

ICMIEE-PI-140423

Experimental investigation on developing remote controlled and robot assisted firefighting system for better security in home, industry and forest areas

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ABSTRACT

The firefighters of developing and developed countries are equipped with modern firefighting system, still they become helpless in many cases as found in the forest fire in Australia, USA and even in Russia. Every year, fire hazards cause a lot of damages in domestic, commercial and industrial areas. Several fire hazards in commercial and garment industries in Bangladesh made the awareness and need of developing firefighting equipments so that factory, people and wealth can be protected from the devastation of fire. This research investigation shows that automatic emergency door opening system can protect the occupants in industries from burning and other fire hazards. Automatic water supply can help to extinguish and control the fire spreading in domestic, commercial and industrial areas. Improved water supply system can protect fire from one floor to another in multistoried building. Automatic and remote controlled firefighting system can also be operated from outside. Experimental investigation on an automatic firefighting system and remote control robot assisted firefighting system was made by the authors and it is found that these systems be used more efficiently in domestic, industrial and forest areas. This paper describes the usages of auto-controlled and remote controlled firefighting system with and without surveillance system and developed necessary program and microcontroller circuit to control the firefighting equipments. These investigations showed that the fire hazards can be controlled satisfactorily by auto controlled firefighting system and robot assisted remote control system with and without surveillance r system

Key words: Auto-control, remote control, mobile phone, robot assisted, firefighting system.

1. Introduction

Most of the firefighting systems are equipped with electric motor driven vehicle or IC engine driven vehicle. Battery powered patrol car of different model like Electric Patrol Car with 48V/3.7kw, CE 1, Trojan Patrol Car, Electric Car, Electric Patrol Car and Electric Vehicle are available in international markets. IC engine vehicle mounted firefighters like ISUZU *Fire truck*, *Water truck*, *Fire engine truck* are also available but robot assisted firefighting system are rarely found.

Robots can be used in many operations of industrial processes. Industrially developed countries are widely using robots in their industrial processes, but its application is rare in firefighting system. In the robot assisted automated firefighting system, the robot is started automatically soon after getting the signals of the initiation of fire and robotic gun can supply water in the room in all directions as per design and program in robot. Near future the application of robot will be more in firefighting equipments because of the facts that

human being cannot work so efficiently and so rapidly like a robot.

Zoppi, M et al. [1-4] established an integration of mechanical and control aspects involved in the design of an innovative 3-D of parallel kinematics machine. The openness of control systems has been addressed in several ways by worldwide research projects both in the field of robot and machine tools (i.e. OROCOS OSEC/JOP, OMAC, OSACA) [1-4].

Lange, E. et al. [2-5] established a sensor based control with different types of sensors and investigated for robots with a positional interface. Sensor data are used to build a representation of the desired path.

Flordal, H et al. [3-6] developed a method for automatic generation of collision free, blocking free and work cycle time optimized supervisors for industrial robot cells has been implemented. The individual robots' tasks are specified as a set of targets that the robot should

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visit in arbitrary order. Minimum of six degree of freedom is required; three for position and three for orientation. This makes a good intuitive sense as the description of an object in space requires six parameters.

M. M. Syed Ali [7] conducted research work with pneumatic powered robot and fire fighting system. A mobile phone was used to operate the firefighting system and the pneumatic powered robot. The firefighting system and pneumatic power robot were operated and controlled by mobile phone guided GSM Network perfectly. This was shown in national TV and ATN News channel in 2008.

Later on M. M. Syed Ali et al. [8] took an undergraduate research project on GSM Network base Remote Control System for an Unmanned Vehicle. This scheme is known as Dual Tone Multi-Frequency (DTMF), Touch-Tone or simply tone dialing. The test result showed that mobile phone guided wireless remote control system is applicable to control, surface vehicle.

M. M. Syed Ali et al. [9] also took this research works on automatic robot assisted firefighting system using this mobile phone guided GSM and surveillance AGSM network. The robot assisted fire fighting system can be controlled from far remote area or from other country by 3G mobile network. It is also found that laptop surveillance system can also be used to the robot assisted firefighting system by the installation of program in and webcam with microcontroller module for operating the robot and connecting the operator and robots with surveillance system.

2. Construction and main components of the firefighting system:

The main components of firefighting systems are water supply system, controlling unit, and firefighting robot.

2.1 Water supply system:

An electric motor (220V, 0.75Hp), water tank (pot) and water supply lines and hoses have been used to construct water supply system for the building and robotic gun.

2.2 Controlling System:

2.2.1 Auto-starting system: In this auto starting system, the fire fighting system receive signals and opens the emergency gate, starts firefighting equipment, and robot at any pre-set room condition.

2.2.2 Mobile phone guided starting system: In addition to the above auto starting system, it can start the same operation of the fire fighting system by remote control system or mobile telephone using its keypad and GSM networks.

2.2.3 Firefighting Robot with remote surveillance control system: Micro-controller based firefighting robot is guided by GSM and AGSM network. It is necessary to make the circuit so that signal from the mobile phone can send signal to the input of the microcontroller. Special care should be taken in this regard as these wires are laminated and the lamination must be removed before the wires are connected to the signal decoder. The decoder receives the tone and sends the corresponding binary number to the microcontroller. According to the program in the microcontroller, the water pump motor or unmanned water vehicle will start moving.

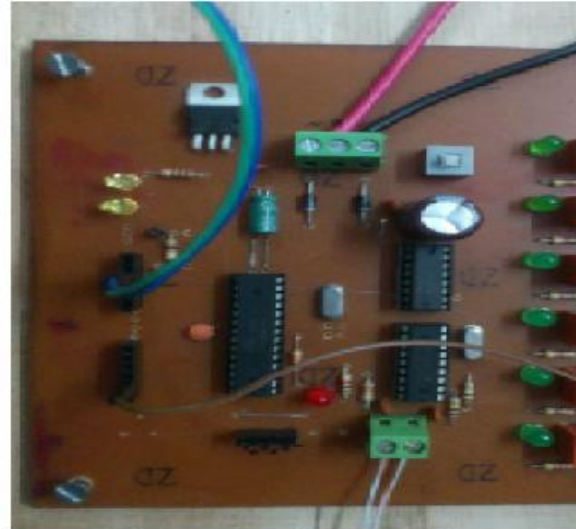


Fig. 1: Micro-controlled circuit board for input and output device.

This hardware circuit is consist of the microcontroller, decoder, ULN relay driver as shown in figure 1. The ULN relay driver is high-current Darlington transistor arrays. The ULN relay driver are supplied in 16 pin plastic DIP packages with a copper lead frame to reduce thermal resistance.

2.3 Firefighting Robot:

This robot has been constructed with the three degree of free-dom so that it can operate water gun to any stirred or place as desired. The robotic firefighting system can be started automatically. It can be operated by its own program

3. Experimental Set-up and Results:

Three experimental setups for three different models of the fire fighting equipments have been constructed and tests with the following multilayer facilities and security system.

3.1 Experimental Set-up - 1 :

Mobile Phone Guided Automatic Firefighting System: In this model test figure 2, a three storied model house has been constructed with emergency gate and

firefighting system including water pump, water tank and a microcontroller board. This firefighting system is equipped with necessary accessories. The test result shows that the following facilities can be obtained from this model test.

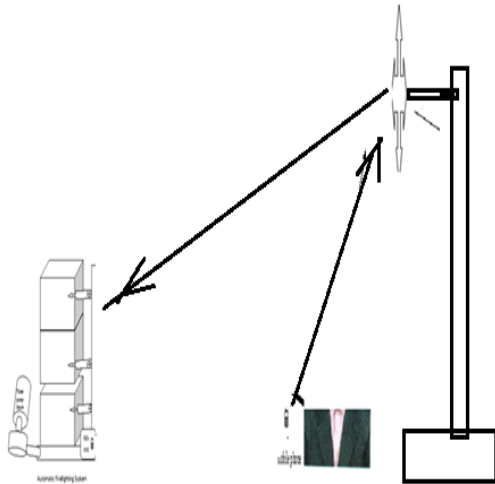


Fig. 2 Experimental set-up 1 for an automatic and remote controlled firefighting system

- (i) The firefighting system is automatically started if fire occurs and it can supply water to the water hose pipe of the firing spot or floor in building so that occupants can also use and supply water to dire fire spot.
- (ii) An emergency gate of the hall room or store under fire will be opened automatically so that occupants can go out of fire and are not burnt.
- (iii) If emergency gate of the hall room or store under fire is not opened automatically, the emergency gate can be also be opened by remote control switch board or mobile phone keypad by the controlling officers from factory or from out of the factory or from other country or subcontinent.
- (iv) Firefighting system can be started and operated by controlling officers using mobile phone keypad and GSM networks.
- (v) Firefighting system is designed and developed in such a way so that water supply and cooling device will protect the fire spreading from one floor to other floor.
- (vi) It can also be started manually by the operator in ground floor.
- (vii) It can also be started by occupants of respective floor where fire is initiated.
- (viii) If fire is initiated, two alarms will come from smoke sensor and light sensors so that occupant can take preventive measures from fire initiation.
- (ix) Thus the occupants under fire will be able to get automatic water supply, automatic emergency door opening, emergency door opening by mobile phone for their own protections. Thus the firefighting system can be equipped with multi-layer security systems to protect people in homes, commercial areas, and in industries.

3.2 Experimental Set-up 2

Robot Assisted Automatic Firefighting System Controlled by Mobile Phone Guided GSM Networks: In addition to above automatic firefighting system, robot assisted firefighting system was constructed and tested to improve overall performance of the fire fighting system as shown in figure 3. The test result shows that it can provide the following additional facilities

- (i) The robot assisted fire fighting system may be over-head mounted or floor mounted industries and the robot may be movable or stationary.
- (ii) In the robot assisted fire fighting system, the robot is started automatically and supplies water in the room in all directions (in horizontal plane and in vertical plane with reciprocating motion) as per program in robot and designed and installed.

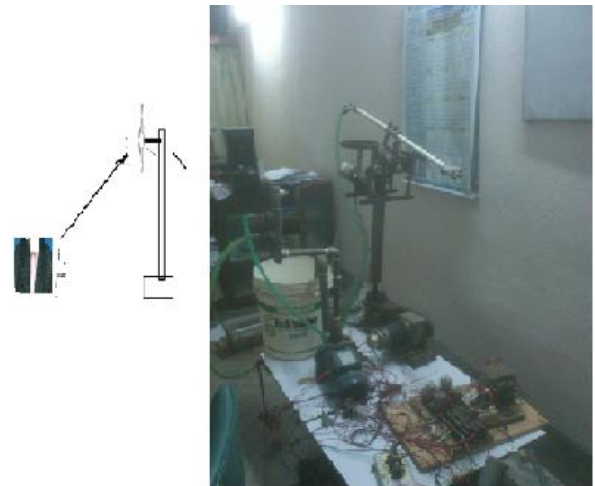


Fig.3.1 Experimental set-up 2 for a robot assisted firefighting system with remote controlled system

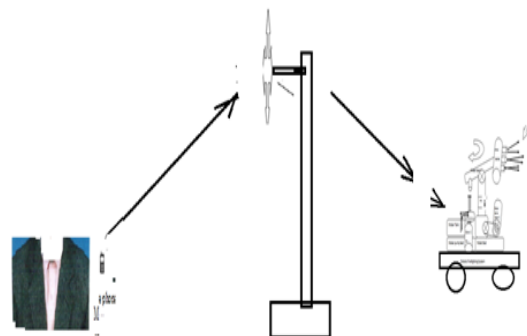


Fig.3.2 Experimental set-up 2 for a robot assisted firefighting system with remote controlled system

(iii) Robot assisted firefighting system can also be started by mobile phone and the robot can be operated in manually control mode or in auto motion by the key pad of mobile phone.

(iv) In automatic robot assisted firefighting system, the robot will supply water in designed motion without operator in horizontal plane and in vertical plane as programmed.

(v) In manual control mode, the robotic water gun can be operated and controlled by the key pad of mobile phone.

(vi) If the robot is mounted on vehicle, the vehicle motion can also be controlled by mobile phone.

(vii) For short distance, the remote control system can be operated by eye vision where no surveillance control is required. Firefighting robot can be installed on water tanker for better performances.

These robot assisted firefighting system are preferably applicable in big store of sea port, air port, in garment industries, factory, and store of factory.

3.3 Experimental Set-up 3

Robot Assisted Surveillance Firefighting System using AGSM Networks:

Some time the operator cannot enter in the store room during fire where robot can enter the room with external water spray and internal cooling system. Here remote surveillance control system can guide and operate the robot from outside. The following distinct facilities and features are available in this system as depicted in figure 4.

(i) The robot assisted fire fighting system can be controlled from remote area or from other country by 3G mobile network or by the installed surveillance control system between operator and robot module where webcam camera and microcontroller fitted with robot.



Fig. 4.1 Experimental Set-up 3 for surveillance remote controlled firefighting system for industries

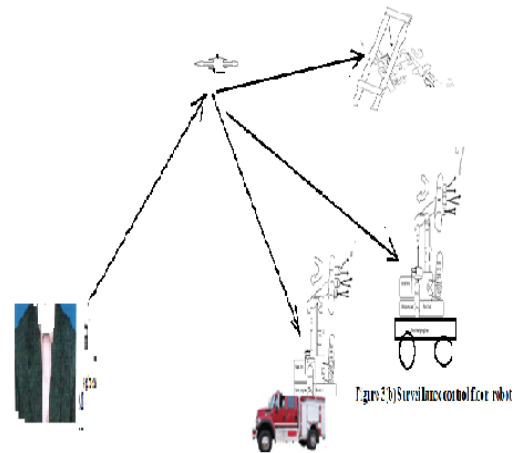


Fig. 4.2 Experimental Set-up 3 for future surveillance remote controlled firefighting system for industries and forest areas

(ii) A self cooling for self protection for robot or robotic vehicle can be added so that it can enter hot area during fire extinguishment.

(iii) Robot can be mounted in 3-wheel vehicle or 4-wheeled vehicle or on water tank which can be operated surveillance control device and mobile keypad applicable in house or store of factory and factory

4. Conclusion

In this research work, the remote control and surveillance system of firefighting robot were tested. The following conclusions may be made

(i) Automatic opening of emergency door can protects occupants from fire burning.

(ii) Automatic starting of water pump and water supply system can provide instant water supply to different floor and occupants which is helpful to control fire.

(iii) Robotic water gun can be used more effectively in controlling fire.

(iv) Both robot and auto-fire fighting can be operate remote control system using mobile phone and GSM network

(v) Surveillance system of 3G mobile or separately installed surveillance system with necessary program and module can used to control these firefighting equipments.

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