AUTOMATED FIRE EXTINGUISHING SYSTEM WITH GSM ALARM

A Thesis

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Of

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DECLARATION

We hereby declare that research work titled "Automated Fire extinguishing System with GSM Alarm" is our own work. The work has not been presented elsewhere for assessment. We develop the new method where material has been used from other sources it has been properly referred.

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CONTENTS

Abstract

This paper demonstrates the requirements, specifications, design problems and solutions for the fire extinguishing system project fulfilling the requirements. Fire fighting is an important and hazardous job. A fire fighter can be able to extinguish fire quickly, averting the damages and reduce losses. Technology has joined the gap between firefighting and machines using some effective method. The purpose of this thesis is to establish a system that can detect fire and extinguish it in the shortest time subject to a few effective factors. In this case, the system aims to put out the fire before it spreads increasing the security of home, laboratory, office, factory and building that is important to human life. We develop an intelligent sensor and camera system security system that contains a fire extinguishing capacities in our daily life. The name of the system is "AUTOMATED FIRE EXTINGUISHING SYSTEM WITH GSM ALARM". The *IEEE SOUTHEASTCON 2003* Hardware Competition tests the minds of college students all over the nation with the challenge of extinguishing a fire located in a simulated house autonomously. To any one unfamiliar with robotics, for a robot to be autonomous means the robot must operate

On its own independent of any human. This system can detect abnormal and dangerous situation and notify us this paper establishes the necessities, conditions, design problems, solutions and future plans for the firefighting system. First, we design a system with extinguisher .This system includes structure, avoidance obstacle, software development system, fire detection and others. We implement some computer program to detect only fire. We implement the system and if fire accident is true, the fire extinguisher system can find out the fire source by the proposed method and move to fire source to fight the fire using extinguisher.

1. INTRODUCTION

Home can provide safety, convenience, and efficiency for people in the 21st century. An intelligent home system is integrated by many function and systems. One of the most important systems is the fire detection function in an intelligent home. The fire event may involve dangerous in life. There have been many deaths around the world because of fires [1] [2] [3].The deaths are especially rising as last year more than five hundred people were killed because of fires in Pakistan and Bangladesh[1][3]. The deaths in the other countries might be less but it is still a worrying factor because as well as lives the amount of product which is lost due to fire. There are not many buildings that have fire detectors because of their price and installation. Even if there are detectors installed the primitive technology that is used in the devices make them unreliable as because of false alarms and those which are free or are reliable they are priced at a very high range which is why they are often avoided .The fire detection device is fixed on the wall or ceiling . It is not very convenient that uses many fire detection modules in the home. In the paper, we design a fire extinguishing system to detect fire event, and use extinguisher to fight the fire source and the transmit fire information to us. In the recent years there have been studies and work done to ensure a better fire detection and fire extinguishing system [4][5] among them this system is only for fighting fire.

In the past literatures, many experts research in the service robot. Some research addressed in developing target-tracking system of service robot such as Hisato Kobayashi et al. proposed a method to detect human being by an autonomous mobile guard robot [13].Yoichi Shimosasa et al. developed Autonomous Guard robot which integrate the security and service system to an Autonomous Guard robot, the robot can guide visitors in daytime and patrol in the night. D.A Ciccimaro developed the autonomous security robot “ROBOT III” which equipped with the non-lethal-response weapon .Moreover , some research addressed in the robot has the capability of extinguishing the fire .There are some products that have been published for security robot. Such as, SECON and SOC in Japanese and International Robotics in USA, and Chung Cheng # 1 in Taiwan [20] .Wang et al developed a multisensory fire detection algorithm using neural network. One temperature and one smoke density sensor signal are fused for ship fire alarm system. Healy et al. Presents a real time fire detection system using color video input. The spectral, spatial and temporal properties of fire were used to derive the fire- detection algorithm. Neubauer apply genetic algorithms to an automatic fire detection system. The on-line identification of stochastic signal models for measured fire signals was presented. Ruser and Magori described the fire detection with a combination of ultrasonic and microwave Doppler sensor. Luo and Su use two smoke sensors, two temperature sensors and two flame sensors to detect fire event, and diagnosis which sensor is failure using adaptive fusion method.

What we have designed is not a robot but an automatic fire fighting system that detects and puts out the fire form a mounted position in a room. By mounting it and making it into a fire monitoring system we can target only the fire and decrease the chance of collateral damage. Thus we ensure we don’t have to worry about the fire becoming so intense and out of control that it can causes damage to life or the surrounding environment not only that also notifying and alerting the employees about the fire. The firefighting robot is designed to search for a fire in a small floor plan of a house, extinguish the fire (by placing a cup over the LEDs), and then return to the front of the house. This mission is divided into smaller tasks, and each task is implemented in the most efficient manner. The navigation of the robot throughout the house is achieved by data provided by a line tracker and ultrasound transducers. The target acquisition is achieved by data provided by a camera. The deployment of the extinguishing device is implemented with a custom arm controlled by servos. Along with these crucial tasks were other design constraints, such as the size, speed, and supply of power. Each defining characteristic of the system is described in more detail in this document.

1.1 Importance of Fire Extinguishing System

1.1.1 Life safety

This system can play a vital role in life safety. Automated Fire Extinguishing systems are the most effective means of fire controlling. When properly installed this system can be highly effective safe-guard against loss of life and property.

According to a recent article on HotelInteractive.com, a leading web portal for hotel professionals, an estimated 3,900 fires occur each year in hotels and motels. Annually, these fires result in $76 million in property loss.

According to a recent report by the U.S. Fire Administration, 46 percent of hotel and motel fires are caused by cooking, with electrical malfunctions and heating each causing an additional 7 percent of fires. These fires occur primarily in the evening, between 6 p.m. and 9 p.m. While 73 percent of fires are confined to the object of origin, 18 percent are confined to the room of fire origin and the remaining 9 percent of fires extend beyond the room of origin.

With 73 % of these fires confined to the object of origin, it is easy to see the absolutely critical role that fire extinguishers play in keeping the guests in hotels safe. Extrapolating the prominent studies, this indicated more than 20 fires everyday are put out by fire extinguishers in hotels.

There is lots of extinguisher that works for our life safety and also save our property.

Water fire extinguishers are good for putting out flames on carpets and soft furnishings, but are dangerous when used on flammable liquids or cooking fats. This is a good device to have in the bedroom and living room, especially if you are a smoker, but not useful for the kitchen.

Foam extinguishers are effective on woods and flammable liquids, petrol and spirits but not for kitchen or electrical fires, making this a handy device to keep in the garage.

Carbon-di-oxide (CO2) is effective on flammable liquids and electrical fires, but not suitable for cooking fats or soft furnishings.

Dry powder can be used on the widest range of fires in the home. It is safe to use on textiles, wood, flammable liquids/gases and electrical fires. However it cannot be used on kitchen fires involving cooking fats and oils. It's a good device for garages and living areas, but you will still need a separate device for the kitchen.

Wet chemical is safe to use on soft furnishings and cooking fat fires, yet hazardous when brought into contact with electrical or flammable gases and liquids. It is good for the living room and kitchen but unsuitable for the garage.

Fire blanket is a handy item to have in cooking areas and can stop small pan fires from spreading. They are mounted on the wall and easily accessible: using a fire blanket is the best and quickest way to extinguish a pan fire. They can also be used to wrap around people when their clothing has caught fire.

The best thing to do is to make an assessment of the places in your home where you see the greatest potential risks of fires occurring and keep the appropriate devices in an easily accessible place nearby. A fire blanket and wet chemical extinguisher in the kitchen and dry powder device in the garage could prove invaluable tools in saving your home and your life in case of a house fire.

1.1.2 Important documents and materials safety:

The most prevalent threat faced by all cultural institutions is FIRE. No institution is immune from fire. Until the owners/trustees of these institutions develop plans for dealing with the fire threat, they place the building and its occupants, visitors, and collections at risk. The complexity of these plans may vary from a simple evacuation plan, to a fire prevention program, to a more complex plan that includes passive and automatic fire protection systems.

Property damaged by floods can often be dried out and restored. Structural damage from an earthquake might be repaired. Stolen property always has a chance of being recovered. Damage from fire, however, is usually permanent and irreparable. Historical buildings or contents, once reduced to ash, can never be restored. Fire is more cunning and less discriminating than a thief. It can travel (spread) through very small openings and concealed spaces to reach other parts of a building, deprive occupants of a life supporting environment, and cause partial to total destruction of property.

There exists a cavalier attitude in this country that "fire won't happen to me," that" it is someone else's problem." Americans also place a lot of blind faith in their local fire department to save them and their property from any fire that may occur, and believe insurance will cover the rest. Reality is very different, and our daily fire statistics bear this out

At the very least, every institution should have an emergency self-protection plan that spells out how to report a fire and safely evacuate the premises.

To provide some additional insight, a 2010 White Paper from Worcester Polytechnic Institute reported on the use of fire extinguishers to combat real fires in academic settings. According to their research, fire extinguishers are used approximately 15,000 times each year in schools, colleges, universities, dormitories, fraternities, sororities and barracks.

That means that fire extinguishers are called into service more than 41 times each day as the first line of fire defense in our nation's schools.

In office and educational institutions, fire can destroy all the important documents, papers, and other important materials. Thus, our system can protect these important elements from being burnt by extinguishing fire at early stage.

1.1.3 Environment protection:

Fire extinguishers also play a critical role in protecting the environment by controlling fires at their very early stages.

From a safety as well as from an environmental and carbon release perspective, the management of a fire with a fire extinguisher when it is in its very early stages is a best case scenario.

Green Collar Research sums up the beneficial role that fire extinguishers, and particularly electronically monitored fire extinguishers like those offered by en-Gauge, in the following manner.

Fire and fire protection plays a significant role in releasing greenhouse gases into the atmosphere. Fire extinguishers play a crucial role in protecting the environment due to their proven ability to fight fires while they are at their very early stages. The availability of accessible and working fire extinguishers assures that the highest possible percentage of fires will be controlled with the minimal environmental impact possible.

Replacing the inefficient and carbon-intensive manual extinguisher inspection methodology with electronically monitored extinguishers will have significant positive impacts on the environment, including:

- ·Fewer carbon emissions from fire incidents in which a missing, blocked or non-functioning fire extinguisher is a contributing factor
- Reduced embodied carbon generated via the manufacture of replacement building materials necessary to repair fire damage
- Reduced carbon emission from the burning of fossil fuels for transportation necessary for the manual inspection of extinguishers
- Reduced water use required to fight fires
- Reduced levels of persistent pollutants associated with fires and waste water run-off

Figure- Environment protection

1.2 Contrast with existing systems

The Automated fire extinguishing system that we made is more realistic in its structure, cost, and activities .This system is more feasible than other system that is being used in present time. Besides it has low production cost than other and it has the capability in extinguishing the fire at root level so that we can reduce the losses. At present, we can see that, the materials that are used as extinguisher are very expensive like carbon-di-oxide, vaporizing liquid, wet material etc .Besides; we cannot use all materials as an extinguisher. Because it depends on fire what materials should be used in proper place? In this sense, our system is viable and time consuming also.

1.3 Damage Statistics due to Fire

We can see the damage statistics all over the world due to fire occurrence.

Fire in the U.S.

In 2011, fire departments in the United States responded to 370,000 fires in the home. These fires resulted in more than 2,500 civilian deaths and nearly 14,000 civilian injuries, with almost $7 billion in direct property damage and an incalculable amount of personal loss.

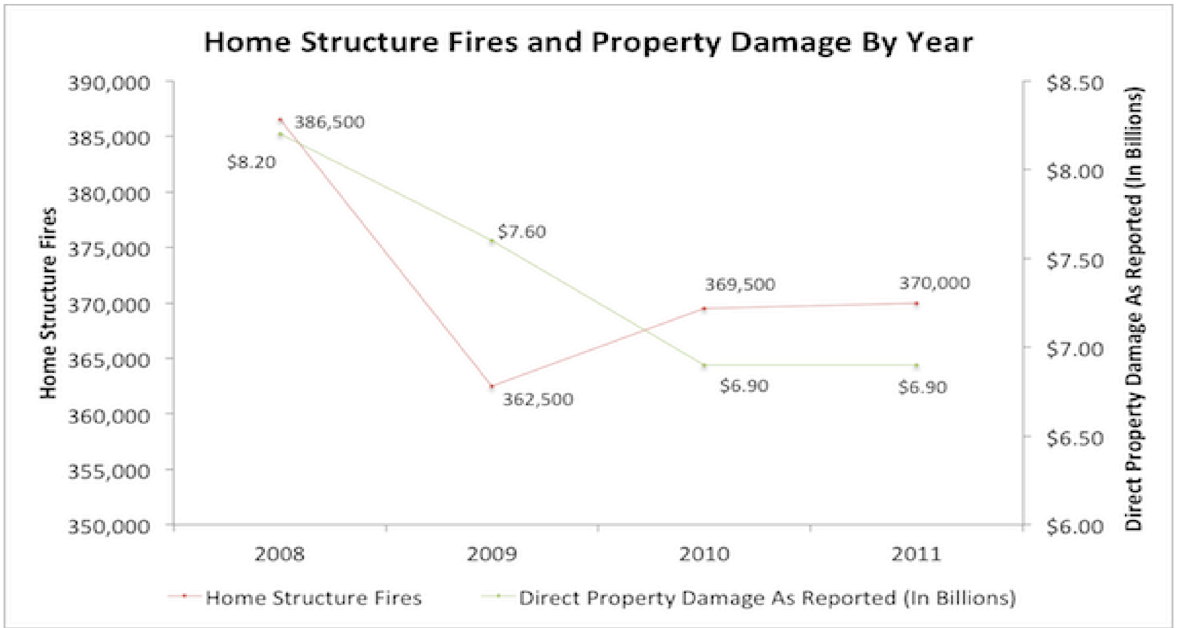


Figure- Home Structure and Property Damage

Homes structures are defined as dwellings, duplexes, manufactured homes, apartments, townhouses and row houses.[**T6**]
(Data via: National Fire Protection Association)

The overwhelming majority of home structure fires were avoidable, and almost two-thirds of the lives lost could have been saved for less than $100. Home structure fires almost invariably start in the home, with most of the exceptions resulting from wildfires. The good news is that there are many resources — and some simple steps that can be taken — to dramatically improve fire prevention and safety.

In 2012, there were 1,375,000 fires reported in the United States. These fires caused 2,855 civilian deaths, 16,500 civilian injuries, and $12.4 billion in property damage.

- 480,500 were structure fires, causing 2,470 civilian deaths, 14,700 civilian injuries, and $9.8 billion in property damage.

- 172,500 were vehicle fires, causing 300 civilian fire deaths, 800 civilian fire injuries, and $1.1 billion in property damage.
- 692,000 were outside and other fires, causing 60 civilian fire deaths, 825 civilian fire injuries, and $813 million in property damage.

The 2012 U.S. fire loss clock a fire department responded to a fire every 23 seconds. One structure fire was reported every 66 seconds.

- One home structure fire was reported every 85 seconds.
- One civilian fire injury was reported every 32 minutes.
- One civilian fire death occurred every 3 hours and 4 minutes.
- One outside fire was reported every 46 seconds.
- One vehicle fire was reported every 156 seconds.

The most inclusive and direct interpretation of “electrical fire” is a fire involving some type of electrical failure or malfunction. Any equipment powered by electricity can have such a failure .In 2011, an estimated 47,700 home structure fires reported to U.S. fire departments involved some type of electrical failure or malfunction as a factor contributing to ignition. These fires resulted in 418 civilian deaths, 1,570 civilian injuries, and $1.4 billion in direct property damage. In 2007-2011, home electrical fires represented 13% of total home structure fires, 18% of associated civilian deaths, 11% of associated civilian injuries, and 20% of associated direct property damage.

In 2011, an estimated 16,400 non-home structure fires reported to U.S. fire departments involved some type of electrical failure or malfunction as a factor contributing to ignition. These fires resulted in 13 civilian deaths, 243 civilian injuries, and $501 million in direct property damage. In 2007-2011, non-home electrical fires represented 13% of total non-home structure fires, 5% of associated civilian deaths, 13% of associated civilian injuries, and 21% of associated direct property damage. The national estimates in this report are derived from data reported to the U.S. Fire Administration’s National Fire Incident Reporting System (NFIRS). These statistics include fires reported as “confined fires,” for which detailed reporting is not required. Estimates of detailed characteristics for confined fires require statistical allocation of a large share of unknowns and so involve less confidence.

Half (48%) of 2007-2011 reported non-confined U.S. home structure fires involving electrical failure or malfunction had some type of electrical distribution or lighting equipment as equipment involved in ignition. The leading other types of equipment involved in ignition were fan (6%), washer or dryer (6%), space heater (4%), air conditioning equipment (4%), water heater (3%), and range (3%).Home electrical distribution or lighting equipment fires. In 2011, an estimated 21,300 reported U.S. non-confined home structure fires involving electrical distribution or lighting equipment resulted in 295 civilian deaths, 840 civilian injuries, and $822 million in direct property damage. Fires reported as confined fires would add only 2.1% to the estimated non-confined fires and less than 2% to associated losses.

Electrical distribution or lighting equipment accounted for 6% of 2007-2011 home structure fires, ranking fourth among major causes behind cooking equipment, heating equipment, and intentional. Electrical distribution or lighting equipment also accounted for 13% of associated civilian deaths (ranking behind smoking materials, heating equipment, and cooking equipment, and tied with intentional), 7% of associated civilian injuries (ranking fourth), and 11% of associated direct property damage (ranking fourth).

Wiring and related equipment accounted for the largest share (63%) of 2007-2011 home structure fires involving electrical distribution or lighting equipment, followed by lamps, light fixtures, and light bulbs (20%), cords and plugs (11%), and transformers and power supplies (6%). Cords and plugs accounted for larger shares of civilian deaths (30%) and injuries (21%) than of fire incidents (11%) associated with home electrical distribution or lighting equipment fires. Three-fourths (74%) of 2007-2011 home structure fires involving electrical distribution or lighting equipment cited some type of electrical failure or malfunction as a factor contributing to ignition. The majority of 2007-2011 home structure fires involving electrical distribution or lighting equipment began with ignition of products and materials often found in structural areas, including wire or cable insulation (32%), structural member or framing (16%), insulation within structural area (6%), and exterior wall covering (5%).

Nearly half (44%) of deaths in 2007-2011 home structure fires involving electrical distribution or lighting equipment resulted from fires that began in a living room, family room, or den (23%) or bedroom (21%).Nearly two-thirds (64%) of deaths in 2007-2011 home structure fires involving electrical distribution or lighting equipment involved victims who were outside the area of origin when injured. By comparison 47% of fatal victims for all home structure fires were outside the area of origin when injured.

Based on special reports by the U.S. Consumer Product Safety Commission, analyzing data from the death certificate data base, in 1999 to 2011, 58 people died per year of injuries from unvented carbon monoxide from generators. Generators are the only electrical distribution or lighting equipment that burn fuel, which makes them the only electrical distribution or lighting equipment that generates carbon monoxide.

Halogen lights have a higher risk of fire than incandescent lights, which have a higher risk than fluorescent lights. Compact fluorescent lights now account for more than two-thirds of all fluorescent lights in residential usage. Incandescent lights are due to be phased out in favor of fluorescent lights, but as of 2010, incandescent lights still outnumbered fluorescent lights by nearly 2-to-1 in residential usage.

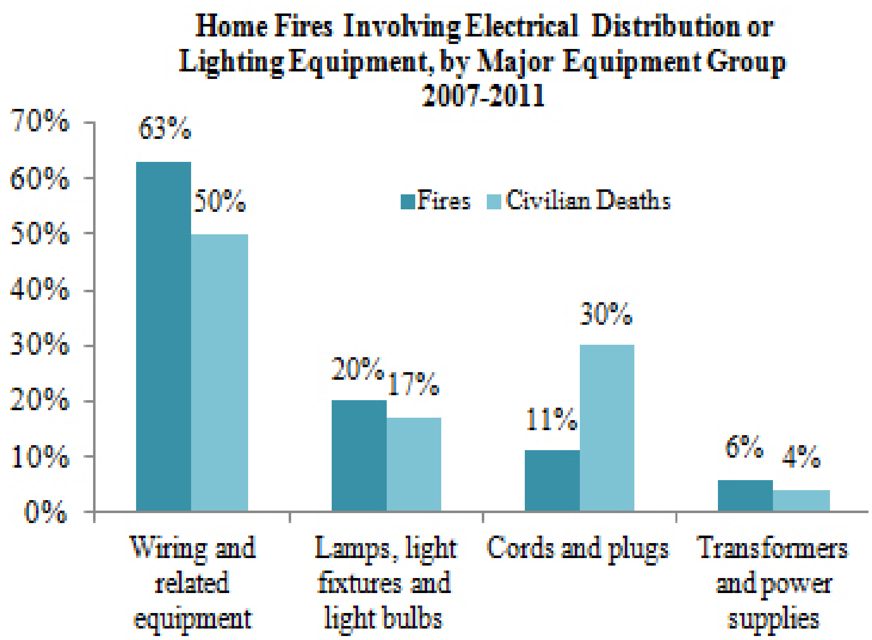


Figure- Home Fires Involving Distribution

In Bangladesh

Urban fire incidence is alarmingly increasing all over Bangladesh particularly in larger Urban centers. Due to rapid unplanned urbanization and the absence of adequate safety

Measures in the city system, Dhaka City is seriously facing this hazard at present.

At present, Dhaka is serving the role of a metropolis with over 11.3 million people and Also serving the role of the national capital for 149 millions of Bangladeshis (BBS, 2001).

The national urban population share of Dhaka city was 25% in 1981, 31% in 1991 and 34%

in 2001 respectively. Among the urban centers of Bangladesh, Dhaka's dominance is not

Only in terms of population, but also in terms of economy, trade, commerce, and administrative facilities. In 1991, among the thirty four mega cities of the world having a

population of more than five million, Dhaka ranked twenty fifth while in 2000 it ranked eleventh and it is predicted to be the world's fourth largest city by the year 2015 with an estimated population of 21.1 million (GoB, 2002). Along with the rapid urbanization, the civic facilities of Dhaka city are yet not developed in a proportionate manner. As a result, the citizens usually have to face varieties of
Frequent disorders in their everyday living of Dhaka City. Fire hazard is one of such phenomena which are at present causing huge economic loss as well as tragedy of human death in a frequent manner. The reported fire incidences from 2004 to 2006 in Bangladesh were 7140, 7135 and 9642 respectively; whereas within Dhaka City the incidences were respectively 803, 984 and 1161 in each year. In 2006, country's 12% fire accidents occurred in Dhaka city which were 13.79% and 11.2 % in the years of 2005 and 2004 respectively (BFSCDA, 2007). Apart from human death and injury, the damage of property in Dhaka city was estimated to be more than Tk. 6 crore on an average due to fire accidents in every year (Sayeed Uzzaman, 1990). However, this figure has been increased manifold at present. According to the official record of BFSCDA, the monetary loss due to fire accidents within Dhaka City was Tk. 48 crore in 2007 which was Tk. 80 crore in 2006 and Tk. 52 crore in 2005. The annual monetary loss due to fire accidents is very high in Dhaka City compared with the other urban centers in Bangladesh as the city is involved in the highest concentration of economic activities.

414 garment workers were killed in fires between in 2006 and 2009
79 workers lost their lives in 2010 in 21 separate recorded incidents
Taren garments in Savar and Mondol groups also face a disastrous situation in last year(2013).

Nearly 800 people have been injured in scores of largely unreported fires in garment and textile factories in Bangladesh in the last 12 months, according to new figures compiled by international labor campaigners.

The high numbers of casualties will raise concerns at the slow pace of change in the politically unstable south Asian state, where more than 1,130 people died when a building housing factories making garments for chains including Primark and Matalan collapsed in April. The tragedy was the worst industrial accident anywhere in the world for a generation.

But activists in Bangladesh say fires pose as serious a threat as poor building construction. Five months before the April collapse, 114 people had died in a fire in a factory making clothes sold by global retailers such as Wal-Mart, Sears and C&A among others. There are an estimated 5,000 garment factories in Bangladesh, of which around two thirds are active.

"The reality is that we have so many factories that every day there is something happening in some place but it doesn't make the news," said Mohammad Riaz Uddin, director of the Alternative Movement for Resources and Freedom Society in Dhaka.

In the last year there has been more than one fire a week, according to figures compiled in Bangladesh by the American Center for International Labor Solidarity. The statistics are based on reports in the local media and from their network of affiliated union groups.

The true number of injured is unknown, however, and may be even higher, said Alonzo Glenn Suson, the ACILS country director.

On November 25, at least 15 people were injured in a stampede as panicked workers rushed to exit when a fire broke out at a factory outside Dhaka belonging to the Mondol Group, which deals with western brands. Another 20, including five local people, were injured after a blaze at a mill where textiles are prepared in the Ashulia industrial zone. Two weeks earlier 15 more were injured when fire took hold at a dyeing facility in Gazipur, another major center of the garment industry.

"If industries are there then accidents can happen. It is a big challenge for the country as well as the sector," said Reaz bin Mahmood, vice-president of the Bangladesh Garments Manufacturers and Exporters Association, an industry body that represents factory owners.

Though an increasing proportion of factories in Bangladesh are purpose-built, hundreds of older units are found in converted residential buildings. Often these lack adequate fire escapes, alarms, first aid or fire-fighting equipment. Many produce clothes for sale in the west. Training at many factories is also poor, industry experts say. More than 250 workers have been injured in stampedes triggered by false fire alarms this year, according to the ACILS data. One such incident occurred at the Rana Plaza complex in December last year – exactly five months before the collapse – after a light exploded and workers panicked. On at least one occasion over the last year, workers have died falling from unsecured staircases or in other accidents during evacuations.

"Frankly we have no accurate estimation of the magnitude of the unsafe factories. Over the last 20 years of exponential growth of the garment factory, monitoring mechanisms were not able to catch up to speed," said Srinivas Reddy, country director of the International Labor Organization.

More than a hundred international retailers have now signed up to two different agreements, one legally binding, which commit them to funding a push to improve safety and working conditions in the factories where they source their products.

A third initiative, involving the government of Bangladesh and the ILO, aims to fill the gaps between the two industry initiatives with a new inspection regime run by government engineers and technicians. [**T** 7]

Owners have warned that the new safety measures coupled with a rise in minimum pay could mean up to a third of existing factories will have to close down, putting a million people out of work.

Analysts dismiss such concerns. There is a shortage of skilled labor and continuing demand, which together mean any workers who are made redundant will rapidly find new jobs, said Ahsan Mansur, an economist and executive director of the Policy Research Institute .Others downplay the problem, even if obstructed evacuation routes are known to constitute one of the major risks to workers.

"If the aisles [between lines of production] aren't blocked then it's not a real factory," said one owner of a series of factories producing for western retailers.

The scale of the problem means reforms are bound to be slow, Reddy, the ILO chief, believes

Figure: Bangladeshi firefighters battle a fire at Taren garment factory in Savar

Figure: A damaged factory hall after a devastating fire Aswad Composite Mills at Mauna

1.4 Motivation

The motivation towards working on this research and development program was originated from the view of massive fire occurrence in Bangladesh and it is increasing rapidly day by day. The existing fire extinguishing system is working according to our needs but we wanted to establish an innovative idea and make more feasible and reliable system .Thus we can reduce losses than before and protect human life and property.

1.5 Project Overview

Our project is divided into two parts –

- Software
- Hardware part

The fire detection and camera controlling is the software part and implementation ,integration and application is the hardware part .As we are making a monitoring system we choose the non-thermal detection technique type that uses purely color based system to detect fire [T5] [T6] [T7] [T8] [T9] [T10] [T11] and for this purpose we have chosen a IR camera . We used RGB and HSV and the color threshold technique [8] to isolate the fire pixels thus making us capable of detecting fire using a simple method. Because of its simplicity this method of approach can be used in any number of ways on any type of camera.

Software Design

The software for the robot was coded in MATLAB, because of compiler availability, our familiarity with the language, as well as the greater control of the system offered as compared to other higher languages. While our Microcontroller supports assembly, it was avoided because it’s a difficult to maintain, and varies greatly from processor to processor. MATLAB allowed us to easily break apart the components of software design so that different members of the team could code the system. The software design had four major components, including interfacing its peripherals and image processing, control of its motors and servos, navigation, and target acquisition. In fire detection section, we used three types of MATLAB format and in smoke detection section, we used gas sensor.

1.6 Summary of the Following Chapters

In the next chapter of the paper, the existing designs of fire extinguishing system Are clarified; also, the feasibility of the proposed system and the scope for improvement Are studied.

Then we discussed the software portion at first including fire and smoke detection process and formats (RGB, YUV and HSV).We discussed the isolating fire pixel process and its classification.

The development and comparison of control algorithms; and three different techniques for implementing these algorithms are also discussed in next part. Corresponding to each of these techniques, three extensional circuits were designed and tested. We discussed the instruments and materials that were used in our project (DC motors, Servo motor, Arduino Shield, Solenoid valve etc.) and the implementation process and camera controlling.

2. Fire detection

2.1. Input options

There are multiple sources that can detect fire in a room but these devises are not that fast active or that much accurate. As fire can spread to the entire room in nothing more than two minutes [7] or it cannot be approachable in less than one minute [8] it becomes unavoidable that we need a much more modern and effective system that can detect fire between smoke and other obstacles. Thus the best way to determine where the fire is to use a video input devise such as a camera. There are many types of cameras out there but the best camera would be to use a thermal camera as it can detect the heat from the fire and it has the best chance to detect fire as fire has a temperature which is above any other objects. But the thermal camera is expensive and we want to create a system that is low in cost but is effective any were. Thus we take a normal IR camera and use different types of detection methods to fully detect fire. For our thesis we use an A4tech PK-760MB (mirror webcam) which gives us a normal field of view and enough accurate to be placed anywhere in the room (15x15 ft) and get a good detection. The only problem is that it takes video recordings in YUV format but by using small calculations we can easily rectify the small inconvenience.

2.2. Format Options

As our main input system is a camera which is taking a video there are a lot of different formats that we have to work with. The main two formats that we are working with is YUV and RGB. The camera that we chose the PK-760MB gives the files in the YUV format.

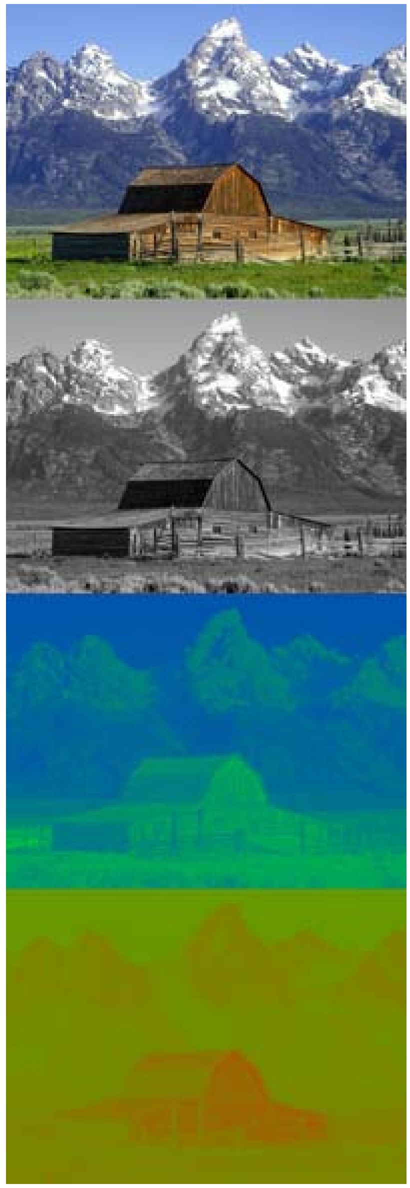


Fig 1: An image with its Y, U and V components

Here we are working with pictures and why we are using the picture detection for real-time fire detection we are going to explain it a little further down the line. The YUV is a color format where as we know it is part of the color imaging pipeline [9], where there are two different parts of the format where one packets them all in micro pixels and the other acts like three different planes and by combining the three planes we get the main image. The packet format of YUV is commonly known as Y, U (cb) and V (cr) and in the other format where each of them acts as a plane that is called normal YUV. Here Y is considered luminance and the other two are the chrominance components [9]. A small difference of the methods is given below.

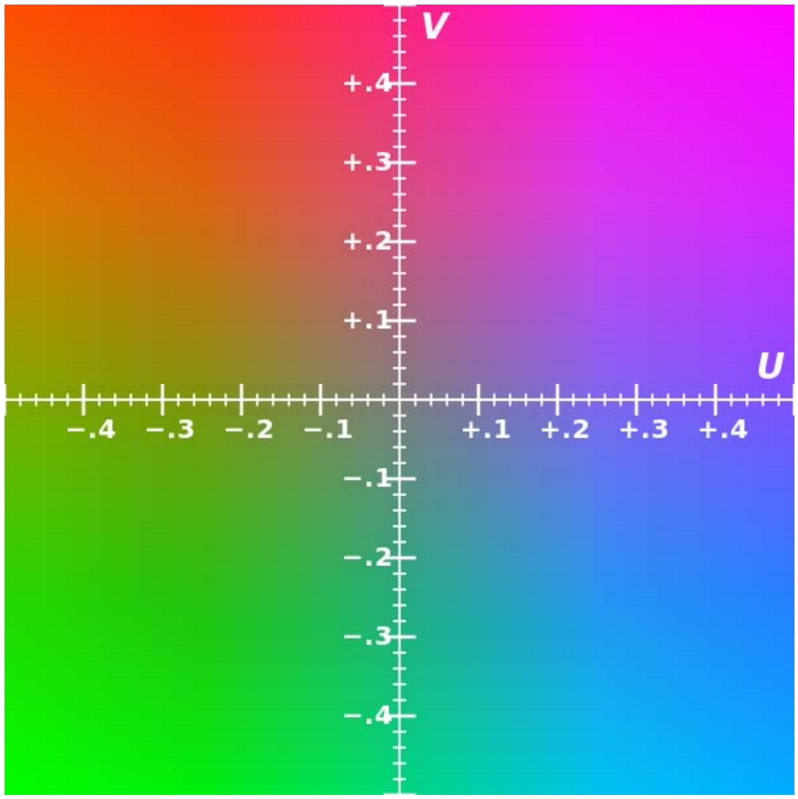


Fig 2: Different V and U values for Y=0.5

Now even though we get the file in YUV we also have to know about the RGB format as even though we are getting the file in YUV format as most of the detection algorithms are dependent on RGB format. The RGB format is a lot like the latter of the YUV formats as it is represented in three planes. RGB stands for red, green and blue. It means that the first plane is the red plane the second plane is the green plane and lastly the third plane is the blue plane. As the three plane join together as one to make the original picture we can understand how it is easier for us to use this technique. As we are familiar with the combinations we can easily start to make the combinations that can get us the desired pixels we need and the RGB values also have a limit. Unlike HSV or

YUV the range of the RGB values is 0-255 where 0 is the smallest value and 255 is the biggest value.

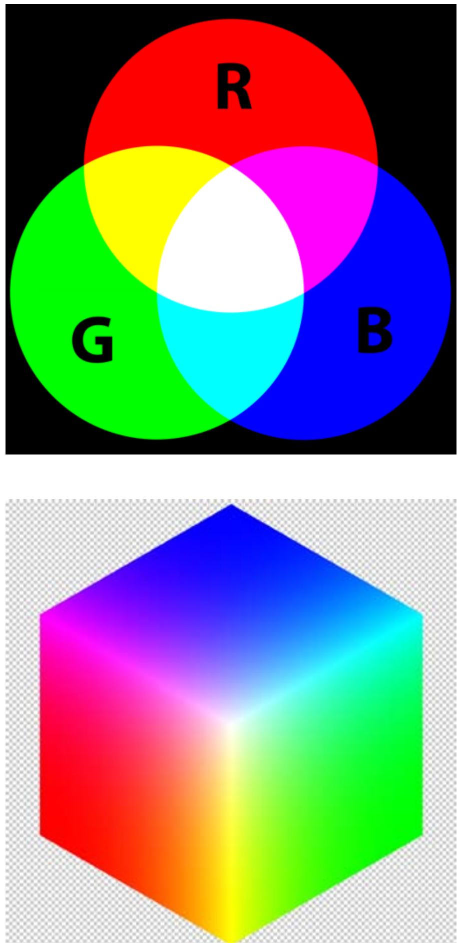


Fig 3: the three planes and combinations of RGB

But as our camera is giving a YUV format video then we need to change the format from YUV to RGB then the equations according to [13]

$$Y = (0.257 * R) + (0.504 * G) + (0.098 * B) + 16 \qquad \text{(i)}$$

$$V = (0.439 * R) - (0.368 * G) - (0.071 * B) + 128 \qquad \text{(ii)}$$

$$U = - (0.148 * R) - (0.291 * G) + (0.439 * B) + 128 \qquad \text{(iii)}$$

2.3. Fire pixel

The fire pixels are pixels that actually represent the fire. Meaning that in a image the pixels that make the fire are those we can call fire pixels but to identify a pixel as a fire pixel is tough as we can see from fig 4 that different fires have different RGB values meaning that there can be a big difference in color and shape as those two are almost never the same.

Fig 4: Different types of fire

2.4. Fire pixel detection

Thus instead of taking a single point of RGB value like many companies gives the values of fire like (170, 66, 3) are the values of red, green and blue respectively [10]. This creates problems because as we mentioned above that different fires have different fire values as such they have different color values. This hampers the idea that only one value will work on all the types of fire. So to work around this problem what we do is instead of taking just one value we take a range of values. By doing that we get much more capable result and we don't have to worry about not isolating it. The range that we picked for the thesis is

i. R= greater than 250 (iv)

ii. G=greater than 190 (v)

iii. B=greater than 165 (vi)

And we also apply the theory that R>G>B. So the range 250 to 255 for R 190 to255 for G and 165 to 255 gets us fire but this range was selected because in the normal household fires and basically the normal fires the color of the fire is not fully reddish but there is a white part to it and that is the part that we want to isolate. If we take only the pixels that are in the range and meet the condition we get images like in fig 5

Fig 5: separated fire pixel

2.5. Video weaving

From the first we have been saying that our device is going to be detecting fire using a camera and cameras give us video output. Videos are actually a long stream of still images that are placed one after another. So what we do is we take frames from this video at a rate of 10 frames per second and converted them to still images. Thus we can apply the above mention techniques to separate the fire pixels and can get the places where there is fire. This is also where we apply the blob analysis. As our camera is getting a 640x480 image and we are going to apply the system in common household or factories we can account that there could be some fire that would be acceptable (i.e. for cooking). So this is where we apply blob analysis to determine the limiter to how much fire or at what level the fire has to be for the device to actually pick up the fire. We came to a conclusion that a area of 80 pixels is the lower limit meaning that if the fire has a area of 80 pixel in the image then the system will detect it otherwise it will not be detected and it will not detect as fire. After applying the blob analysis we get the final image but that is only a very small part as that is only the first frame. Thus we take the next frame and run the process again and again and converting the final image to frame and weaving the frames together so that we can get the video of the detected and singled out fire.

2.6. Results and limitations

After using the techniques we get a video that is showing us the detected fire and only the fire [11]. We can also see that if there is an obstruction that it can't detect it and when the obstruction or obstructions are gone it works normally and thus we can detect fire only using a camera but it is not without any problems because there are some places that it detects false fire but that happens only when the camera is directly looking at sun that is why it is not applicable in the outdoors but it is perfectly capable of detecting fire in the indoors.

3. Hardware required

3.1 Arduino Uno

Two pieces of Arduino Uno was used in this system. Arduino Uno. The hardware consists of an open-source hardware board designed around an 8-bit Atmel AVR microcontroller. Arduino Uno has a clock speed of 16 MHz [13]. It was chosen for its available digital and analog pins, PWM generation ability, serial communication and low power consumption. Such attributes make Arduino Uno perfect for the given system. Two Arduino were used: one for communicating with the central station and one for driving and controlling the motors.

Fig: Arduino Uno

3.2 Motor shield

A shield in Arduino terms is a circuit board which coincides and fits perfectly with a basic Arduino board in order to serve a specific purpose. In this system, a motor shield has been used. A motor shield enables and Arduino Uno or Mega to run multiple motors at the same time. The motors can be in the form of stepper, servo or dc. A dc and a servo motor have been used in the system.

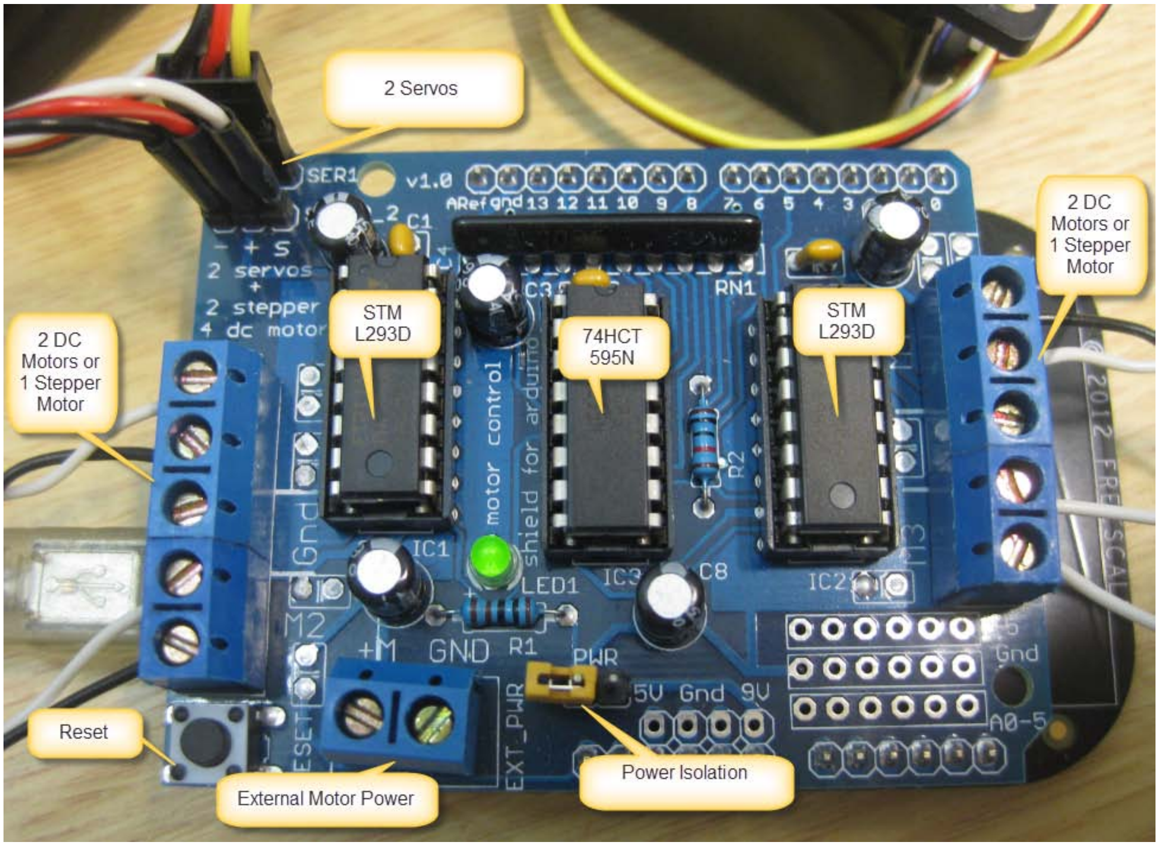


Fig: DK Electronics Motor Shield

3.3 DC motor

DC motors run on direct current. DC motors consist of one set of coils, called armature winding, inside another set of coils or a set of permanent magnets (to maintain a fixed polarity), called the stator[15]. Applying a voltage to the coils produces a torque in the armature, resulting in motion in a particular direction. [15]

Here are the essential parts of a DC motor

Stator

The stator is the fixed outside part of a motor [15]. The magnetic field is created by an electromagnet or a permanent magnet. In the former case, which is more popular, a

DC coil (field winding) is wound around a magnetic material that forms part of the stator[15].

Rotor

The rotor is the inner part which keeps in motion [15]. The rotor is composed of windings (called armature windings) which are connected to the external circuit through a mechanical commutator [15]. Both stator and rotor are made of ferromagnetic materials. The two are separated by air-gap [15].

Winding

A winding is made up of series or parallel connection of coils. Armature winding is the winding through which a DC voltage is applied for the motor to function[15]. Field winding is the winding through which a current is passed to produce flux (for the electromagnet) resulting in a rotation[15]. Windings are usually made of copper due its availability and ferromagnetic properties [15].

The ratings in this motor are 12V, 15 rpm. The rotations per minute has to be kept in check since if too fast, the camera attached would not be able to capture sufficient and stable frames for fire detection. Dc motor has been use to facilitate horizontal movement for a good 90 degree with both backward and forward. It stays connected to both the Arduino. A relay is attached to its live connection. So that it can stop on the spot once fire is detected.

Fig: DC motor

3.4 Servo motor

Inside a servo motor, there are a small DC motor, potentiometer, and a control circuit. The motor is attached by gears to the control wheel. As the motor rotates, the potentiometer's resistance changes, so the control circuit can precisely regulate how much movement there is and in which direction[16].

The servo motor in this project operates on 6V. Servo motors are mainly used for armature movement. The servo serves as a means of moving the supporting structure vertically with precision. The speed of servo motor can be varied. The speed of the motor can be controlled by providing consecutive pauses. A pause of hundred milliseconds was chosen after each degree movement of the motor.

Fig: Servo motor

3.5 Relays

Three relays were used in this system. Their voltage ratings were 6V. Two of them are normally closed. Relays here are used as circuit breakers. Whenever a fire is detected both the relays open their terminals via a command from Arduino, rendering both the motors stationary at that particular point. The other relay is connected to the solenoid valve. This relay is normally open and wpuld only close once fire is detected.

Fig: Relay breakout board

3.6 Solenoid valve

Solenoid valves are electrically controlled by the virtue of induced magnetic properties of a solenoid. When charged with a particular voltage, the solenoid gets magnetized and pulls the armature towards itself leaving the valve open. A high pressurized fluid is to be connected to the input of the solenoid valve. After the motors are in position, the valve is activated via a relay and the fire extinguishing fluid is sprayed.

The valve used here is a 1/4” input output, 12V operated valve.

Fig: ¼” solenoid valve

In choosing solenoid valve there were several factors involved. General purpose solenoid valves are used with a wide variety of liquids and gases in a broad spectrum of applications [17]. The capacity of a valve depends on the parameter “flow factor” (Cv) of the valve, referring to all operating conditions [17]. The Cv value is the number of U.S. gallons of water at 16°C (60°F) per minute that, when flowing through the valve, results in a pressure drop of 1 psi or 0.0680459639 atmospheric pressure [17]. This measure of capacity is usually stated for every model in their respective catalog. The five main parameters to consider when selecting a valve are: Cv, media compatibility, pressure, temperature, and process fitting. For each of these parameters, maximum values are listed for each valve[17] . To choose the correct valve compare each parameter and check that it is less than the maximum value listed.

In our application, the liquid is essentially incompressible and of low viscosity, and only the following factors need be considered in sizing a valve [17]

:

Cv = Flow factor of valve

Q = Flow expressed in U.S. gallon

per minute (GPM)

P = Pressure drop across the valve

(= P1-P2)

P1 = Inlet Pressure (psig)

P2 = Outlet Pressure (psig)

G = Specific Gravity of the fluid

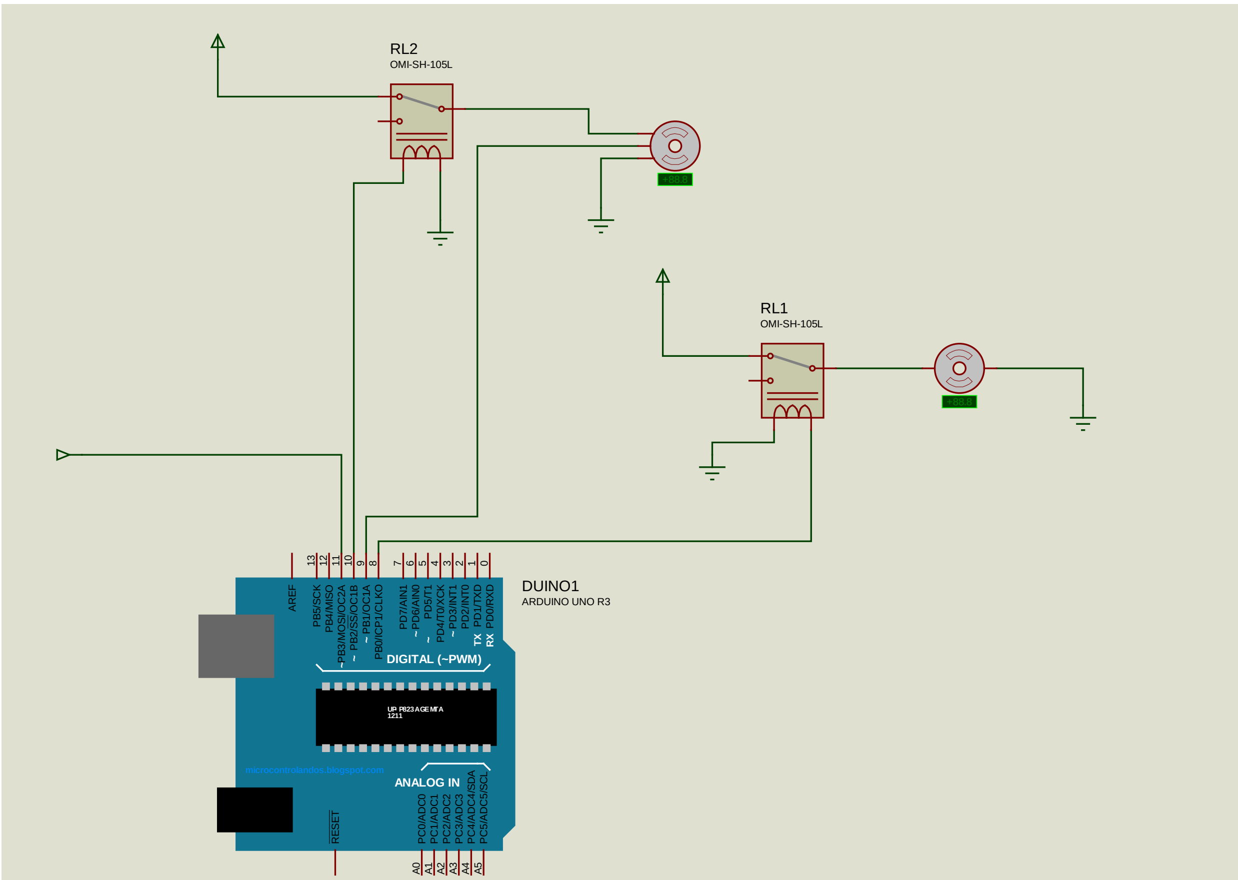
(G = 1.0 for water at 16°C (60°F)

These factors are related according

to the equation:

$$C_V = Q\sqrt{\frac{G}{\Delta P}}$$

3.7 Motor control circuit



4 Further Development:

4.1 Efficient fluid mechanism:

The cause of fire may be different so the destruction of fire may be different. By a research we can see that for different type of application we need different types of agents. This means that to extinguish fire, different types of extinguisher are needed for different kinds of things. For an example FM 200 is used for Electronics, medical equipment, production equipment, libraries, data centers, oil pumping stations, switch rooms, control rooms, FE 13 is used for Police evidence freezers, inerting natural gas pumping stations or trains/trucks/cranes operating in cold weather, wet chemical is used for commercial kitchen, ABC dry chemical is used for Paint booths, dip tanks, coating operations, flammable liquid storage areas, paint mixing areas, exhaust ducts etc. in our fire fighting system we used foam as our fire extinguisher, but only foam cannot be able to save all products. As a result we want to make such a system that will contain almost all types of fluid mechanism so that it can be used in anywhere to save any kind of product.

4.2 Model ready for manufacture:

In future we want to manufacture our fire fighting system so that it will be more beneficial.

4.3 Efficient use of wires:

First of all our models outlook is too complicated and it is difficult to carry because of the excessive use of wires. So we want to make a manufacturable model by decreasing the use of wires. It will give the system an attractive outlook and also make it easy to build, carry and use.

4.4 Compact Size:

Secondly the size of our system is small in compare with other fire fighting systems. As our system is automated so that it will work automatically and it has to be set on the top of a room so the size of the system should be more compacted and more lighter. We are going for a new design of the system with more attractive and compact in size.

4.5 GSM Modem:

GSM means Global System for Mobile Communications, originally Groupe Spécial Mobile. At first we want to add a GSM Modem with our system. GSM modem is a class of wireless modem devices that are designed for communication of a computer with the GSM and GPRS network. It requires a **SIM (Subscriber Identity Module)** card just like mobile phones to activate communication with the network. Also they have **IMEI** (International Mobile Equipment Identity) number similar to mobile phones for their identification. A GSM/GPRS MODEM can perform the following operations: Receive, send or delete SMS messages in a SIM and Read, add, search phonebook entries of the SIM moreover Make, Receive, or reject a voice call. The MODEM needs AT commands, for interacting with processor or controller, which are communicated through serial communication. These commands are sent by the controller/processor. The modem sends back a result after it receives a command. Different AT commands supported by the modem can be sent by the processor/controller/computer to interact with the GSM and GPRS cellular network.

Figure: GSM Modem

Our further task will be making such a system that when our fire fighter system can detect any fire, it will throw fire extinguisher fluid to the fire so that it can save an object initially. At the same time it will send a signal to the GSM Modem. So after getting the signal GSM modem will sent text SMS to the mobile phone of the authority so that they can be alert about the fire and can take necessary statements. Not only that but also the GSM Modem will create an alarm so that each and every person can hear the alarm and can go to a safe place to protect themselves. The SMS sending process will be differ depending on the amount of the fire. For an example, if the system will use for an office area then only few people of that authority will get the SMS when the amount of fire will be low, but when the amount of the fire will be too high then all the person of that local authority will get the SMS. By this every person can protect themselves and also protect their necessary and valuable things.

4.6 Outdoor durability:

Our next aim is to set our system not only for indoor system but also for outdoor service. Our system cannot differentiate the sunlight with fire. That is the main problem for using the system for outdoor purpose. To overcome this problem we have to modify the code used for running the system, so that we can save the outdoor environment from fire burnt.

5 Assessments:

The fire fighting system can move 90 degree angle, so it has to be used in one corner of a room to detect the position of the fire. So a single unit is enough to cover a 15 by 15 feet room. It is enough for a house to be protected. This system can be used not only for domestic purpose but also for industrial and commercial purpose. Structures like industrial shades would require more than one unit. Normally the standard length of an industry is average 100 meters. So for a 100 meters length industry we have calculated that we need 24 fire fighting systems. The amount of the system is low in compare to other fire extinguisher.

5.1 Cost:

The cost of fire extinguisher is very high in the whole world. By a survey it is proved that by using fire extinguisher the safety of the people are increasing but at the same time the price of the fire extinguisher are also increasing at the same rate. In compare to that fire extinguisher our fire fighting system is not too much costly. So it is more profitable than any other fire extinguisher.

5.2 Safety:

The fire fighting system is automated. So it can works automatically, no one has to operate the system or use it at risky position when fire hazard occurs. So it is too much safe in compare with other fire extinguisher. We know that fire fighting is a very risky occupation. Many people are becoming injured by using fire extinguisher, but automated fire fighting system can ensure us a safe environment without destroying anyone’s life.

6. Objective and Implementation:

The objective of our project is to minimize fire damage to the building and its contents. We know many building and many important and necessary things are becoming totally damaged all over the world due to not preventing fire. The most valuable is the life of a human. Many people are died and many people are injured for fire attack. Our aim is to prevent injury and loss of life. Now-a-days to extinguish fire, the fire brigades use a lot of water which is a loss of water. Moreover by this process they cannot reduce loss. By using our fire fighting system one can drastically reduce water damage resulting from fire fighting operations. Not only that but also it can prevent fire at the root level. So people can safe their life as well as their valuable things. Again our aim is to proven reliability as our system is much more reliable than any other fire fighting system. Furthermore, fire fighting system is not safe at all. Fire brigades have to be affected to extinguish fire. Our objective is also save the life of those people as our system can work automatically without any external help. At last we wanted to give people a new model of fire fighter that can help them to prevent, which they can use at their house and can punches it at a very reasonable price.

7. Conclusion:

In our daily life, whether it’s an industry or domestic, the most common and fatal accidents occurred are due to fire. This results in both human loss and property loss. Fires claim the lives of innocent people around the world every single day. A small amount of fire is able to damage a huge part of a society. Although smoke detectors and fire alarms alert people of danger, they often have few choices other than escaping from a building and calling the fire department. Although waiting for fire fighters to rescue people may not always be the best choice. The modern day home and business should be equipped with at least one fire extinguisher. Using modern fire extinguisher is not so easy and only a professional user can use it. Fire fighting is a highly technical profession which needs a lot of training and education to become a professional. So using a fire extinguisher is not at all suitable for people’s residence. For those purpose automated fire fighting system will be the best choice.

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