Design, Construction and Performance Test of an Automatic Fire Fighting System

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Abstract

In this study, a 5 kg laboratory ball mill has been designed, constructed, and its performance analysed. This was achieved by using Bond?s equation to calculate the specific and shaft powers required to drive the mill at the specified capacity, and also to size the mill. After the fabrication of the ball mill, grinding test was conducted with the mill, using limestone as the feed material. This was followed by the particle size analysis of the ground product from the mill in order to determine the performance of the mill. The design results show that the minimum shaft power required to drive the ball mill is 0.2025 horsepower, the length of the mill at a fixed mill diameter of 210 mm is 373 mm, and the required shaft length and diameter are 712.2 mm and 30 mm respectively. The results of the particle size analysis, before and after the grinding test, show that the values of F50, F80, P50, and P80 of the limestone that was fed into the mill are 650 microns, 1950 microns, 47.5 microns and 85 microns respectively. The fabricated ball mill is efficient in its performance as the value of P80 of the products from the mill (85 microns) is less than P80 (100 microns) used in the design of the ball mill.

Index terms— laboratory ball mill, bond?s equation, shaft power, milling efficiency.

1 Introduction

he responsibility of preserving and protecting an institution's collections, buildings occupants and operations requires certain attention to minimize adverse impact due to climate, pollution, theft, insects, and fire. Because of the speed of the destroying forces of fire, it is one of the most serious threats. Automatic fire control systems extinguish fires without human intervention. Some examples of automatic systems include fire sprinkler system and gaseous fire suppression. When fires are extinguished in the early stages, loss of life is minimal since 93% of all fire-related deaths occur once the fire has progressed beyond the early stages.

[1] With this information, the role and interaction of these supplemental fire safety systems in the protection process can then be better realized.

The heat from oxidation raises the temperature of surrounding materials, which increases the rate of oxidation and begins a chemical chain reaction of heat release and burning. A fire can progress from the smoldering phase immediately or slowly, depending upon the fuel, nearby combustibles, and the availability of oxygen in the surrounding air. **??**2] In the modern era, fire departments constitute a comparatively recent development. Their personnel are either volunteer (no salaried) or career (salaried). There is a different type of firefighter like volunteer firefighters are found mainly in smaller communities, career firefighters in cities. The modern department with salaried personnel and standardized equipment became an integral part of municipal administration only late in the 19th century. **??**3] This model presents an overview of fire detection, alarm and sprinkler systems including system types, components, and operations. The smoke sensor is highly sensitive and gas flammable and has the ability to quick-fire detection. It has a long life and low cost and compatible with the Arduino Uno board based on ATMEGE328 microcontroller. Smoke alarm attached with a detector can warn people when they are sleeping or busy or in a different part of the house but when they are not at home automatic controlling systems will control the fire.

2 II.

3 Literature Review

Different methods exist to provide estimates of smoke detector response based on optical density, gas velocity thresholds, and temperature rise. The objective of those types of the study was to assess the uncertainty associated with these estimation methods. Experimental data were used to evaluate recommended alarm thresholds and to quantify the associated error. [4] According to the survey, 96-97% of US households have at least one smoke alarm, yet in 2007-2011, smoke alarms were present in only three-quarters (73%) of all reported home fires and operated in half (52%) of all reported home fires. ("Homes" include one-and twofamily homes, apartments, and manufactured housing.) More than one-third (37%) of all home fire deaths resulted from fires in homes with no smoke alarms, while almost one-quarter (23%) resulted from fires in homes in which smoke alarms were present but did not operate. These lists are based on data from the U.S. Fire Administration's (USFA's) National Fire Incident Reporting System (NFIRS) and the National Fire Protection Association's (NFPA's). [6] New advanced fire suppression systems in recent years. Some of the newly developed fire controlling systems include halocarbon and inert gaseous agents, compressed air foam systems, and aerosol, water mist systems and gas generators. This paper describes the newly developed fire controlling systems and provides pragmatic information on the fire suppression performance of each Bashar, Khayrul ? Islam Nazmul ? & Abdullah Al Saeed ? system as well as the limitations or concerns related to using the new suppression systems. [7] The automatic fire alarm system provides real-time surveillance, monitoring, and automatic alarm. The early alarm sends when the fire occurs and helps to reduce the fire damage. Nowadays, wireless sensor network has become the most important technology in environmental monitoring and home or factory automation in recent years. An automatic fire alarm system based on wireless sensor networks is developed, which is designed for high-rise buildings are discussed in this paper. [8] A method of monitoring the condition of the battery of a smoke or heat alarm so as to provide a warning of an impending low battery condition, the said condition being that of a battery which has depleted to an energy level at and below which it is recommended that the battery be replaced to maintain the full 'functionality of the alarm device. [9] An apparatus for and method of detecting fires comprising detecting (With one or more detectors) levels of carbon monoxide, carbon dioxide, and smoke in an ambient environment, computing (using a processor) overtime rates of increase of each of the levels' and generating an alarm if one or more of the rates of increase exceeds predetermined threshold rates of increase. [10] An upright fire protection sprinkler having an input orifice at an input end of the sprinkler for receiving fluid and an output orifice at an output end of the sprinkler for outputting fluid. The sprinkler has a connection portion at the input end of the sprinkler and a body extending between the connection portion and the output end. A pair of frame arms extends from the output end and meets at a hub positioned in axial alignment with the output orifice. A detector is positioned on the hub and is configured to direct fluid output from the output orifice substantially in a direction back toward the output end. [11] Analyze the safety of the process. Multistate of the fire protection system is mainly expressed in the unit versatility and impact of external interference signals. Moreover, in a fire system, water supply system, power supply system, and an automatic alarm system achieve operation of the system through triggering and flowing of water signal and current signal. [12] X. Liao et al. [13] have provided an automatic fire extinguishing strategy with real-time monitoring, exploration and programmed fire alarm. The paper proposed an algorithm that sends an early alarm when the fire occurs. This system consists of a smoke detector and a temperature sensor whose outputs are connected to the control. The paper demonstrated their results by showing temperature and area in table format. The cost was calculated in Bangladesh Taka (BDT) currency.

A. ?EBKOWSKI [14] has proposed a system which comprises a smoke detector and a temperature sensor and outputs are controlled by a controller. The density of smoke takes into account and thus the probability of false alarms can be avoided. It consists of ATMEGA328, Ultrasonic sensor, Gas sensor, IR module, Motor, Water pump, Servo motor, Power supply. Flame and gas intensity were detected by the IR Sensor and gas sensor respectively and the signal was given to the ATMEGA328.If the flame is detected, the robot starts moving towards the flame. It is done by a motor. After detecting the location of the flame, the robot comes close to the location and the pump is turned ON till the flame is extinguished. A. Ahmed et al. [15] have developed a system with main purpose of controlling fires by using a sprinkler system. The system consists of smoke and temperature sensor which send a signal to the microcontroller. If temperature and smoke cross the safety level, a buzzer will be buzzing and spraying water by using pump via the sprinkler system. The paper showed prototype design for a home also. Justin Aaron Geiman et al. 1 shows the block diagram of three sensors such as a temperature sensor, a smoke sensor and a flame sensor which are connected with the microcontroller system. When the system will be on the buzzer is automatically buzzing and water will be spraying in the indicated area by using ac pump.

4 b) Schematic

In this circuit diagram (Fig. 2) Arduino Uno was used as a micro-controller platform. The smoke sensor MQ2 was attached with pin A0, the flame sensor was connected pin A1, the temperature sensor was attached at digital pin 3. Buzzer and LED was attached 12 and 8 pins respectively. The relay was attached by a pin 10. Dc and Ac power supply was provided for the total electrical system and ac pump respectively.

5 c) Construction

From Fig. **??**

6 }

In above, the Arduino Code has been shown that was used for this project. The codes were perfectly operated by the user and the output has been given in the result section. The performance of a fire fighting system greatly depends on the sensing capability of the smoke, temperature and flame sensor. When microcontroller gets signal alarm will operate otherwise it will wait for 1s. Microcontroller produced a satisfactory result which was shown in Table **??**, Table **??**I and Table **??**II.

Temperature Sensor Verification has been shown in table 1. In this method, it is designed to verify different temperature and if the temperature is more than our desire level then the pump will automatically on and the buzzer will be buzzing for different temperature such as 30, 40, 50 and 60 degree was considering individually. The different data table is given below in Table **??**.

Smoke Sensor Verification can be found by observing table 2. It is designed to verify different temperature and if the flame is more than our desire level then the pump will automatically on and the buzzer will make a sound for different temperature. Such as 300,400,500 and 600 ppm were considered individually. The data are given below in Table **??**I. Flame Sensor Verification is shown in Table **??**II. For verifying different temperature and if the flame is more than the desired level, the pump will automatically on and the buzzer will also make the sound for different temperature. If flame occurs within 0-1. 5 feet than it will "close fire" .If flame occurs in the range of 1. 5-3 feet, it will "distance fire" and rest there will no fire. V.

7 Results and Discussion

8 a) Result

From the above project the following results were found: Temperature Sensor 1. Everything went good in performance test. 2. Different temperature was coded and it worked perfectly, sometimes made small error for high temperature.

Smoke Sensor 1. Everything went good in performance test. 2. Some disturbance was observed for power supply.

Flame Sensor 1. Everything went good in performance test. 2. Small error was observed for poor component Some other component such as relay and ac pump, rotating sprinkler worked perfectly. There was a small leakage problem because pipe line was not perfectly constructed. 1. Remotely controlled aerial camera 2. Detecting fire 3. Automatically taking an action Automatic fire controlling system has become a great issue in this modern era. Every section of apartment building, bank, office, restaurant, market, parking place, police station, hospital, industry each and every portion of building its necessary to control the fire. Every scope of daily life now wants a promising and smooth fire-fighting system for a building. It would be one step ahead advantage if we can control fire automatically.

9 Future Prospects

Temperature sensor, smoke sensor, and the flame sensor will detect fire automatically and spraying water in controlling the area immediately so that fire cannot explode quickly and we control fire easily. [1]

1
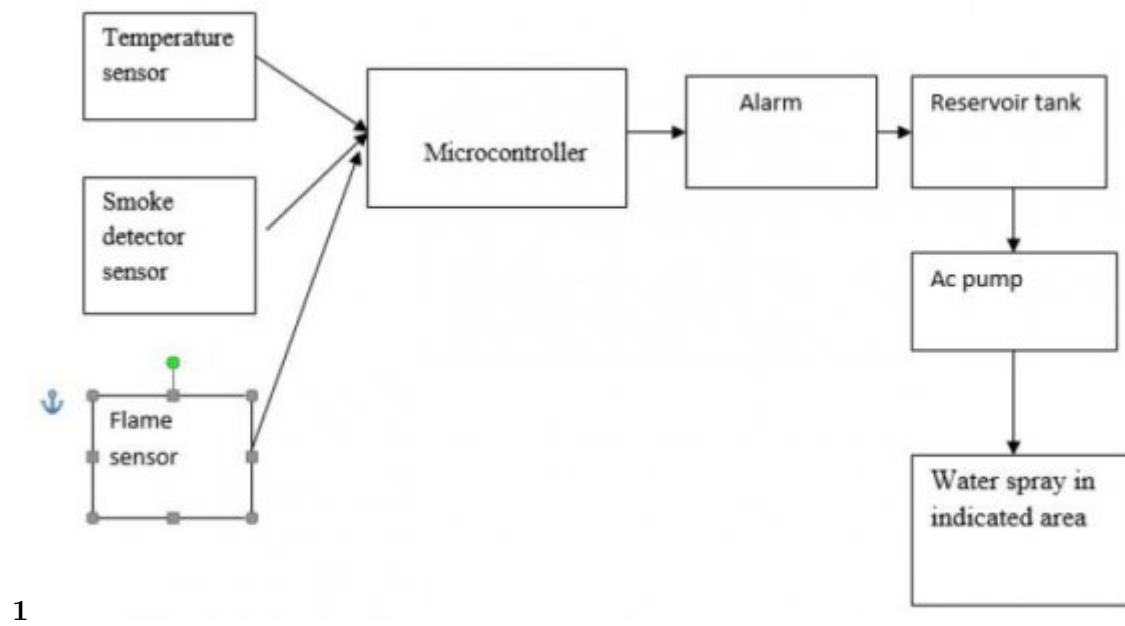
Figure 1: Figure 1 :

Figure 2:

Reservoir tank

Discharge pipe

Suction pipe

Controlling system

Rotating sprinkler

Control area

pump

(all dimension are taken in meter)
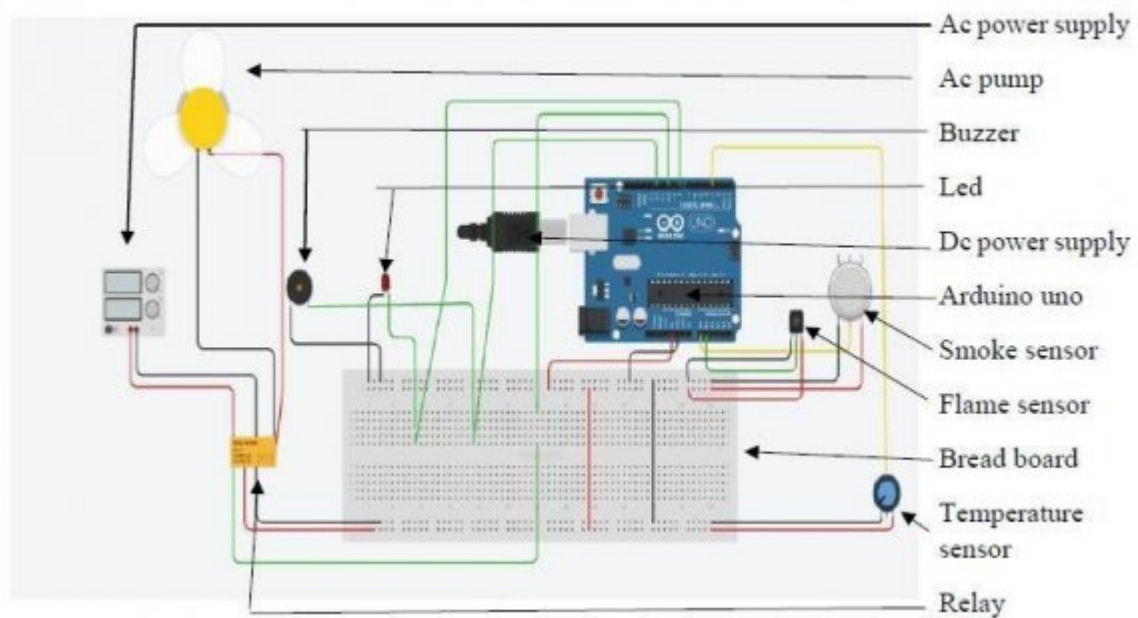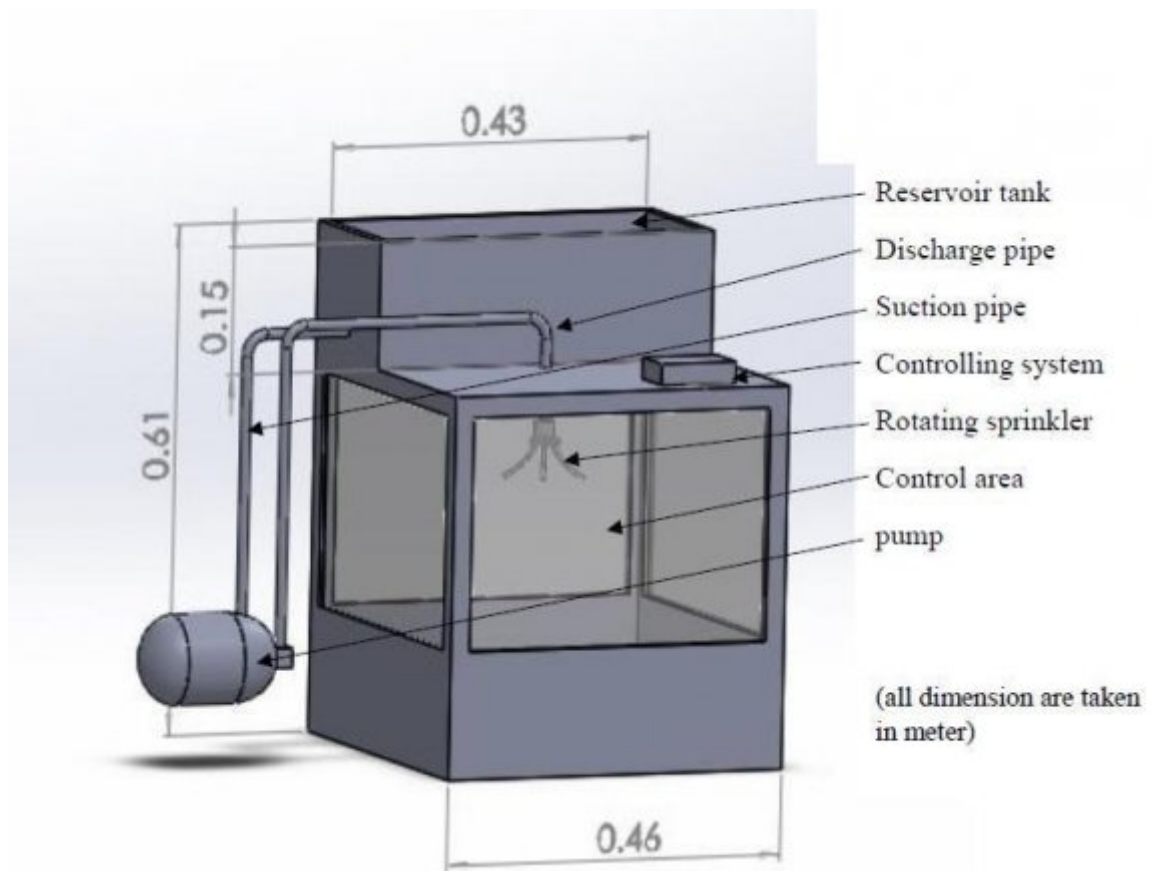
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Figure 3: Figure 2 :

Figure 4:

4

Figure 5: Figure 4

5

Figure 6: Figure 5 :

2

Figure 7: Table 2 :

3

Figure 8: Table 3 :

1

Experiment no.	Temperature (degree)	Verified	Command Sent
1.	0-59 degree	Yes	Not to start buzzer and pump, Green light on.
2.	60 or 60 plus degree	No	Start buzzer and pump, red light on till temperature below 30 degree.

Experiment no.	Smoke (ppm)	Verified	Command Sent
1.	0-559 ppm	Yes	Not to start buzzer and pump, Green light on.
2.	600 or 600 plus ppm	No	Start buzzer and pump, level below 300 ppm. red light on ti

Experiment no.	Flame distance (inch)	Command received	Verified	Command Sent
1.	2-18 inch	Close fire	No	Start buzzer and pump, red light on.
2.	19-34 inch	Distance fire	Yes	Start buzzer, yellow light on. pump is off,
3.	34-infinity inch	No fire	Yes	Not to start buzzer light on. and

Figure 9: Table 1 :

Fire Eliminator Robot -A mobile robot with features like: - 1. Thermocouple detection system. 2. Water reservoir tank. 3. Fire extinguisher system. Automatic SONIC FIRE EXTINGUISHERS SYSTEM Component Name 1. Temperature sensor Smoke sensor Flame sensor 2. Microcontroller (arduino uno) 3. Pump (12.5 hp) 4. Relay 5. led 6. Ic regulator 7. Resistance 8. Capacitor 9. Diode 10. Bread board 11. Sprinkler 12. buzzer 13. Pipe 1. No.	Number of equipment	Cost (BDT)
	2+2+2=6	200 500
	1 1 1 3	1200 30
	1 5 2 1	4.5 12 5
	1 1 2 3ft	3 1.5 100
	total	200 40
		50 2346 taka

Figure 10:

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Figure 11: Table 4 :

140 [Ilbert Alain and Garrick] , Lindsay Ilbert Alain , Garrick .

141 [AOSFST ()] , *AOSFST* 2001.

142 [2an-introduction-to-fire-detection-alarm-andautomatic-firesprinklers References Références Referencias (2018)]
143   '2an-introduction-to-fire-detection-alarm-andautomatic-firesprinklers'. `https://www.nedcc.org/`
144   `freeresources/preservationleaflets/3.emergencymanagement/3.` *References* *Références*
145   *Referencias* 2018. Jun-2018. 1 p. 14.

146 [Multer et al. ()] *AUTOMATIC FIRE PROTECTION SPRINKLER WITH EXTENDED BODY*, Thomas L
147   Multer , Westm1nster ,) Us , George Greer . April. 24 2012. (SC (Us). United States Patent, Patent No.:
148   US 8,162,069 B2, Date of Patent)

149 [Bangladesh Fire service Fireservice.gov.bd (2018)] 'Bangladesh Fire service'. `http://www.fireservice.`
150   `gov.bd/` *Fireservice.gov.bd* 2018. Mar-2018. p. 2.

151 [Xu et al.] *Building Fire Protection System Reliability Analysis Based on GO Method*, Ling-Ling Xu , Chun-Xiao
152   Li , Hui-Bin Du . Zhangjiakou 075000, China. Department of Management, Hebei Institute of Architecture
153   and Civil Engineering

154 [Cammeray (2000)] Marie Cammeray , Court . *FIRE DETECTOR SILENCEABLE LOW BATTERY PRE-*
155   *ALARM". United States Patent*, Jun. 27, 2000. (Patent Number: 6,081,197)

156 [Chen and Fe (2006)] Shin-Juh Chen , Santa Fe . *FIRE ALARM ALGORITHM USING SMOKE AND GAS*
157   *SENSORS ". United States Patent, Patent No.: US 7*, Nov. 28, 2006. p. .

158 [Delichatsios et al.] M A Delichatsios , B Z Dlugogorski , E M Kennedy . *RECENT DEVELOPMENT IN FIRE*
159   *SUPPRESSION SYSTEMS" .Proceedings*, p. 5.

160 [Ahmed and Mansor ()] *Design and Fabrication of an Automatic Sprinkler Fire Fighting System*, A Ahmed , A
161   Mansor . 2015. p. . (Design and Modeling of Mechanical Systems -II)

162 [Zhang and Wang] 'Design and Implementation of Automatic Fire Alarm System based on Wireless Sensor
163   Networks'. Lei Zhang , Gaofeng Wang . *Proceedings of the 2009 International Symposium on Information*
164   *Processing (ISIP'09)*, (the 2009 International Symposium on Information Processing (ISIP'09))

165 [Electric Vehicle Fire Extinguishing System PRZEGL?D ELEKTROTECHNICZNY ()] 'Electric Vehicle Fire
166   Extinguishing System'. *PRZEGL?D ELEKTROTECHNICZNY* 2017. 1 (1) p. . ?EBKOWSKI

167 [Aaron Geiman ()] *EVALUATION OF SMOKE DETECTOR RESPONSE ESTIMATION METHODS*, Justin
168   Aaron Geiman . 2003. University of Maryland, Master of Science

169 [iaff266.com -iaff266 Resources and Information (2018)] `http://iaff266.com/flashover` *iaff266.com*
170   *-iaff266 Resources and Information*, 2018. May-2018. p. 18. (Iaff266.com)

171 [Ahrens (2014)] *Smoke Alarms in U. S. Home Fires". National Fire Protection Association Fire Analysis and*
172   *Research Division*, Marty Ahrens . March 2014.

173 [Liao et al. ()] 'The Design and Implementation of Automatic Fire Extinguishing and Explosion Suppression
174   System's Testing Equipment'. X Liao , H Shan , Z Quan , L Peng . *Applied Mechanics and Materials* 2014.
175   p. .