is moving.

Wireless security cameras are closed-circuit television (CCTV) cameras that transmit a video and audio signal to a wireless receiver through a radio band. Many wireless security cameras require at least one cable or wire for power; "wireless" refers to the transmission of video/audio. However, some wireless security cameras are battery powered, making the cameras truly wireless from

top to bottom. Wireless cameras are proving very popular among modern security consumers due to their low installation costs (there is no need to run expensive video extension cables) and flexible mounting options; wireless cameras can be mounted/installed in locations previously unavailable to standard wired cameras. In addition to the ease of use and convenience of access, wireless security camera allows users to leverage broadband wireless internet to provide seamless video streaming over internet.

G. DTMF DECODER

DTMF keypad is placed out on a 4 cross 4 matrices, in which each row represents low frequency, each column represents high frequency, with DTMF, each key passed on a phone generates two tones of the specific frequencies one tone is generated from a high frequency tones and low frequency tone. These tones are converted to digital form using DTMF decoder circuit. These codes are the address of the destination which is read and preceded by the computer that connects the caller to the destination. The DTMF decoder circuit used in many electronics projects for better connectivity to control the applications.

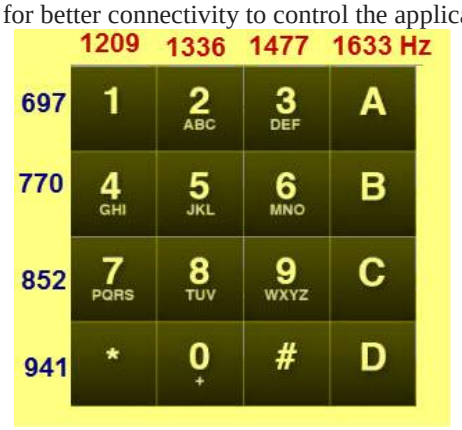

Fig 2.2: DTMF Codes with their frequencies

The decoder IC is an electronics circuit which is consisting of an inbuilt op-amp and to separate low and high frequencies, the output of an operational amplifier is given to the pre-filters. And it passed though the code detector and frequency circuits. The tone which is generated from the mobile is sent through a capacitor and the resistor of the DTMF.

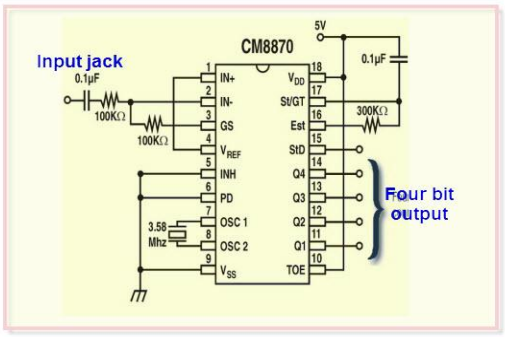

Fig 2.3: Pin Architecture of DTMF

- Pin1 is a non inverting pin, which is connected to the pin 4.
- Pin3 is the output of the operational amplifier, which is feedback to the pin 2.
- The pin 7 and pin 8 is connected to the crystal oscillator of both pins.
- Pin 15 is the data interconnection pin.
- The procedure of the signal from the frequency detection to digitalization is done steering circuit that consists of resistor, capacitors, receiver and transmitter and etc.
- 11, 12 pins are output pins that are connected DTMF pins. Then DTMF is connected to relay.
- Relay output is connected pb0 and pb3 pins of microcontrollers.
- PD0, PD1 are output pins of controller that are connected to the relays.
- Relay output is connected to the load.

H. Sensors

I. Fire Sensor

Fig 2.4: Fire Sensor

A flame detector is a sensor designed to detect and respond to the presence of a flame or fire. Responses to a detected flame depend on the installation, but can include sounding an alarm, deactivating a fuel line (such as a propane or a natural gas line), and activating a fire suppression system.

II. Gas Sensor

A gas detector is a device that detects the presence of gases in an area, often as part of a safety system. This type of equipment is used to detect a gas leak and interface with a control system so a process can be automatically shut down. A gas detector can sound an alarm to operators in the area where the leak is occurring, giving them the opportunity to leave. This type of device is important because there are many gases that can be harmful to organic life, such as humans or animals.

Gas detectors can be used to detect combustible, flammable and toxic gases, and oxygen depletion. This type of device is used widely in industry and can be found in locations, such as on oil rigs, to monitor manufacture processes and emerging technologies such as photovoltaic. They may be used in firefighting.

Gas leak detection is the process of identifying potentially hazardous gas leaks by sensors. These sensors usually employ an audible alarm to alert people when a dangerous gas has been detected. Common sensors include infrared point sensors, ultrasonic sensors, electrochemical gas sensors, and semiconductor sensors. More recently, infrared imaging sensors have come into use. All of these sensors are used for a wide range of applications and can be found in industrial plants, refineries, waste-water treatment facilities, vehicles, and homes.

I. Fire Extinguisher

Inside, a fire extinguisher is quite like a giant aerosol can, often with two different substances inside. One of them is a solid, liquid, or gas substance for fighting the fire. The other one is called a propellant and is a pressurized chemical that makes the fire-fighting substance come out when you press the extinguisher handle. The propellant is stored inside at a high pressure. Strong canisters are needed to stop the extinguishers from exploding.

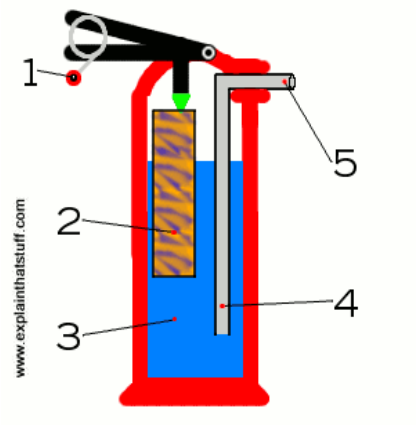

Fig 2.5: Working of Fire Extinguisher

1. A ring or pin on the handle stops the fire extinguisher from being set off by accident. It also acts as a tamper-proof seal.
2. Inside the sturdy steel case, there's a canister containing high-pressure gas.
3. Most of the extinguisher is filled with water.
4. A tube runs right up the inside of the tube to a nozzle outside.
5. The nozzle often ends in a piece of bendy plastic which is easily directed toward the base of fire.
6. To operate the extinguisher, you pull the ring and press the handle.
7. Pressing the handle opens a valve that releases the pressurized gas from the canister.
8. The gas immediately expands and fills the inside of the extinguisher, pushing the water downward
9. As the water is pushed down, it rises up the tube
10. A jet of water emerges from the nozzle.

J. GSM MODULE

GSM (Global System for Mobile) / GPRS (General Packet Radio Service) TTL-Modem is SIM900 Quad-band GSM / GPRS device, works on frequencies 850 MHZ, 900 MHZ, 1800 MHZ and 1900 MHZ. It is very compact in size and easy to use as plug in GSM Modem. The Modem is designed with 3V3 and 5VDC TTL interfacing circuitry, which allows User to directly interface with 5V Microcontrollers (PIC, AVR, Arduino, 8051, etc.) as well as 3V3 Microcontrollers (ARM, ARM Cortex XX, etc.). The baud rate can be configurable from 9600- 115200 bps through AT (Attention) commands. This GSM/GPRS TTL Modem has internal TCP/IP stack to enable User to connect with internet through GPRS feature. It is suitable for SMS as well as DATA transfer application in mobile phone to mobile phone interface. The modem can be interfaced with a Microcontroller using USART (Universal Synchronous Asynchronous Receiver and Transmitter) feature (serial communication).

Features:

- Quad Band GSM/GPRS : 850 / 900 / 1800 / 1900 MHz
- Built in RS232 to TTL or vice versa Logic Converter (MAX232)
- Configurable Baud Rate
- SMA (Sub Miniature version A) connector with GSM L Type Antenna
- Built in SIM (Subscriber Identity Module) Card holder
- Built in Network Status LED
- Inbuilt Powerful TCP / IP (Transfer Control Protocol / Internet Protocol) stack for internet data transfer through GPRS (General Packet Radio Service)
- Audio Interface Connectors (Audio in and Audio out)
- Most Status and Controlling pins are available
- Normal Operation Temperature : -20 °C to +55 °C
- Input Voltage : 5V to 12V DC
- LDB9 connector (Serial Port) provided for easy interfacing

3. APPLICATIONS

DTMF controlled robotic vehicle with wireless surveillance can be used in underground mines and other remote areas where human intervention is impossible. It can also be used in warfare when the range of operation is increased.

When there is a situation of gas leakage from tanks, the fire fighting robot can be used to cool the tank and prevent from bursting. Also if we also attach an arm to the robot it can also be used to pick or place an item.

Since a micro controller is used, it has innumerable future scope. With this technique we can control a car which is parked outside with the help of multiple cameras attached to it. A car can be started remotely and drive it by using the images from the camera. When the frequency range is increased it can transmit up to 1 km which is extremely beneficial.

4. CONCLUSION

5.

In our project we are using DTMF from mobile phones. Here a robotic fire fighting vehicle is wirelessly controlled using the DTMF. Here we use a mobile to control the motion of the vehicle in 'Front', 'Back', 'Right', 'Left'. The same mobile with different code sequence can be used to control the movement of the camera as well as the extinguisher system.

It contains DTMF decoder, Zigbee transceiver, microcontroller, motors etc. For each code pressed by the user the microcontroller senses these codes and perform a certain movement or action.

REFERENCES

[1] Ratnesh Malik, S. S. Kumbhalkar, „Fire Fighting Robot: An Approach", Indian Streams Research Journal, Vol.2, Issue.II/March; 12pp.1-4.
[2] Taiser T. T. Barros, Walter Fetter Lages, „Development of a Firefighting Robot for Educational Competitions", RiE 2012, Prague.
[3] V.J. Lumelsky and A.A. Stepanov, "Path Planning Strategies for a Point Mobile Automaton Moving Amidst Unknown Obstacles of Arbitary Shape", Algorithmica, Vol. 2, No. 4 pp403-430, 1987
[4] Goto, Y. Strntz, A., "Mobile Robot Navigation: The CMU System", IEEE Expert, Vol. 2, No. 4, winter, 1987
[5] Martin, F. Robotic Explorations, a Hands-On Introduction to Engineering, Upper Saddle River, New Jersey: Prentice Hall, 2001.
[6] Ren C. Luo, Kuo L. Su, „Autonomous Fire-Detection System Using Adaptive Sensory Fusion for Intelligent Security Robot", IEEE/ASME Transactions On Mechatronics, VOL. 12, NO. 3, JUNE 2007
[7] Alexander Zelinsky, „A Mobile Robot Navigation Exploration Algorithm", March 2001.
[8] Chia Song-Hiang, Su Hsu-Shan, „Mobile Robots Based Intelligent Fire Detection and Escaping System", October 2012