



Design And Development Of Automatic Fire Fighting Robot Using Arduino

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ABSTRACT

Firefighting is a dangerous yet vital profession, and this research looks at how technology can help. A robot's primary function is to contain a fire before it spreads. Collaborating with firefighters, it could help lessen the likelihood of harm coming to victims. This project showcases the robot that fights fires. There are three main components to a robot's development: hardware, electronics, and programming. The castor wheel and two DC motors make up the robot's driving system. Water suction and spraying are made possible by a 12-volt DC pump. Motor for axial water spraying (SG90 servo).degrees Celsius 0–60A number of sensors can be connected to the Arduino Uno Board. The programming portion involved deriving the robot's movement from sensor input using the Arduino IDE language.

KEYWORDS : Robots, Fire fighters, castor, dc motors, servomotors, and arduino

1.INTRODUCTION

As part of our team's Industrial Systems Design and Integration project, this report details the steps we took to build a robot that could battle fires. In addition to finding and putting out two flames (candlelights), the robot must run autonomously while avoiding obstacles. We have adopted a modular design technique to provide optimal performance with effective implementation. The robot is divided into multiple logical modules based on functionality.

Our design consists of four main modules:

- i. Chief operator
- ii. Management of motor functions
- iii. Managing close quarters
- iv. Smoke detectors

Connected to the master controller, each module has its own set of sensors and microcontroller.

In the two chapters that follow, the project's requirements are detailed. Then, separate sections address the design and execution of each module. At last, the report wraps up by assessing the project.

1.1 PROBLEM DESCRIPTION

The goals of this project are listed below:

- i. It must run automatically
- ii. It must avoid any obstacles present
- iii. It must track and find flames (candle lights) and extinguish them without making direct contact

The entire project must not exceed a budget of Rs. 10000

1.2 OBJECTIVES

- To find fire in the region vulnerable to disasters.
- When fire is detected, it is put out.
- Lowers the amount of devastation and labor effort put out by humans, as well as the harm done to human life.
- To utilize flame sensors to detect fire.
- To automatically put out a fire when one is detected

2. LITERATURE SURVEY

The urgent need for intelligent solutions in dangerous circumstances has sparked substantial academic and corporate interest in autonomous fire-fighting robotics in recent years. Robotic fire suppression systems have benefited from the ground-breaking insights provided by a number of important studies.

Sindhu et al. brought forth an innovative method for simulating the operation of firefighting robots in simulated settings by making use of MATLAB's Virtual Reality Toolbox. Their model had little practical use due to its inability to adapt to real-world environments and lack of interactivity, however it worked well for testing initial algorithms.

Verma et al. built a firefighting robot that uses Arduino to detect flames with infrared and flame sensors. A submersible pump and gear motors allowed the robot to put out fires. Despite its success in putting out fires, the system was lacking in features that required environmental awareness and real-time adaptation, such as the capacity to navigate obstacles or detect gas.

Dr. T. Guhan and colleagues unleashed a fire-fighting robot that could operate sprinklers and detect flames on its own. Despite the robot's impressive fire-detection capabilities, it was not safe to use it in hot conditions due to its lack of flame-retardant structural components.

Ayuni Binti Abd Majid created a robot that can detect fires on its own and is ideal for use in smart buildings. The system's wireless connectivity was enabled via a GSM module and a PIC18F4550 microprocessor. It has three flame sensors that could detect fires and send out notifications through the mobile network. The platform's architecture prioritized alarm production over active fire suppression, notwithstanding its smart capabilities.

2.1 OVERALL DESIGN

We settled on the following design for our robot after team talks and research on prior designs:

Equipped with six sensor panels that can detect flame sources from all directions. Many of the older projects appear to be moving at a snail's pace because they have to pause, turn around to locate the flame, and then keep going in that direction for a brief moment before stopping and spinning around again.

Make use of DC motors or servos.

Make use of infrared sensors to identify closeness

All of the activities that our robot will need to complete are divided up into different parts of the project according to its modular design, as shown in the figure:

Interfacing multiple proximity sensors allows for the detection of objects' presence in a given area.

Building a motor controller that can receive commands and carry them out is what this entails.

We can consistently detect flame sources in a 360-degree fashion by flame tracking, which includes integrating sensors in such a way

Combating fires entails determining the best means of extinguishing them.

Coordination of the aforementioned subunits will be handled by a core unit.

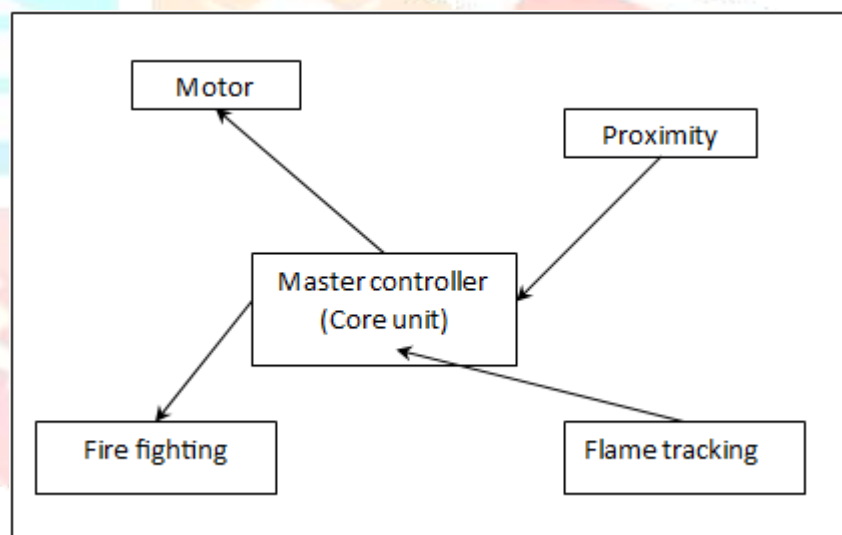


Figure 1.1 Modular design of the robot

There are several benefits to our robot's modular design:

Because we have divided up the work, everyone on the team has a better chance of finishing by the due date.

A single board contains all the components needed for a certain set of sensors, allowing each team member the freedom to work autonomously according to their own timetables.

It is possible to test each board separately prior to integration since they are separate.

By disconnecting power from the different modules, the finished robot's functionality can be turned on and off. The final robot is easy to debug in this way.

Because of their numerous redundancies, modular systems are less likely to experience component failures. Replacement of malfunctioning components is a breeze.

We limited our robot's capabilities to a minimum and used a modular design technique. Every time someone on the team is unsure about how to apply something, these limitations are there to help:

The provided specifications must be met by all modules. Any execution will do provided the requirements are satisfied.

Under no circumstances will the robot halt its movement. Due to their frequent starting and stopping and long lags between tasks, many older robots operate at a snail's pace. Because we've always intended for our robot to be extremely responsive, we've never included a halt or reverse command in the motor controller specifications.

Cheaper components are favored over more costly ones. We have a lot more leeway in this case in case a part breaks or the specs change.

2.2 TASK ASSIGNMENT

Each team member is given a module to complete. The following tasks have been assigned:

Control of motors and design of chassis:

Managing close quarters:

Smoke detectors:

Overarching design, calibration, and master microcontroller:

VARIOUS ROBOT SYSTEMS DESIGN AND INTEGRATION

i.MASTER CONTROLLER

We skip over stages one and two because the master controller really just needs calibration and programming from other elements.

ii.HARDWARE

The most basic circuitry is located on the main board. In terms of physical components, such as wires and components required for a PIC to operate, all that was required was for the central board to receive messages from the sub modules and subsequently output the appropriate messages for operating the fan and motor. List 1 displays the main components of the board:

Machined sockets

10MHz oscillator

PIC16F877A

Programmer Socket

The use of a 10MHz oscillator is noteworthy since it allows the main chip to essentially run at a significantly faster speed than the sub modules. From a hardware perspective, this means that the CPU can potentially communicate with all the submodules simultaneously without impacting overall system performance.

The PIC's pin connections reveal the locations of the submodules' interfaces with the main board.

SOFTWARE

The main chip's software is the most complicated part. This is because the central processing unit (CPU) needs to keep an eye on all the sub-modules and respond appropriately to signals from outside sources. No line-by-line analysis will be given here since the actual code is taken directly from the FSMs.

You can find the code in APPENDIX A. We will be discussing specific issues with the RTOS (Real Time Operating System) here.

RTOS

The term "real time operating system" (RTOS) refers to an OS in which several subsystems (components) interact and share data in real time. In most cases, this can be accomplished by laying a foundation that can distribute tasks among various components that share resources or execute simultaneously. Communication between components is also the responsibility of the foundation. A typical real-time operating system is depicted in figure 1.2.

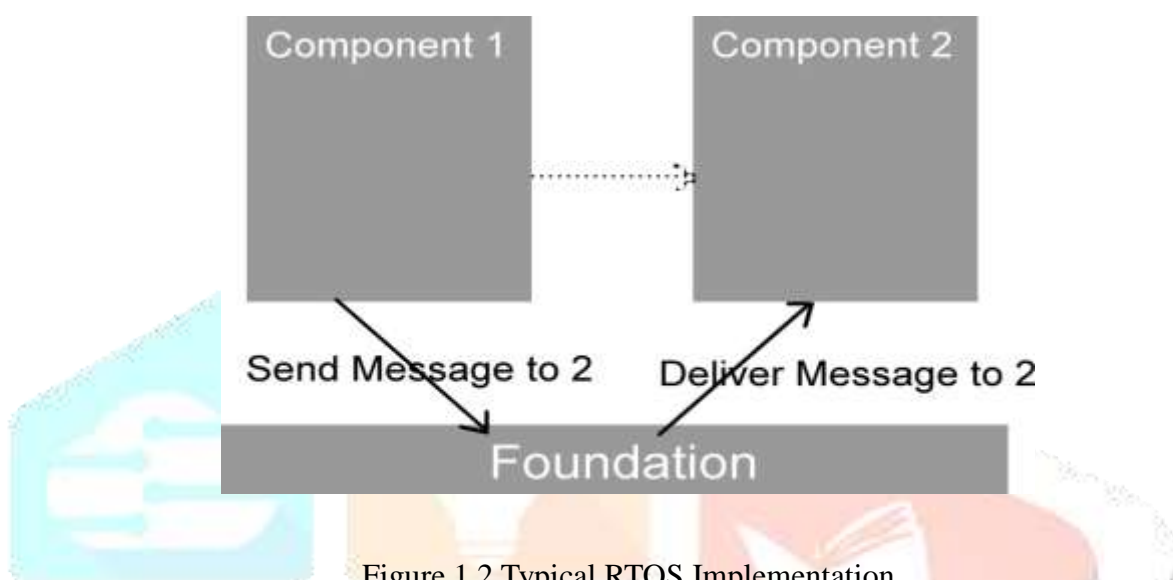
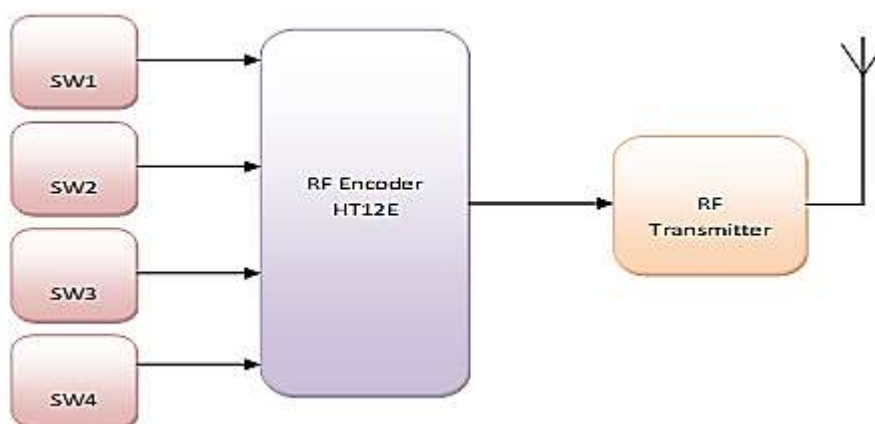


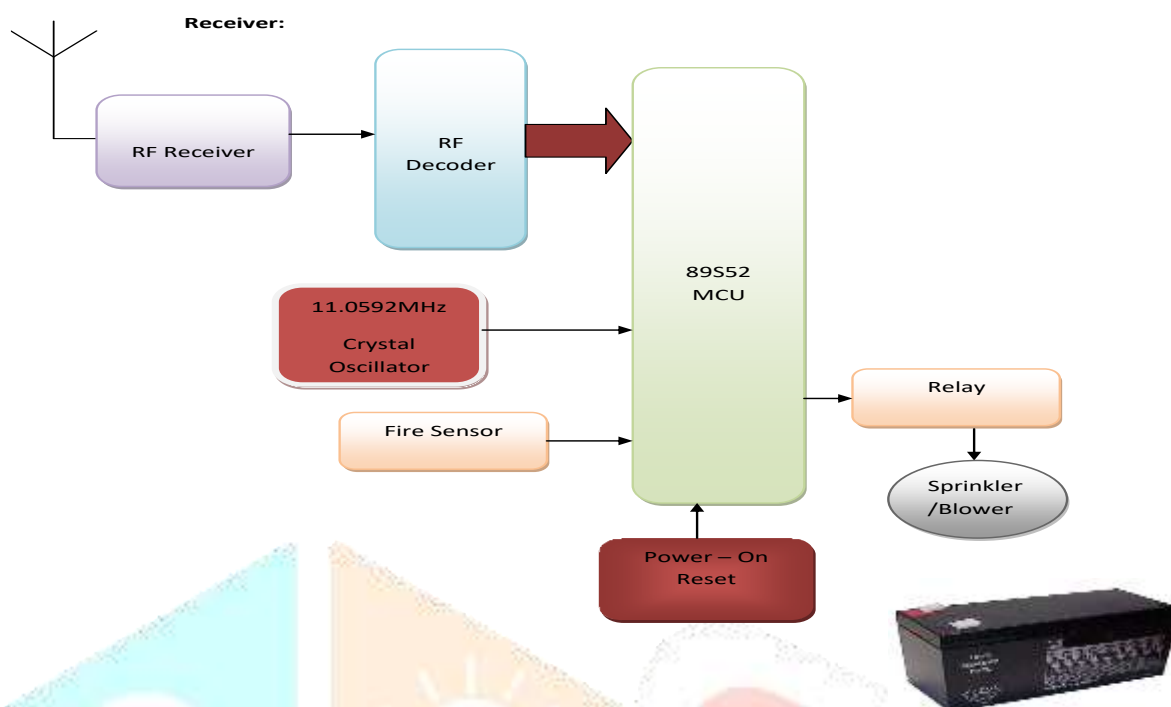
Figure 1.2 Typical RTOS Implementation

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BLOCK DIAGRAM : TRANSMITTER



RECEIVER



EVALUATION

We see that some design principle paid off for the project:

By avoiding the robot from coming to a halt, we managed to build an extremely responsive machine that can react to any outside stimulus in under half a second. The robot is capable of navigating difficult situations, such as a 45-degree right-angle corner, and it will continue moving indefinitely.

We constructed a system with six separate panels that can detect fires for about \$40 using affordable components, rather than purchasing a single costly specialized fire detector, which may cost as much as \$100. Despite dealing with three defective PICs, we managed to keep costs down.

Components susceptible to voltage fluctuations must have capacitors. No matter how many PIC boards we tested, a capacitor between the power source and ground prevented the chip from randomly resetting itself whenever the voltage of other components became too low.

2.3 APPLICATION

Shopping Malls

Residential societies

Police dept

Fire dept

Hopitals

Indusriaries

Offices & schools

Wherever fire risk generates accidentally

FUTURE SCOPE

Similar hardware kit with few upgrades can be developed for the high capacity water jets with trucks & jeeps i.e. to install in actual fire brigade vehicles.

- The exact spot where the fire started is located.
- With its enhanced adaptability, it can accurately identify.
- It's reliable and affordable.
- People are able to accomplish less because of it.

CONCLUSION

Finally, the firefighting robot's implementation was facilitated by our method of modular design strategy, which allowed personnel to work on their responsibilities autonomously. Because microcontrollers are so ubiquitous, the integration stage is really rather straightforward. The ability to debug on a module-by-module basis allowed us to quickly resolve the remaining issues encountered during the integration process.

Thus, our finished robot model can locate "fire" and get there without any problems. In addition, we were able to build the robot within the allotted budget of Rs 4000.

As we worked on the project, we were able to put our technical expertise to good use and hone our technical abilities. We learned a lot of new things about the technical component markets in New Zealand and other countries thanks to this initiative.

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