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PRINCE MOHAMMAD BIN FAHD UNIVERSITY

**College of Engineering**

**Department of Mechanical Engineering**

Fall 2020-21

# Senior Design Project Report

# Design and Manufacturing of a Ball-Shaped Device for Detecting Life during Fire

**In partial fulfillment of the requirements for the Degree of Bachelor of Science in Mechanical Engineering**


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## Abstract

The purpose of this research is the designing and manufacturing of a fireproof ball build-in with a 360 Camera. The Fireproof ball is designed and manufactured for use during firefighting of a building. It will be through in the building. The 360 Camera will help for the better understanding of the behavior of fire and what is going on in the building. This will help the fire fighter to understanding the behavior of the fire and if there are people who need emergency exit. Ultimately it will help them understanding the how to deal in a better way with this unfortunate Situation, which will help to reduce the risk of injury as well as casualties.

This idea came from the Fireproof ball which serve as a fire extinguisher during the fire. For its modeling, first the Solid works was used. For the manufacturing purpose, a fireproof material is used which can withstand at high temperature of the fire. This fireproof camera can be connected to any electronic device (Tab, Mobile, LCD), which will help the fire fighter about better understanding of the behavior of fire as well as the as condition of the structure of building.

## Acknowledgments

Before anything, we need to pay our special gratitude to our advisor <advisor name> for his continuous support and encouragement towards our project. Moreover, we pay sincere thanks to other co-advisors who helped us and guided us. We are also extending our gratitude to <chair name>, chair of Mechanical Engineering Department at KFUPM, for his continuous encouragement. Lastly, we thank our parents and colleagues who provided their continuous support, attention, and encouragement for our project.

## List of Acronyms (Symbols) used in the report:

| | |
|---|---|
| $ | US Dollar |
| W | Watt |
| m | Meter |
| K | Kelvin, Thermal Conductivity |
| Kg | Kilogram |
| ˚C | Degree Celsius |
| Sec, s | Second |
| g | Gram |
| d | Diameter |
| L | Length |
| F | Force |
| a | Acceleration |
| $\theta$ | Theeta (Angle) |
| $C_D$ | Coefficient of Drag |
| Q | Heat Transferred |
| A | Area |
| $\Delta T$ | Temperature Difference |
| psi | Pounds per Square Inch |
| $v$ | Poisson's Ratio |
| MPa | Mega Pascals |
| J | Joules |
| ˚F | Degree Fahrenheit |
| h | Enthalpy |
| mAh | milli-Ampere per Hour |

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# Chapter 1: Introduction

## 1.1 Project Definition

The purpose of the project is to design a ‘Fireproof Camera Ball’ which can help during firefighting.
Fireproof Camera Ball is basically a camera which is inserted into a ball like structure. This ball is built with fireproof material and is able to cover a 360 orientation with the help of the camera which is installed in it.
The Camera in the connected with any electronic device (Tab, Mobile, LCD), which will help the fire fighter about better understanding of the behavior of fire as well as the as condition of the structure of building.
The Material use is should be having minimum thermal conductivity and high melting point. The material we select is Aluminum. it can withstand with a high fire temperature, so it is suitable for the outer structure of the fireproof ball. The Cameras Covering the 360 view are covered with the high temperature resistant glass, which will support the cameras in such a high temperature.
The person Watching all the 360 view of the fire place can better handle the firefighting team. This idea is basically come from the fire extinguisher ball which we through into the fire place.

## 1.2 Project Objectives

This major purpose of this project is to help the fire fighter in better understanding the behavior of the fire in the building, which can result in the reduction of risk of injury as well as casualties. It will serve like a robot at a single place standing inside the fire place and will be able to give a 360 view.
The person Watching all the 360 view of the fire place can better handle the firefighting team. This idea is basically come from the fire extinguisher ball which we through into the fire place. Knowing the highly instance fire place in the building which is on fire can help the fire man.
The main purpose of the fire proof camera ball is to avoid firemen from going to the dangerous region of fire.
It is also common scene for police and that of emergency services. They want to enter the building but they don't know what awaits them inside.
This is design after being inspired by the idea of the fire extinguisher ball use during the fire fighting.

## 1.3 Project Specifications

Basic model of the Fire Proof Cmera Ball is folloing:

Figure 1 3D Model

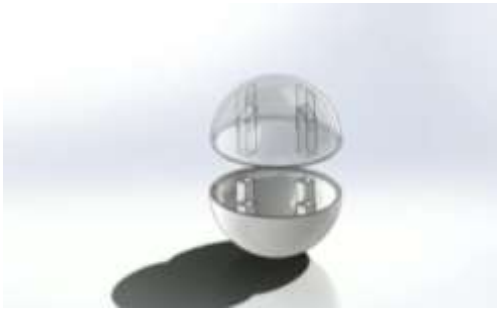


Figure 2 Second 3D Model

a. Metrics

We used a camera ball which can be thrown upward and can cover the 360 degrees view. It is made of 36 numbers of 2 mega-pixel and final image can reached up to 72megapixel mark. But basically, it main function is not the lenses, it is integrated with the accelerometer

Figure 3 Ball Camera

Figure 4 Ball Camera Inside View

Main body of the camera is made from Stainless steel 304 due to its lower thermal conductivity.

b. Project Specifications with respect to Market

- The product is a little expensive
- It is easy to handle
- Portable
- Light weight
- Automatic
- Environment Friendly

c. Engineering Standard

Material should be fire proof for this purpose

- Material should be having Low thermal Conductivity.
- It should be having a high melting point.

We use Stainless steel 304 due t its very low thermal conductivity.

## 1.4 Applications

This technology has following application:

- This technology can be used to build a fire proof ball camera, which will help in the fire fighters by giving them the idea of the behavior of fire in different places of building on fire by throwing camera ball at different places of the building.
- It can be used assists the Police, by throwing these camera ball they will be able to know what waits them in different part of the building.
- Fire Extinguisher Ball.
- The simple ball camera is also used by the people to take picture at 360 degree at a height by throwing it upward.

# Chapter 2: Literature Review

## 2.1 Project background

Project basic part is camera.
A **camera** is the optical instrument which is **used** in recording the images. It is basically having a body having a small hole in it. This small hole permits the light in for capturing the image on the light-sensitive surface which is usually photographic film or the digital sensor.

Figure 5 Mini Camera

Camera now these days is an essential part of every smartphone. Photography itself is a big profession, people love caught the memorable moment of life in pics by the use of camera.
There is wide list of the quality of the picture which depends upon the Resolution and a common term for mobiles is Megapixel.
There are 36 number of cameras use in our project which are of 2 Megapixel each.
The use of camera is increasing in wide range and in different fields like:

- Photography
- Movie Making
- Catching different events
- Camera is now being used for the security purpose in the form of CCTV camera in shops, street, home and in wide range of market.

Figure 6 CCTV Camera

- In our project we are using the camera in the farm of a ball to help the fire fighters in their operation by inserting camera ball into fire proof material say Aluminum alloys.
- These cameras can even be used by the police to see what awaits them inside by throwing the camera ball inside the building.

Figure 7 Camera Ball

Idea of the Fire proof Camera ball is originated from the fire extinguisher ball, having similar geometry and is also used in the same way but its purpose as fire extinguisher where it is being thrown.


Figure 8 Fire Ball

## 2.2 Previous Work

This portion is for the research work we made up till now, by study the previous studies.
As far as the project is concern, previously there is little work for this topic. Different researcher has their different ideas, like closest to this the research work on the

- Fire Extinguisher Ball
- Simple Camera Ball
- Fire proof Robot as a Fireman

Combining their research work help me to work on my project of Fire Proof Camera Ball
Basically, my project is the combination of all describes work.
Using this Researches I got much help for my product design related to

- Design
- Material selection
- Manufacturing
- I use Stainless Steel type 304 for the outer body of the fire proof ball camera.
- I use 36 cameras all having 2 Megapixel
- Fire rated Glass

## 2.3 Comparative Study

For the project, I go through many research papers, out of three I have discus in previous work.
These were related to the following topics:

- Fire Extinguisher Ball
- Simple Camera Ball

- Fire proof Robot as a Fireman

Taking a comparison between these topics and my project research
Considering the **fire extinguisher Ball**, it was basically the point I got an idea for the Fireproof ball camera.
Taking a comparison, it basically is a ball which act like a fire extinguisher when throw in fire. These are also where there is risk of fire as a prevention.
On the other hands my project will have the same methodology of throwing into the fire but its purpose is different, its purpose to capture the inside view of the fire place so that it could be helpful for the fire fighters.
Considering the **Simple Ball-Camera** it gave me the idea how I am going to build a fire proof camera in the form of a ball.
Considering a comparison, the simple ball camera is used to capture 360 degrees view at a height when thrown upward, while my project involves its undated version, which will also be fire proof.
Considering the **Fire Proof Robot**, I get a complete idea how my project is going to deal with the fire, which material I am going to use.
Considering a comparison, you can say that a fire proof robot is even the undated version of the fire proof ball camera. I cannot only give you the understanding of the behavior of the fire inside the building but also will act as a fire extinguisher and can move here and their due to the complex programing in it
It basically using Aluminum alloys as the main body structure, but in my project, I am going to use the Stainless steel 304, which have higher melting point with comparatively lower thermal conductivity.

# Chapter 3: System Design

## 3.1 Design Constraints and Design Methodology

1st we draw the geometry design on the Solid Works and the and researches about manufacturing and its design Constraints, i.e, how it is going to behave with respect to these constraints.

**Geometric Constrains:**

Constraint is something which controls you by keeping you in particular limits for what you do.

Taking about Geometric constraints, these are the dimensional conditions which one imposes on the other geometric dimensional operations.

- Our project is model by keeping in the geometric constraints.
- Two circular dome are join together which contains almost 36 cameras.
- It will be having a weight of 400g at final.

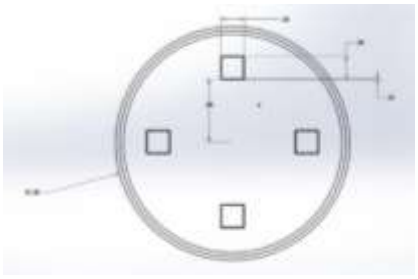


Figure 9 2D Design

Figure 10 3D Model

- Geometric constraints were applied while designing the geometry for the project

**Sustainability Constraints:**

Sustainable design required the reduction of the negative impact of the design on the environment, comfort and on health of the building occupants, and improving performance of the building.

Sustainable design Principles:

1) It should optimize site potential.
2) It should minimize energy consumption of the non-renewables.
3) Use of the Environment friendly products.
4) There should be minimum water waste.
5) Product should design such to increase operational and maintenance practices.

- Design of Fire Proof Camera Ball measured the sustainability constrains.
- There was no waste of water.
- Using a fire proof camera will increase the efficiency of the firefighting staff.

**Economic Constraints:**

Major purpose of the economic constrains is to control the cost of the product and make it market compatible.

- We have use best possible economical material which can serve our purpose in better way to minimize the product cost, so in this way our product is under the economic constraints.

**Environmental Constraints:**

Environment Constraints are the boundaries by which limits the production which are harmful for the environment even if they are cheap and efficient.

- The product we are going to design does not has any negative impact on the environment.
- It does not have any noise, land or air pollution.
- It is used to help the firefighting team in firefighting operation, ultimately saving environment from the pollution and is lifesaving.

**Health and Safety Constraints:**

Major purpose of the health and safety constraint is to make a product which does not have any negative impact on the health and Safety. It should be design for the betterment of the life quality of human beings.

- As far as the concern of the health and safety, the purpose of the designing of the product is safety. These fireproof cameras are going to be use for the safety of the firefighting team and to help them in their firefighting operation.

**Manufacturability Constraints:**

Major concern of this constraint is to design such a product which is easy to manufacture. Production of its parts and its assembly should take in mind which designing the product and should have an acceptable cost.

- We have tried our best to make a design which will be very easy to manufacture, it has such an assembly design that you can even assemble it at home.

**Social Constraints:**

Purpose of the social constraint is to design a product such that it should be according to the requirement of the human and it should address the social issues.

- The major purpose of our product design is to address the firefight issue and be a product which have a great social impact to save people life by reducing the danger for firefighters.

**Ethical Constraints:**

Major purpose of this constraint is not to design a product which may result to heart the people feeling. There is code of conduct for this and you should be well aware of these code of conduct while designing your product. Its purpose should not be to hurt any religion, beliefs and law of the state. Product should be design to be acceptable socially worldwide.

- Fire proof camera ball doesn't have any negative impact on the define constraint.
- It is design under the define ethical constraint.
- It is not against the feeling, beliefs of people.

  But is have a negative point with respect to the Ethical constraint.

- This product has some concerns related to the people privacy.

**Comparative study of these Constraints**

Primary represents the comparison between fireproof call camera designs and 360 view coving camera design
Secondary represents the comparison between this design and other designs to capture the moments.
Yes mean the product is up to the mark
No means there is some conflict with these constraints

Table 1 Comparative Study of Constraints

| | Primary | Secondary |
|---|---|---|
| Economic | yes | No |
| Environmental | Yes | Yes |
| Health and Safety | Yes | Yes |
| Manufacturability | Yes | Yes |
| Sustainability | Yes | Yes |

| | | |
|---|---|---|
| Social | Yes | Yes |
| Ethical | Yes | No |

## 3.2 Engineering Design standards

### Standards and Codes

Code, standards and specifications are very important and are often essential for the technical documents in engineering and also in related technical fields.

Aa the fireproof camera ball is going to be used during firefighting, so person using this devise and instructor should be aware of the standards and codes of the FIRE (NFPA). So, they can use this while keeping them safe.

There are some standards which are very critical for it.

**NFPA 68:**

It is the standard by the national fire protection association for estimating dimensions of the Fireball. It can to set the dimension for the Camera Ball.

**NFPA 1001:**

NFPA 1001 Standards for the Fire Fighter Professional Qualifications is the widely required training for the new hires.it is a prerequisite for the entry to other NFPA professional standards training. It is both IFSAC and ProBoard accredited.

**NFPA 1500**

NFPA 1500 is the Standard on **Fire Department** Safety and Health Program. It specifies minimum **requirements** for the health, occupational safety and wellness program for the fire departments which provide rescue, **emergency** medical services, fire suppression, hazardous materials mitigation and special operations.

- **NFPA 101:**

It Is the Standard for Fire Fighter Professional Qualification. It identifies minimum job performance requirements for career and that of the volunteer fire fighters whose duties are primarily structural in nature.

## 3.3 Theory and Theoretical Calculations

**Theory:**

A **camera** is the optical instrument which is **used** in recording the images. It is basically having a body having a small hole in it. This small hole permits the light in for capturing the image on the light-sensitive surface which is usually photographic film or the digital sensor.

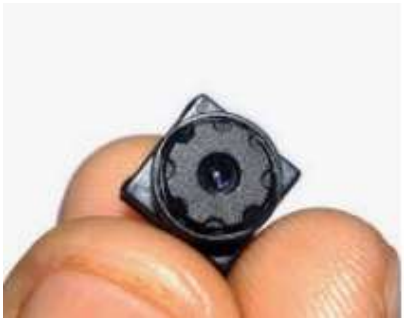


Figure 11 Mini Camera

**Focal Length of the camera:**
Focal length is the distance between lens and that of image sensor when subject is in the focus. It is stated in the mm.
A higher focal length means a bigger zoom and the lower number shows that lens can be used for wider shots.
Idea will be clear by the example that camera with focal length lower than the 30-50 mm will take in the bigger view than you naturally see but with higher numbers focus will be on a smaller aspect of your view.
**Pixel:**
Pixel is basically a tiny dot of color which is the part of the digital image.
A megapixel contains one million pixels in it. When light which flows through **camera** lens is captured in to device inside of camera which is called Image Sensor, then pixel is created.
We are using 36 cameras, each having 2 Megapixel. The final image will be according to the mark of the 72 Megapixel.
**Outer Body Material:**
The material we chose as the outer body of the fireproof camera is Stainless Steel 304
Major properties of concern while choosing the material are:

- **Melting Point**
- **Thermal Conductivity**

**Melting Point:**
Melting point of a material is the temperature at which it changes the state from solid to that of liquid.
Solid and liquid phase exist in the equilibrium at the melting point. Our requirement was to select a material with high Melting point.
Melting point of the Stainless steel 304 is (1400 - 1455 °C).
**Thermal Conductivity:**
Thermal conductivity is as rate at which the heat is being transferred by the conduction through a unit cross-section area of the material, when there exits a temperature gradient perpendicular to the area.
Our requirement to chose a material with low thermal conductivity comparatively.
Thermal Conductivity of the stainless steel 304 is 16.2 W/m-K.

## Calculations:

We are designing a fire proof camera ball, which we will throw into the building to see the inside view of the fire place of the building which is on fire.
Height the ball is going to cover depends upon its weight, initial velocity and time factor.

$$v_y{}^2 = v_{oy}{}^2 + 2\, a_y\, (y - y_o)$$

Here is the formula which give us about the initial velocity needed.
Now talking about the force and mass relationship

$$F.d = (m\_ \div \_2)v^2.$$

This equation will help me to find the force, knowing the mass = 400g
And velocity from

$$v_y{}^2 = v_{oy}{}^2 + 2\, a_y\, (y - y_o)$$

We will be able to calculate the required force need to throw a ball of mass m at a distance of Y.

$$\textbf{Max Height} = d_{ymax} = (V_0 \sin\theta)^2/2a$$

This formula given required angle we know at what height to throw the ball

**Drag Force:**

drag equation states that drag D which is equal to that of the drag coefficient Cd times that density r times half of velocity V squared times the reference area A.

$$F_D = \frac{1}{2}\rho v^2 C_D A$$

**Thermal Conductivity**

Ball camera is going to be thrown into the fire, so the thermal conductivity of the material is very important.

$$K = (QL)/(A\Delta T)$$

Where,

- K represent thermal conductivity in W/m.K
- Q represents amount of heat which transferred through material in W.
- L show distance between two isothermal planes.
- A shows area of surface in m^2
- ΔT is temperature difference in K.

Knowing the value of the Q, L, K and A, we can find how much temperature change the material will experience.

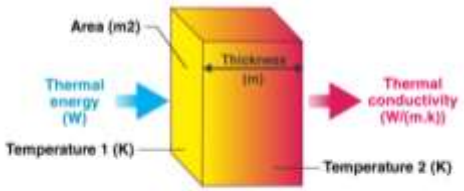



Figure 12 Heat Transfer Diagram

**Stainless steel 304:**

304 stainless steel is the T 300 Series of Stainless Steel austenitic. It composed of:
Minimum of 18% chromium, 8% nickel, combined with a maximum of 0.08% carbon. It is defined as a Chromium-Nickel austenitic alloy. Grade 304 is the standard "18/8" stainless that you will probably see in your pans and cookery tools.

## Mechanical Properties:

**Brinell Hardness:**

170 to 360

**Elastic (Young's, Tensile) Modulus**

200 GPa29 x $10^6$ psi

**Elongation at Break**

8.0 to 43 %

**Fatigue Strength**

210 to 440 MPa30 to 63 x $10^3$ psi

**Poisson's Ratio**

0.28

**Shear Modulus**

77 GPa11 x $10^6$ psi

**Shear Strength**

400 to 690 MPa58 to 100 x $10^3$ psi

**Tensile Strength: Ultimate (UTS)**

580 to 1180 MPa84 to 170 x $10^3$ psi

**Tensile Strength: Yield (Proof)**

230 to 860 MPa34 to 120 x $10^3$ psi

## Thermal Properties

**Latent Heat of Fusion**

290 J/g

**Maximum Temperature: Corrosion**

420 °C790 °F

**Maximum Temperature: Mechanical**

710 °C1300 °F

**Melting Completion (Liquidus)**

1450 °C2640 °F

**Melting Onset (Solidus)**

1400 °C2550 °F

**Specific Heat Capacity**

480 J/kg-K0.11 BTU/lb-°F

**Thermal Conductivity**

16 W/m-K9.2 BTU/h-ft-°F

**Thermal Expansion**

17 µm/m-K

## 3.4 Product Subsystems and selection of Components

**Folloing material was selected for the Manufecturing of the FireProof Camera Ball.**

- Battery
  4v and 2000mAh

Figure 13 Battery

- Processor

Figure 14 Processor

- Memory card for  video recording
  32GB

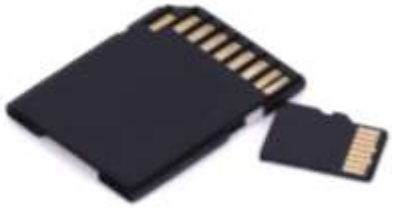


Figure 15 Memory Card

- Electric wires

Figure 16 Electric Wire

- Cicuit board

Figure 17 Circuit Board

- Fire Rated Glass
- Transsitors

Figure 18 Transistor

- Fuese

Figure 19 Fuses

- Diodes

Figure 20 Diode

- 36 mini cameras having 2 Megapixel

Figure 21 Mini Camera

- Heat resistant thermopole
- Stainless Steel 304

## 3.5 Manufacturing and assembly (Implementation)

I followed the the following step for the manufecturing of the Fireproof Camera ball.

- First of all, I assmbled all electric  components. This is how I assembled them.

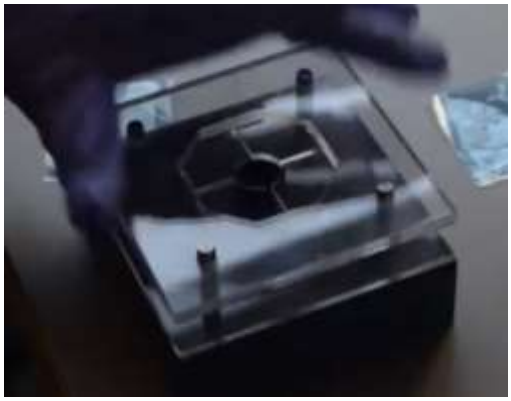


Figure 22 Assembly Process

- Connect the camera with each othe and with the electronic system

Figure 23 Assembly Process

- Assmble the transistor, fuses, diodsand other electronic

Figure 24 Assembly Process

- Assembling them into the heat resistant thermopole

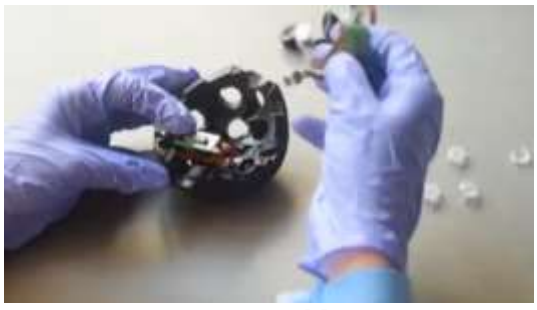


Figure 25 Assembly Process

Figure 26 Assembly Process

Figure 27 Assembly Process

- Fixing the battery conenction

Figure 28 Assembly Process

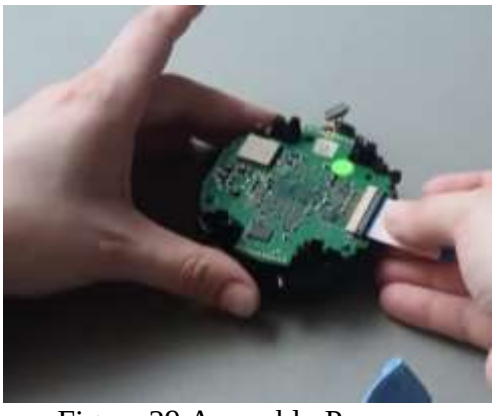


Figure 29 Assembly Process

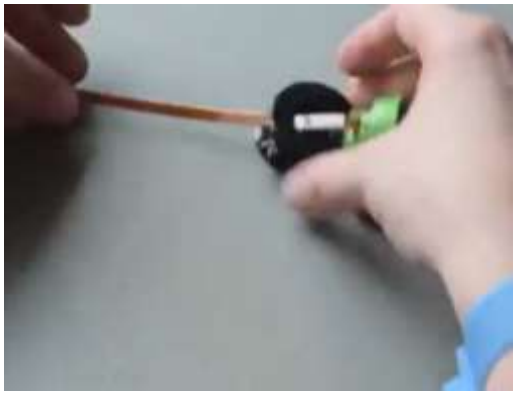


Figure 30 Assembly Process

- Fixing the  cameras with the electronic circuit

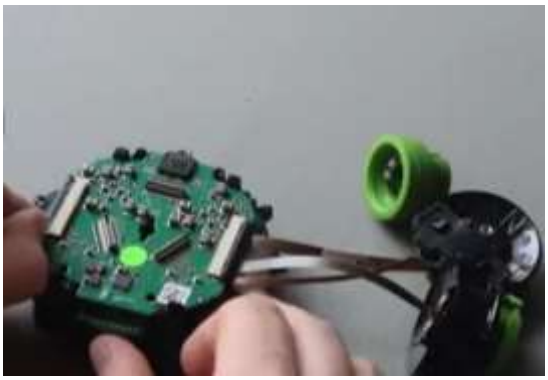


Figure 31 Assembly Process

Figure 32 Assembly Process

- Complete the assembly

Figure 33 Assembly Process

- Then,  put this assmbley in between of two semi sphare which are made up of the Stainless steel 304.
- Cover all the cameras with a fire rated glass.

# Chapter 4: System Testing and Analysis

## 4.1 Experimental Setup, Sensors and data acquisition system

We have use different sensors inside the fire proof camera ball.

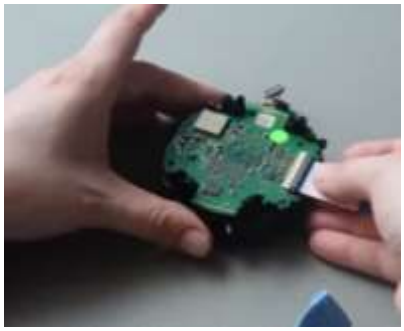


Figure 34 Circuit Board

- Temperature sensor

Figure 35 Temperature Sensor

- CMOS sensors

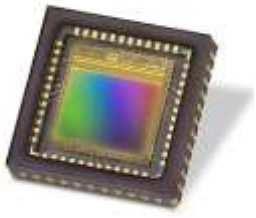


Figure 36 CMOS Sensor

- heat flux sensor

Figure 37 Heat Flux Sensor

**Location of the Sensors:**

- Heat flux sensor is used near the surface of the camera ball inside it
- CMOS sensor is used on the circuit board inside the insulation material

Figure 38 Location of Sensor

- Temperature sensor is used on the circuit board inside the camera ball.

Figure 39 Location of Temperature Sensor

**Specifications of the sensors:**

- **Temperature sensor:**
  We use **Pt1000 sensor** and it's the second most common type of the platinum resistance thermometer. It can sense temperature up to 1000°C and it has a resistance of 1000 ohms (Ω).
- **Reason**

Temperature sensor is used in this project to sense the temperature of the stainless steel temperature which is the outer body of the camera ball.

- **Heat flux sensor**

We use the **PHFS-01 Heat Flux** Sensor for our project. It is cheap and reliable and has minimum thickness. It had excellent sensitivity. It is NIST traceable.

- **Reason:**

Heat flux sensor is used to measure the rate of the heat transfer from the outside to the fire proof material of the camera ball.

- **CMOS sensor:**

We use **NOII4SM6600A** sensor in our project. It has Monochrome Output. This Device is Pb−Free. It is used in Machine Vision, Biometry and Document Scanning.

- **Reason**

This sensor was used in the camera to sense the image and help in taking pictures and videos from the camera ball.

## 4.2 Results, Analysis and Discussion

After making the practical model we make had some goals to test our project and see its performance. So conduct a experiment, get the results and conclude our project.

Experiment Setup:

For experiment we have to test the fire proof fire ball in sense of the temperature change, heat transfer rate and its capability to work in the fire.
So, like a basic fire fighting training we make a A class fire ( fire due to wood, cloth etc) and then throw our camera ball into it to see the results.

Figure 40 Fire Place

Figure 41 Putting Camera Ball into Fire

Figure 42 Camera Ball Working

**Results and Analysis:**

Major thing to consider are Thermal Conductivity, heat transfer rate and their melting point regarding making a fireproof product.
After putting the fire proof camera ball into the fire, we measure how much temperature increment affect the surface of the fire proof camera ball to rise.
Here are the results in the table:

Table 2 Temperature change of the surface with respect to the time and heat of fire

| Time (Sec) | Heat of fire (℃ ) | Surface of the camera ball ℃ |
|---|---|---|
| 0 | 320 | 27 |
| 180 | 372 | 28 |
| 300 | 400 | 30 |
| 380 | 480 | 30 |

It can be seen from the table that there is only a minor change in the temperature of the fireproof ball due to the increase in the temperature due to the fire.
From time 0 to 380 seconds, heat of fire increase from 320 ℃ to 480 ℃ but there is only 3 ℃ Change in the temperature of the camera ball from 27 ℃ to 30 ℃. (2)

Major factor behind this temperature change reason is the thermal conductivity of the materials.
Table of the Density of the material and their thermal Conductivity are following:

Table 3 Density and thermal conductivity of different Materials

| Material | Density Kg/m^3 | Thermal Conductivity (W/mk) |
|---|---|---|
| Aluminum | 2702 | 273 |
| Stainless Steel 304 | 7930 | 16.2 |
| Ceramic Fiber Paper | 200 | 8 |
| Ceramic Mullite | 3220 | 418 |

It can be seen from the table that which factor cause the temperature of the fire proof camera ball to increase so little. The reason is its thermal conductivity.
Thermal conductivity of the Stainless steel 304 is 16.2 W/mk which is the basic reason of this much low temperature change in the camera ball. (3)

Melting point is also very important factor while considering a fireproof product.
Because it is very important to make sure a high melting point material usage in the product which is going to be use as a fire proof product.

Table below show the melting point of some Material:

Table 4 Melting Points of different Metals

| Material | Melting Point ℃ |
|---|---|
| Stainless Steel 304 | 1450 |
| Aluminum | 660 |

| | |
|---|---|
| Brass | 930 |
| Copper | 1084 |
| Cat Iron | 1204 |

Table show the melting points of different metals.
Comparison, Stainless steel has the more melting point of all. Copper also show a greater melting point which is above 1000 ℃ but due to its high thermal conductivity it was not use as the surface of the fireproof camera ball.

Moreover the glass used on the cameras use in this device is also important. As, the standard window glass will break when it's temperature rise above 250° F. on the other hand Tempered glass can last up to 500°F.
But in contract to these, fire-rated glass has a typically capacity to survive heat in excess of 1600° F. That is the major reason why we chose the fire-rated glass. (4)

# Chapter 5: Project Management

## 5.1 Project Plan

Break Down of Tasks:
We have divided the task into 8 tasks

- Literature review
- 3D Modeling
- Identification of the material
- Material purchase
- Making practical model
- Performing test
- Concluding the project
- Report writing

Map tasks to team members.

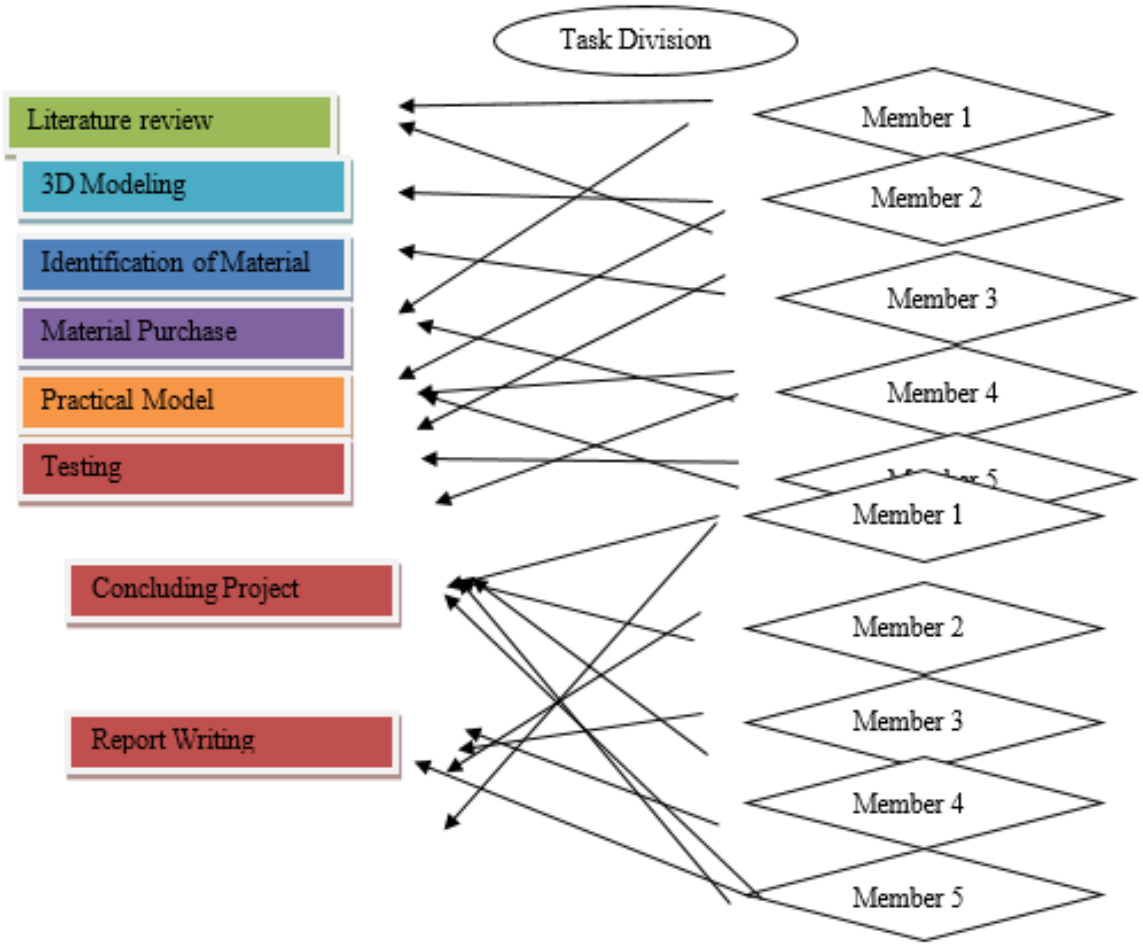



Figure 43 Task Devision

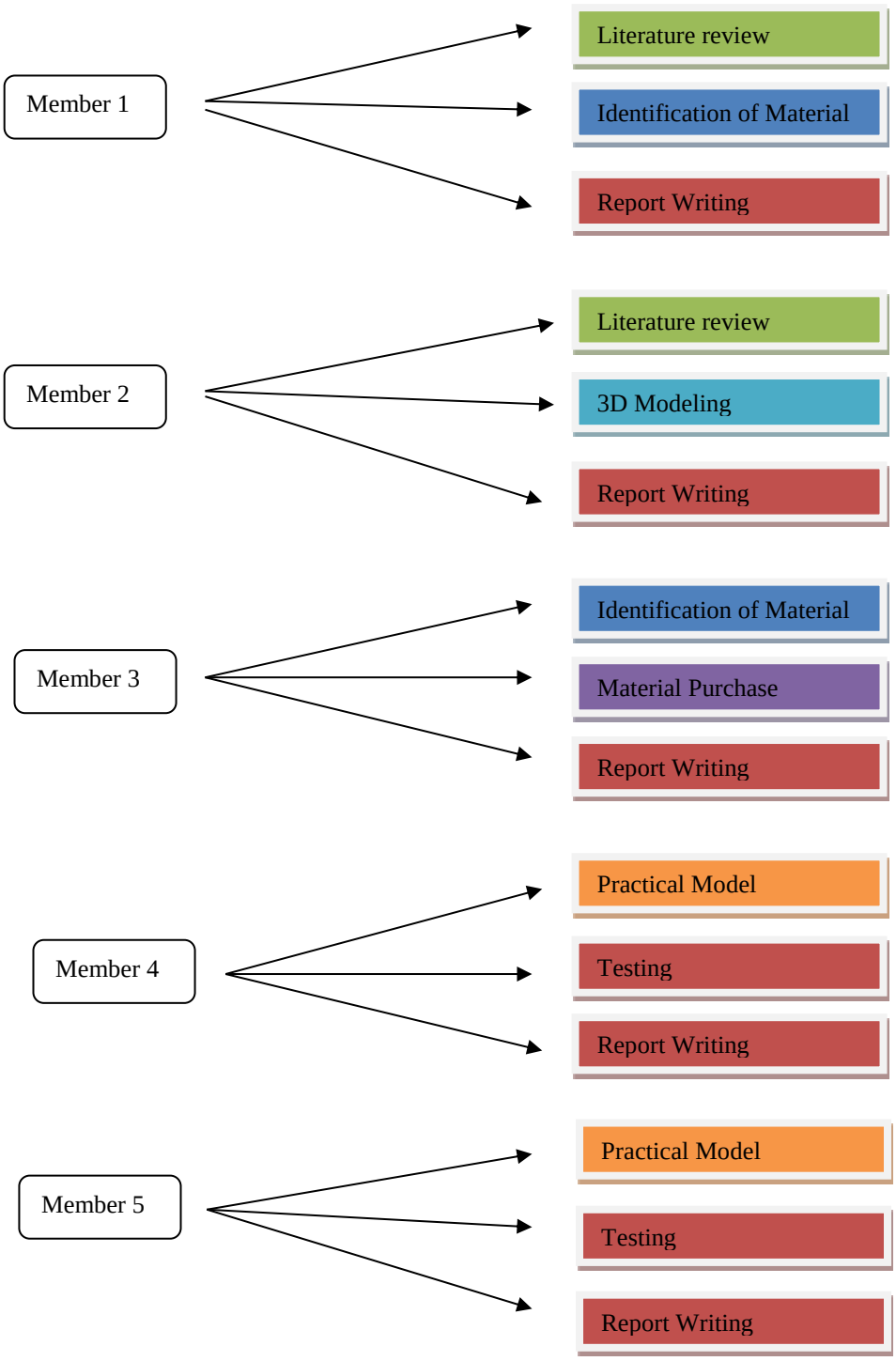
**Time duration table of each task:**

Table 5 Time duration table of tasks

| Task | August | September | October | November | December |
|---|---|---|---|---|---|
| Task 1 | Literature review | | | | |
| Task 2 | | Modeling | | | |
| Task 3 | | Material Identification | | | |

| | | | | | |
|---|---|---|---|---|---|
| Task 4 | | | Material Purchase | | |
| Task 5 | | | | Practical Model | |
| Task 6 | | | | | Testing |
| Task 7 | Report Writing | | | | |

## 5.2Contribution of Team Members



## 5.3 Project Execution Monitoring

**Project Execution performs following activities:**

- Meeting with advisor for selection of semester project
- Literature review
- Selection of project ( fire proof camera ball )
- Literature review for selection of appropriate methodology
- Selection of 3 method ( Analytical Calculations, 3D modeling and Practical Model )
- Analytical Calculations
- 3D Modeling
- Suitable Methodology for practical model
- Approval of method from advisor
- Research for appropriate Material selection
- Meeting with advisor for approval of Material
- Market visit for the purchase of Material
- Meeting with advisor for practical model making
- Practical Model making
- Meeting of all members with advisor for testing criteria
- Perform testing
- Concluding the project
- Report writing

## 5.4 Challenges and Decision Making

**Challenges Faced:**

- Problems with team members not cooperating/meeting.

All the group members do their best for this project and cooperate with each others for their assigned tasks.

Each member did his assign task and also help in others task too.

- Problems or delays in procuring required parts/components/tools.

The major reason for delay in this project was the procurement of the materials. It was task assigned to the member 3 but knowing the difficulty level member 2 and 4 also help him for the purchasing of required parts, components and tools which were being used during the making of the practical model of the project.

- Problems with equipment or components not working or malfunctioning.

Major problem was connections of the electric circuit board and different wiring connections. At a point we are much confused about the way connection are going to be, then we make some help from the internet, some seniors and fellows of the electronics department, which help us to make it complete in a well manner.

**Decision Making:**

This project make me learn a lot regarding the decision making, whole project was having much options and ways for solution but finding a perfect solution was problem all the time in following steps:

- Choosing my part in the project that i could do at my best
- Choosing best suitable team member for his part in project, in which he can give optimum results.
- Choosing for the right methodology for the project
- Choosing right material for the project
- Choosing best test criteria.

When facing these challenges, we have to make decisions that will go best in our favor. For the decision making we get help from internet, previous journal papers, fellows of other departments, seniors and from similar research papers.

## 5.5 Project Bill of Materials and Budget

**BOM**:

Bill of Materials of this project is following, which indicate the expected cost of the project.

Table 6 Bill of Material of Project

| | Unit | Unit price | Total quantity | Total price | Total cost | |
|---|---|---|---|---|---|---|
| 2 Mega Pixel Camera | No. | 25$ | 36 | 800$ | | |
| Rechargeable battery | No. | 3$ | 1 | 3$ | | |
| Memory card | No. | 10$ | 1 | 10$ | | |
| Fuse | No. | 1$ | 2 | 2$ | | |
| Diode | No. | 0.5$ | 3 | 1.5$ | | |
| Transistor | No. | 5.5$ | 2 | 11$ | | |
| Fire rated glass | Ft^2 | 100$ | 1 | 100$ | | |
| Circuit board | No. | 2$ | 1 | 3$ | | |
| Electric wire | m^2 | 0.75$ | 2 | 3$ | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Fire proof aluminum foil bubble sheet | Ft^2 | 2$ | 2 | 4$ | | |
| Stainless steel 304 | Ft^2 | 1.5$ | 2 | 3$ | | |
| Miscellaneous | | | | 100$ | | |
| | | | | | 1040.5$ | |

Our project was expected to be complete in 1050$ but the miscellaneous expenses added to it and increase its costs to almost 1150$ moreover wastage of the material also add some to the grand total, because it was the first time we were making this project and many time we made miscalculation and waste our material and it also add about 50$ to our project. Moreover we lend some tools for this project and adding their cost increase the budge to 150$. So our budget went to almost 1350$. (5)

# Chapter 6: Project Analysis

## 6.1 Life-long Learning

Major learning from this project are:

- Understanding of many hardware in practical life like, diode, transistors, fuse, processor etc
- Understanding of the 3D modeling Software like CAD, Solids works etc.
- How to cross barrier between design and manufacturing.
- To implement your technical knowledge into practical life
- Solution of some engineering problems
- Understanding of the manufacturing process
- Material selection for the project tech me about material science.
- Limited time to complete and wind up the project make mw learn time management
- Working in group make me learn team work.

In all these learning from the project we get help from the internet (scientific topics, research topics, journal papers). We also get help from the books related to this topic. Also some seniors and electronics department fellows help us in learning all above.

## 6.2 Impact of Engineering Solutions

Impacts of the project:

- This project contains a solution of the fire proof material which can be used for the manufacturing of the robot who can serve as fire fighters in future.

- Designing of fire proof buildings

- The major purpose of our product design is to address the firefight issue and be a product which has a great social impact to save people life by reducing the danger for firefighters.

- It is used to help the firefighting team in firefighting operation, ultimately saving environment from the pollution and is lifesaving.

- It is also common scene for police and that of emergency services. They want to enter the building but they don't know what awaits them inside.

It will serve like a robot at a single place standing inside the fire place and will be able to give a 360 view

## 6.3 Contemporary Issues Addressed

Our project has addressed the following issues:

- It has addressed the Safety issue of the fire fighters during fire fighting

- It has addressed the in choosing the right material for your product.
- It has addressed the issue related to the firefighting equipment design.
- It will help the Saudi Arabia particular in its fire fighting department for their optimum action.
- It has addressed the major issue faced by the police during a raid
- It will also help the photographic industry for catching 360 panoramic shots.
- Overall this project will serve a helping hand in security, health and safety point of view.

# Chapter 7: Conclusions and Future Recommendations

## 7.1 Conclusions

- In this project, a new product fire ball camera is designed and manufactured.
- This product can help in detecting the situation during a fire.
- The unique fact about this product is that it can even work in fire and smoke.
- During firefighting, a major concern of the team is to check whether there are people alive in the fire.
- This product can help in identifying the life during fire and it can also assist in identifying the valuable products that can be saved from fire.
- Apart from this, this fire ball can assist the firefighting persons in looking through the fire as it is difficult to look through thick smoke and fire.
- There were many challenges during the design and manufacturing of this project because it was a completely unique and new idea.
- Adding more to it, this project was a great source of learning for us. It helped us in learning the design methodology and the manufacturing of a real-life product.

## 7.2 Future Recommendations

- There are many modifications that can be done to the design of this product.
- The first modification is the installation of a high quality battery that do not melt due to high temperature and that can last for long time.
- Moreover, another important modification is to improve the aesthetics of ball.
- Also, the material of ball can be improved so that if do not get damaged by hitting any hard material.
- Also, the connectivity between the camera and the screen can be improved so that images do not get blur.

# 8. References

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