

RESEARCH ARTICLE

Modernizations of Fire Quench Robot Communication by Imparting IEEE 802.15.4

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Abstract

Security system at hazardous environment is having significant importance in modern days. Fire quench mechanism without human interpretation is forced to develop a working model with the advancement of science and technology. Wireless communication is implanted to initiate the fire quench process. Two micro controllers (AT 89S52) are used for transmission and receiving the signals. The transmitter control unit detects the fire and then transmits the command signal to the receiving control unit using IEEE 802.15.4 system. The receiver control unit enables the fire quench unit in four step mechanism: 1. Path finding, 2. Enable the vehicle Motor driver system, 3. Turn 'ON' the Water sprinkler and 4. Transmit the status of quench process to the control room. This model is developed to optimize the fire quench process and to improve the security standards at hazardous locations.

Keywords: Security system, fire quench mechanism, IEEE 802.15.4 system, security standards.

Introduction

Automation is having its own significance in any environment. Plant automation, device automation and even system automation is playing a vital role in modern electronics and communication era. Communicating the system remotely using wireless technology is advancing day-by-day. Prasanna and Prasad (2013) considered four thermistors to sense the temperature of the ambient atmosphere and one flame detection sensor to enable the fire quench robot. GSM technology is imparted to communicate the sensing device with the fire quench robot. AT '89C52' microcontroller is used to regulate the operations. Premkumar (2013) proposed a multi-functional robot for military application. He considered a temperature sensor, gas sensor, PIR sensor for identifying the fire. Bomb detection sensor also equipped with the robot. PIC 16F 788A microcontroller was used to regulate the operations. Shah (2013) described the significance of the robot to suppress the fire at household applications. The author was not provided the design considerations for the proposed model. Sharma *et al.* (2014) used LM 35 temperature sensor to detect the fire. PIC 16F8778 microcontroller used to regulate the operations. RF technology is imparted to communicate between transmitter and receiver. Sahulhameed *et al.* (2013) proposed a model comprising of fire extinguishing system and image processing. Arm Cortex board is used to process the operations. Taiser *et al.* (2012) proposed a simulated work of the fire fighting robot. Programmable logic controller Siemens S7 2100 was used to regulate the operation. Dutta *et al.* (2014) developed a model to extinguish the fire using ETMEGA 16 microcontrollers.

Against these all backdrops, this study adopted RF technology to establish the communication between the transmitter and receiver. This study aims to enable the fire quench process device using IEEE 802.15.4 protocol. Fire detection and enabling the fire quench unit using wireless communication (IEEE 802.15.4) without interpretation of the human being is having its scope of significance in research era. This study aims to enrich the controlling mechanism of the fire quench process unit. Infrared Technology is adopted to move the fire fighting robot to the targeted location. The entire process is monitored remotely using wireless communication technology. The status of the fire quench process is will be send to the remote control room. The developed model can be adapted to any hazardous environment.

Materials and methods

Fire detection sensor: Figure 1 represents the smoke detector which is considered to identify the fire. The MQ-2 is drawing its TTL output signal in the order of 0-5 V. Higher the output voltage, higher is the concentration of the fire. The MQ-2 sensor is directly interfaced to the microcontroller as an input device for further processing.

Infrared (IR) sensor: Figure 2 depicts the Set of IR sensors assembly used for path following the Fire quench robot. Black and white IR sensors were used to follow the dark line provided to reach the fire location. This supports to curtail the wrong path identification and minimize the time slot for destroying the fire. Shortest path algorithm is used to optimize the travel distance of the robot.

Fig. 1. Fire detection sensor interfaced to microcontroller.

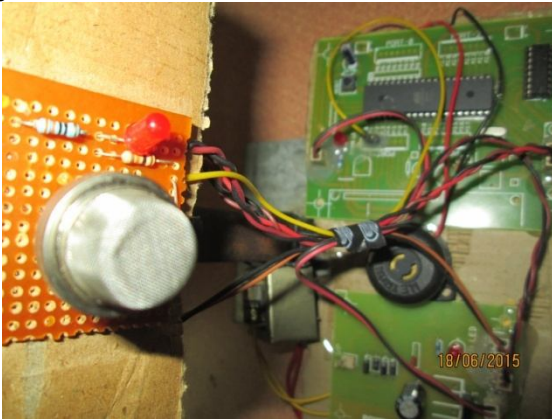
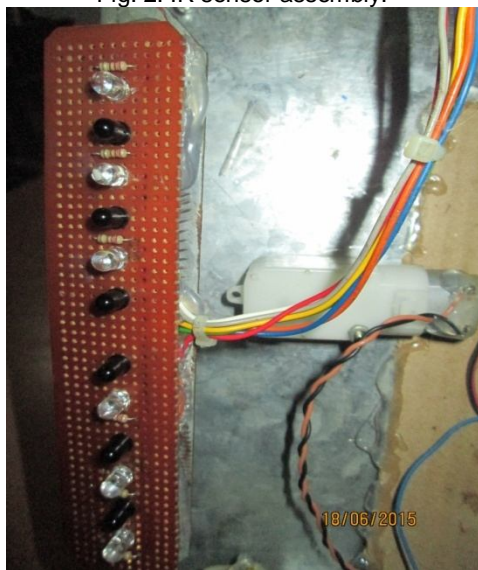


Fig. 2. IR sensor assembly.



Control unit at transmitter section: At 89S52 microcontroller is used to read the signal from fire detection sensor. If the signal levels at the output stage of the sensor is not 'zero' then the microcontroller compares with the initial threshold value of 0.5 V. The input signal above the threshold value enables the transmitting section of the control unit. The data was transmitted using IEEE 802.15.4 wireless communication device (Fig. 3 and 4).

Fig. 3. Simulated circuit of the transmitter section.

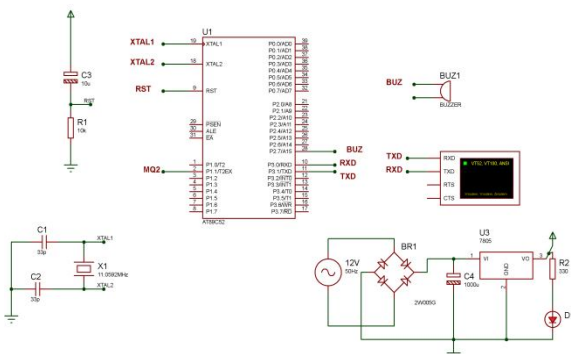


Fig. 4. Transmitter hardware circuit.

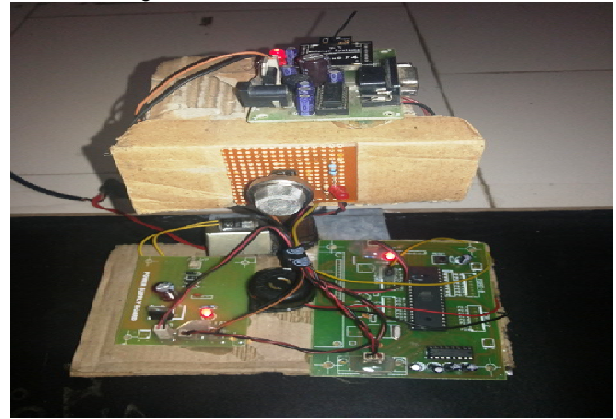


Fig. 5. Simulated circuit of the receiver section.

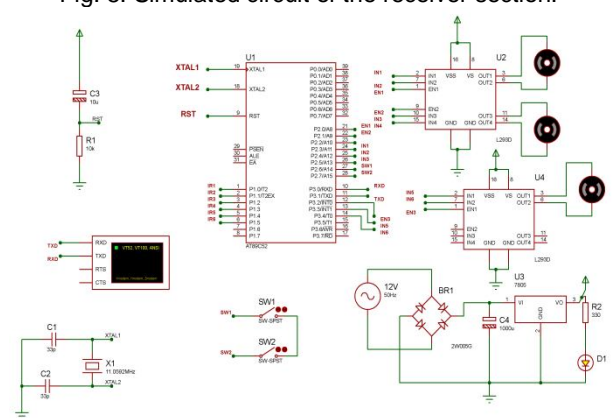
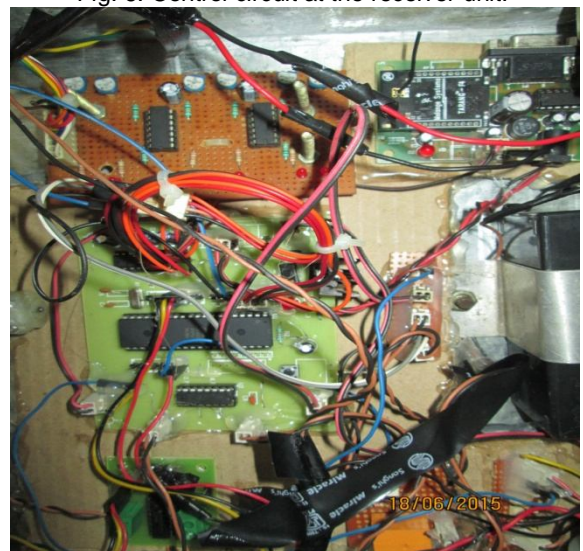


Fig. 6. Control circuit at the receiver unit.



Communication: Low power short range communication is established between the Transmitter control unit and the receiver control using IEEE 802.15.4. Offset Quadrature phase shift keyed modulation stream (OQPSK) with 2.4 GHz is used for transmitting the signal to the fire quench robot (receiver).

Control unit at receiver section: The receiver device input the signal to the microcontroller AT 89S52. The controller displays the received information on the control panel for monitoring the state of the fire. The path finding algorithm is processed to reach the fire location with no deviation. A line follower mechanism is also implanted to reach the targeted location without any deviations. IR sensors are enabled to keep track the provided target path. The controller will enable the motor driving circuitry to move along the line and to reach the targeted location. The 2 ft distance between the fire location and fire quench robot is programmed in the microcontroller. Then the microcontroller will trigger the relay in order to enable the water sprinkler system. Once the fire is suppressed when no smoke is detected, the transmitting control unit will send a stop signal to the receiver control unit. Then, the fire quench robot will resume back to the starting point location. The proposed methodology has been simulated using proteus software. Figure 5 represents the simulated circuit at the receiver stage of the robot. The simulated circuit is then implemented for experimental purpose. Figure 6 represents the hardware circuit to drive the robot motor assembly, to receive the signals from the transmitter and to enable the water sprinkler system.

Soft code implementation

Algorithm 1

Step 1: Read the signal from the fire sensor
Step 2: Compare the signal with the predetermined threshold value
If
The received signal is \geq with the threshold value
Then
Enable the transmitter section and Go to step 3
Else
Go to Step1
Step 3: Read the Receiver data lines
Step 4: Call the algorithm 2
Step 5: enable the IR sensors
Step 6: Enable the Motor driving circuit
Step 7: Compare the distance between the fire quench robot and targeted location
Step 8: If
The distance is \leq 2 feet
Then disable the motor driving circuit and Enable the water sprinkler
Else
Repeat step 6
Step 9: Read the receiver data line
If
The signal is \neq zero
Then repeat step 8
Else go to step 10
Step 10: Return to starting point

For optimum path determination

Algorithm 2

Step 1: Initialize the input and output paths

Step 2: Read the data from range detection sensor
Step 3: Estimate the distance (D1) between source (A) and destination point (D)
Step 4: Estimate the distance (D2) via (A) to intermediate path (M) and (D)
Step 5: Compare D1 and D2
Step 6: if $D1 \geq D2$
Then
Optimum path distance = D2
Else D1
Step 6: Display the result

Results and discussion

Figure 7 represents the fire quench unit. It consists of communication receiver control unit at the bottom surface of the robot, robot driving circuit to enable the DC motors and water sprinkler unit. The white line represents the direction path to reach the targeted location. Figure 8 represents the fire fighting robot reached to the targeted location and ready to enable the water sprinkler mechanism. Figure 9 represents the enabled state of the water sprinkler. The water sprinkler will cover an angle of 180° to kill the fire. It moves right to left and vice versa until the smoke is not detected. Figure 10 and 11 represents the returning state of the robot and resume back to the initial state of the robot. The results proved the developed mechanism produced progressive results to apply this methodology even at highly hazardous environment.

Fig. 7. Fire quench robot.



Fig. 8. Robot reached to the targeted location.



Fig. 9. Robot water sprinkler is 'On'.

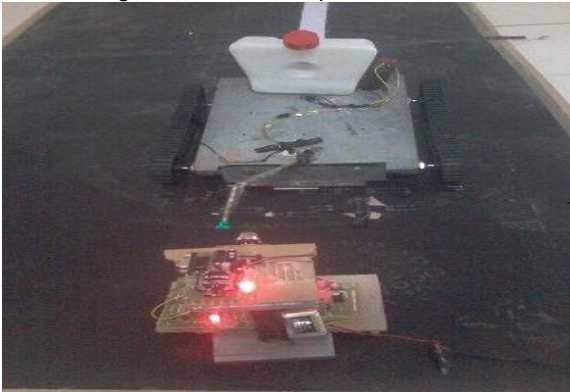


Fig. 10. Robot returning to starting location.



Fig. 11. Robot returned to the starting point.



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References

1. Prasanna, J.S. and Prasad, M.V.D. 2013. Automatic fire sensing and extinguishing robot embedded with GSM modem. *Int. J. Engg. Adv. Technol.* 2(4): 221-224.
2. Premkumar, M. 2013. Unmanned multi functional robot using Zig Bee adopter network for defense application. *Int. J. Adv. Res. Comp. Engg. Technol.* 2(1): 47-55.
3. Sahulhameed, K., Newton David Raj, W., Samsudeen, S., Noorulhak, K. and Sabarish Nagamani, G. 2013. Artificial eye and sensory based an intelligent robot for fire extinguishment task. *Int. J. Adv. Comp. Theory Engg.* 2(1): 101-105.
4. Shah, S.S. 2013. Fire fighting robot. *Int. J. Emerg. Trends Technol. Comp. Appl.* 2(4): 232-234.
5. Sharma, P., Goel, C., Datta, S. and Dhillon, S.S. 2014. Fully automated fire fighting robot with radio frequency module. *J. Acad. Indus. Res.* 3(7): 330-332.

Conclusion

The developed methodology had been proven its reliability and ruggedness in any environment. The results obtained are progressively good. The signal transportation delay is not influenced to improve the response of the fire fighting robot. In future this work can be enriched with ARM 9 Processor to improve the responsiveness and test reliability of the process. The data processing speed can be improved using higher end processors. Night vision camera is to be equipped to enable the image processing component for visual supervision.