

**Modified Hazmat Suit With Controllable Inside
Temperature**

Project Proposal

Faculty of Technology

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1 INTRODUCTION

1.1 Problem Overview

The 2019 – 20 corona virus pandemic is an ongoing pandemic of corona virus disease caused by severe acute respiratory syndrome corona virus 2 (SARS-CoV-2). The outbreak started in Wuhan, Hubei province. The SARS-associated corona virus (SARS-CoV) was recognized in China as early as November 2002. The 2019 disease outbreak in China has been attributed to a corona virus referred to as 2019-nCoV.

At that time, new cases were reported in Australia, Canada, Germany, Japan, Singapore, the US, the UAE and Vietnam. As of February 2, the first death of a Chinese man from Wuhan, was reported in the Philippines. It is the first death outside China. Meanwhile, deaths in China reached 1,016, with 42,638 infections recorded. There were 175 people infected on board the Diamond Princess Cruise ship, docked at Yokohama, the Japanese health ministry said on February 12. Meanwhile, Japan confirmed its first death from the virus.

Spain's death toll rose to 10,003 from 9,053, according to the country's health officials, the highest daily toll since the outbreak began.

The **World Health Organization** declared the outbreak to be a public health emergency of international concern on 30th January 2020 and recognized it as a pandemic on 11 March 2020. As of 4 April 2020, more than 1,110,000 cases of COVID-19 have been reported in more than 200 countries and territories, resulting in more than 58,900 deaths. More than 2,226,000 people have recovered.

In **Sri Lanka** is an ongoing viral pandemic of corona virus disease 2019, a novel infectious disease caused by severe acute respiratory syndrome corona virus 2. As of 4 April 2020, 159 confirmed cases have been reported in the country with 5 deaths. On 3rd March 2020, the 1st reported case involving a Sri Lankan was reported in Italy. As of 23 March 45 quarantine centers have been built in the country by the Sri Lanka army as a preventive measure to tackle the corona pandemic. Nearly 3,500 people have been under quarantine in 45 quarantine centers which also include 31 foreigners from 14 countries.

COVID-19 cases in Sri L

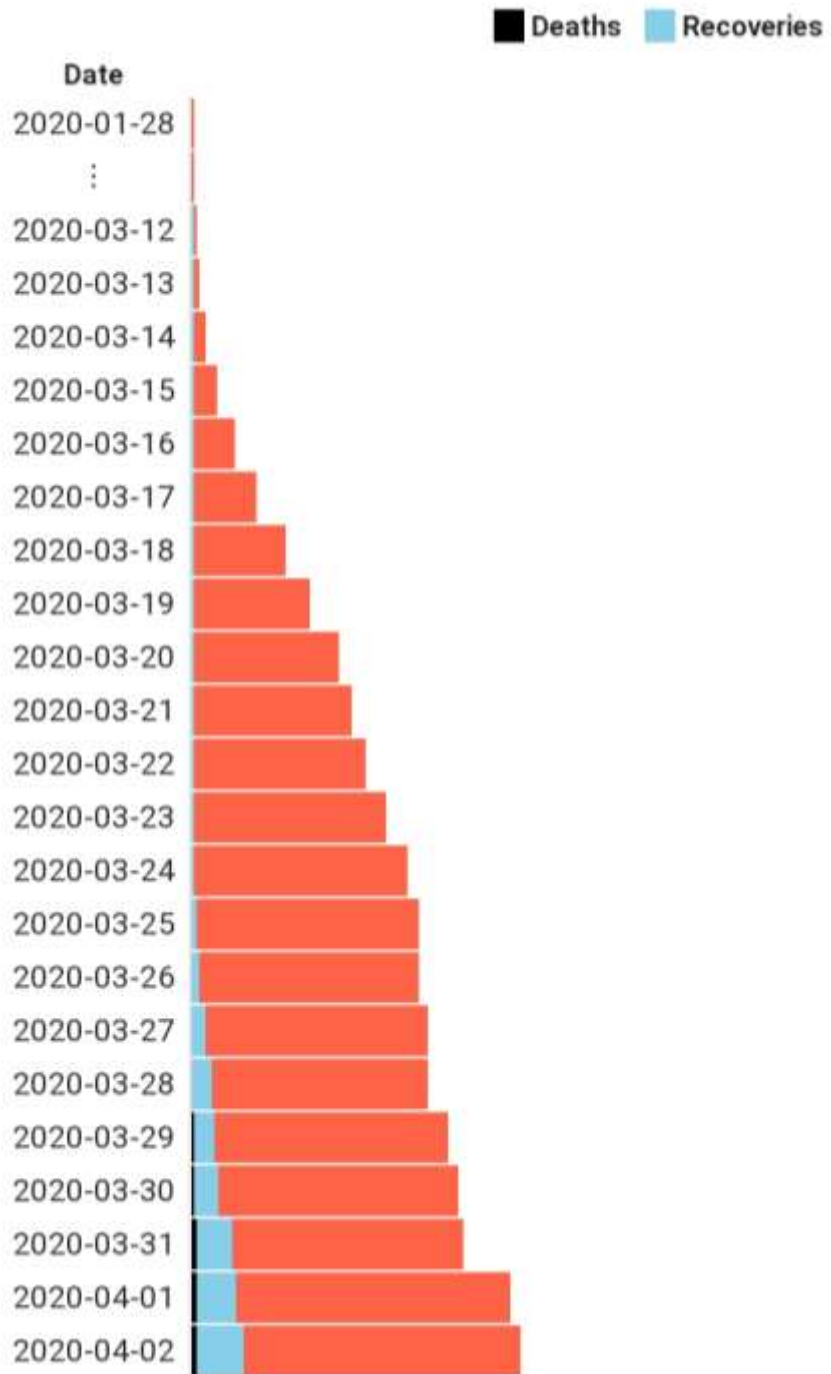


Figure 1-1 Covid deaths in Sri Lanka as at 02nd April 2020

Source:

https://en.m.wikipedia.org/wiki/Ministry_of_Health,_Nutrition_and_Indigenous_Medicine

<https://www.hpb.health.gov.lk/en>

Corona viruses are a large family of viruses that can cause diseases ranging from the common cold to more severe illnesses such as Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS). Corona viruses affect the respiratory system, typically resulting in severe acute respiratory illness displaying symptoms of fever, malaise, cough, and shortness of breath. About 30%-40% of patients reported with MERS have died during previous outbreaks of the disease.

Currently, no vaccine or specific treatment is available to prevent or cure corona virus infections. Treatment for infected individuals is supportive and based on the patient's clinical condition.

According to our investigation we found the main problem in hospitals that are faced during these days. The people who treat and care to viral effected persons wear a special dress, this dress is not so comfortable to wear all the daylong(more than 6 or 7 hours). This uncomfortable suit makes big mess inside the mind of the person who is wearing. When we think about seeking person, the person must be in good mental and physical condition. Because the comfortableness of this dress is very essential thing. Now a day doctors, nurses and other persons who treat to viral effected persons are suffering from this problem. **The good mental and physical condition affects to do their service in very effective manner.**

During this situation our main responsibility is to protect these persons from viral effect and keep them in comfortable environment to do their work in high efficient way.

source:

<https://www.who.int/health-topics/coronavirus/>

<https://www.cdc.gov/coronavirus/2019-ncov/index.html>

<https://edition.cnn.com/2020/03/08/health/coronavirus-evolved/index.html>

<https://www.worldometers.info/coronavirus/#countries>

<https://www.aljazeera.com/news/2020/01/timeline-china-coronavirus-spread-200126061554884.html>

1.2 Problem definition

- The inconvenience of wearing the Hazmat suit which is dressed when treating for viral effected person in the whole day, they cannot do their duty efficiently.

1.3 Aim

- Create a new comfortable hazmat suit for person who treats to virus effected persons
- Make comfortable environment to do their service in very clear mind and effective manner

1.4 Objectives

- Design and develop a solution to protect doctors from covid 19 virus
- Design and develop comfortable Hazmat suit
- Keep the person who treat viral effected person in good mental and physical condition.
- Make the good conditional environment to work more hours with high efficiency.

2 LITERATURE SURVEY

2.1 Existing Hazmat suit and the condition

For every weapon forged there is a piece of armour made to defend against it. For swords it was chainmail, for bullets it was Kevlar, and for chemical agents it's the hazmat suit. Short for hazardous materials suit, this piece of kit is built to defend us both on and off the battlefield by shielding us from harmful liquids and gases.

Hazmat suits are barrier formed of plastic, fabric and rubber, along with an independent source of oxygen. They protect workers by separating them from their hazardous environment. Simpler suits can be slipped on to protect against harmful liquids, but more advanced suits can become completely airtight to defend against airborne contaminants and toxic chemicals. This versatility has meant that hazmat suits can be used by the military, in industry and by healthcare workers.

Chemical warfare

In the unlikely event of chemical warfare, a hazmat suit could be the difference between life and death. Workers operating in waste disposal also make daily use of hazmat suits, and they're used by staff in nuclear power stations to ensure they don't carry any radioactive contaminants home at the end of the day. Recently, nurses and carers treating patients infected with the Ebola virus in West Africa wore hazmat suits to protect themselves against airborne infection.

These examples are just a few of the many ways hazmat suits can keep us safe by protecting our skin, eyes and respiratory system from harm.

Levels of protection

The term 'hazmat suit' covers a wide spectrum of protective clothing. Anything capable of blocking hazardous materials may be labelled as a hazmat suit.

However, a brewer working with a liquid disinfectant would be dressed quite differently to a scientist handling toxic gases. So to ensure the appropriate amount of precaution is taken, hazmat suits are arranged into four different types.

- **Type A** suits are fully concealed from the outside and equipped with a self-contained breathing apparatus. By ably defending against biological and chemical hazards, these are the go-to choice when working in highly dangerous atmospheres.
- **Type B** suits are not airtight but retain breathing equipment. These can be used when handling gases that aren't harmful to the skin.
- **Type C** suits are often worn when working with general biohazards, and a simple respirator is worn.
- **Type D** suits would be worn by our brewer, and could simply include a protective apron, boots, glasses and long gloves.

These viruses spread from sick people to others through close contact, such as unprotected caring for or living with an infected person. Infected people also are known to have spread corona viruses to others in healthcare

settings.

DuPont™ Tyvek®, DuPont™ Tychem®, DuPont™ ProShield® and DuPont™ ProClean® garments are available in disposable coverall, apron, and gown designs, as well as boot covers. Additionally, Tychem® gloves offer hand protection that along with a hooded coverall and attached socks can provide full body coverage.







		Blood & viral protection	
DuPont options for North America		ASTM F1670 & ASTM F1671	ISO 16603 & ISO 16604
	ProClean® 3 Non-hazardous liquid and dry particulate barrier protection for cleanroom applications		
	ProShield® 70 Protection against non-hazardous liquid splash with excellent skid resistance	✓	
	ProShield® 80 Lightweight and breathable garment that provides a barrier against bloodborne pathogens	✓	
	Tyvek® 400 Protection from particulates and light liquid splash		
	Tyvek® 500 Protects against light liquid aerosols and airborne solid particles		✓
	Tyvek® 600 Offers chemical permeation barrier to low-concentration water-based inorganic chemicals including infective agents and bodily fluids		✓

Figure 2-1 DuPont™

<https://www.dupont.com/brands/tyvek.html>

The following DuPont Safety PPE provides protection from the COVID-19 virus:

- Tyvek® and Tychem® disposable coveralls
- Tyvek® and Tychem® long-sleeved gowns
- ProShield® 80 coveralls
- ProClean® shoe covers and sleeves

Nomex® aramid fiber has been used in garments for 50 years for protection against threats from fire, heat and arc flash . Over time, the line of Nomex® products has expanded and evolved to include blends like Nomex® with Kevlar®, other inherently flame resistant (FR) materials and static-dissipative fibers . The family of Nomex® aramid fibers for thermal protective apparel now includes:

- Nomex® MHP, an engineered blend of materials offering inherent multi-hazard protection against heat, flame, electric arc and small molten metal splash
 - Protera®, a unique blend of inherent materials designed for both electric arc and flash fire protection
-
- The Hazmat suit, used by doctors, nurses and other people who work with virus effected persons can be used only one time and one hazmat suit costs like \$ 12-18 or 18 26.
 - And also this dress is not comfortable to work.
 - And some one is not care about their other part of the body except face. Because they normally care their face shield and face mask only. So most are trying to improve face mask and face shields.

2.2 Available design

- The main purpose of the design is purify the air from virus, so now days there are some inventions for this purpose. **Sterilizer chamber and face masks.**

The Sri Lanka Navy has developed a disinfection chamber to prevent and control the spread of new corona virus. Navy said the Eastern Naval Command and the Western Naval Command developed the disinfection chambers. Naval personnel who are engaged in essential services outside the naval bases were sterilized on their return to work.



Figure 2-2 Full body disinfection chamber

Source:

<http://www.dailymirror.lk/110-185732>

2.3 Comparison with existing inventions and already used hazmat suit

Table 2 Comparison between Proposed system, existing design and existing suit

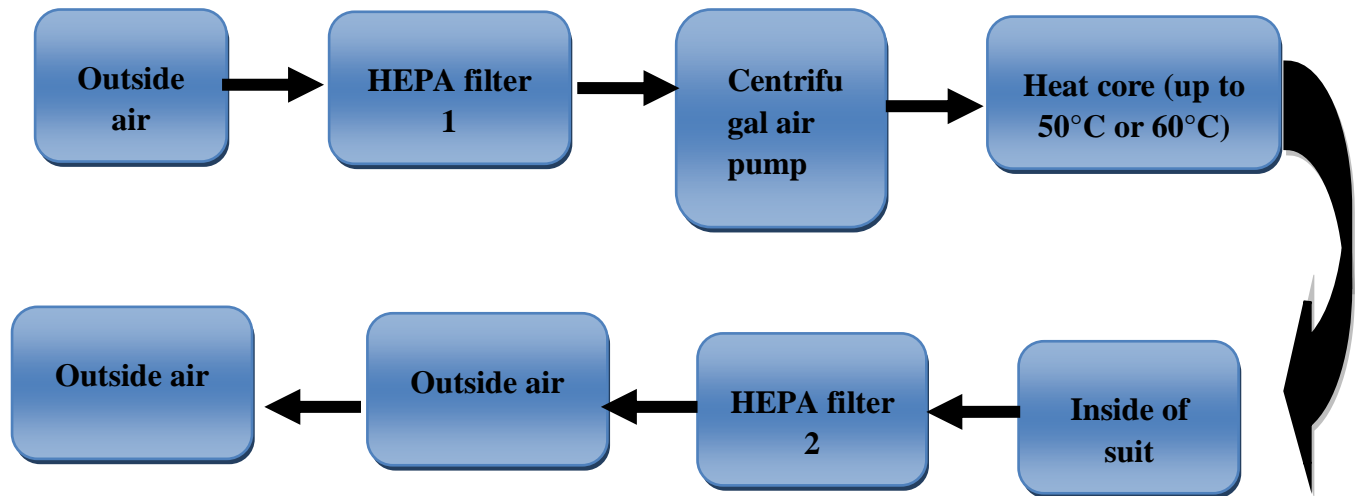
Available Hazmat suit	Proposed design	Existing design
<ul style="list-style-type: none">- High cost and can use only one time	<ul style="list-style-type: none">- Can use several time with high protection	
<ul style="list-style-type: none">- It costs more money	<ul style="list-style-type: none">- Save money and keep safe	
<ul style="list-style-type: none">- Make uncomfortable environment to work	<ul style="list-style-type: none">- Create comfortable environment to work with high efficiency and more hours	
<ul style="list-style-type: none">- Keep bad mental and physical condition	<ul style="list-style-type: none">- Keep good mental and physical condition	
<ul style="list-style-type: none">- Full body coverage with head suit is used Oxygen mask to breath. For this add extra cost	<ul style="list-style-type: none">- Without using this oxygen mask can use this. our system can use for both type of suit. Reduce the extra cost.	

	<ul style="list-style-type: none">- Can do their work in every manner and any place(no limitation)	<ul style="list-style-type: none">- Can work in limited are(purify rooms)
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3 METHODOLOGY

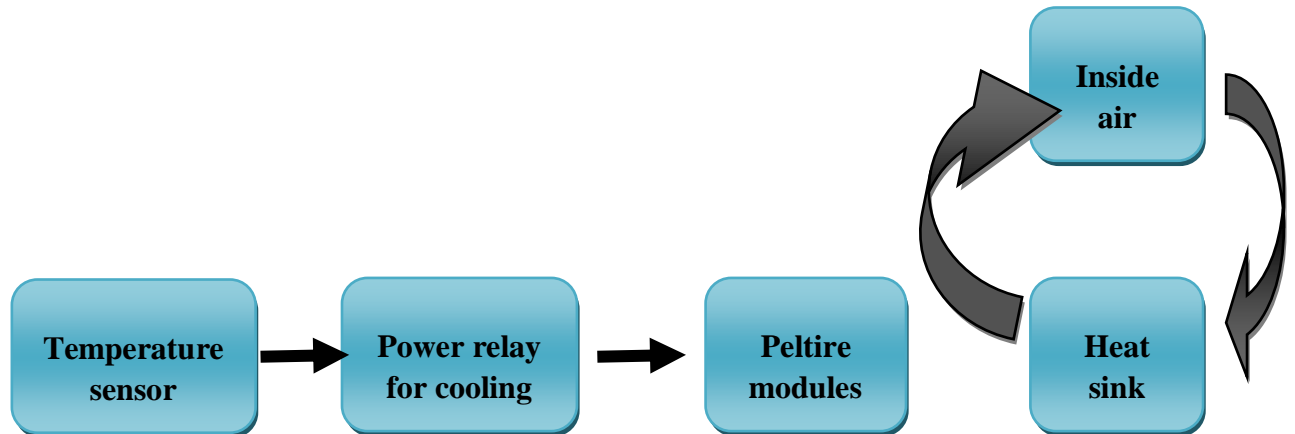
3.1 Proposed methodology

Filtering



- HEPA filter 1 – stop the entering of the virus(99%)
- 12V centrifugal air pump – These are high efficiency powerful air blowers that can be fixed in small space.
- Heat core – Nichrome wire combinations are used for heat up the pressurized air coming from the centrifugal air pump. This heater core heats the air up to **50°C or 60°C**. This high temperature also kill the virus.
- HEPA filter 2 –The extra pressure inside the suit exhaust to the outside and , at the time block the entering of outside virus containing air into the suit.

Cooling



- Peltire modules are used for generate the cool inside the suit. Four cooling fans are used here. These cooling fans circulate the cooling air everywhere inside the suit.

Generated heat from Peltire modules is removed by these 4 heat sink and fans. the temperature inside the suit come up to limited level, cut the power by using control module and give the power again to the system when the system become overheated.

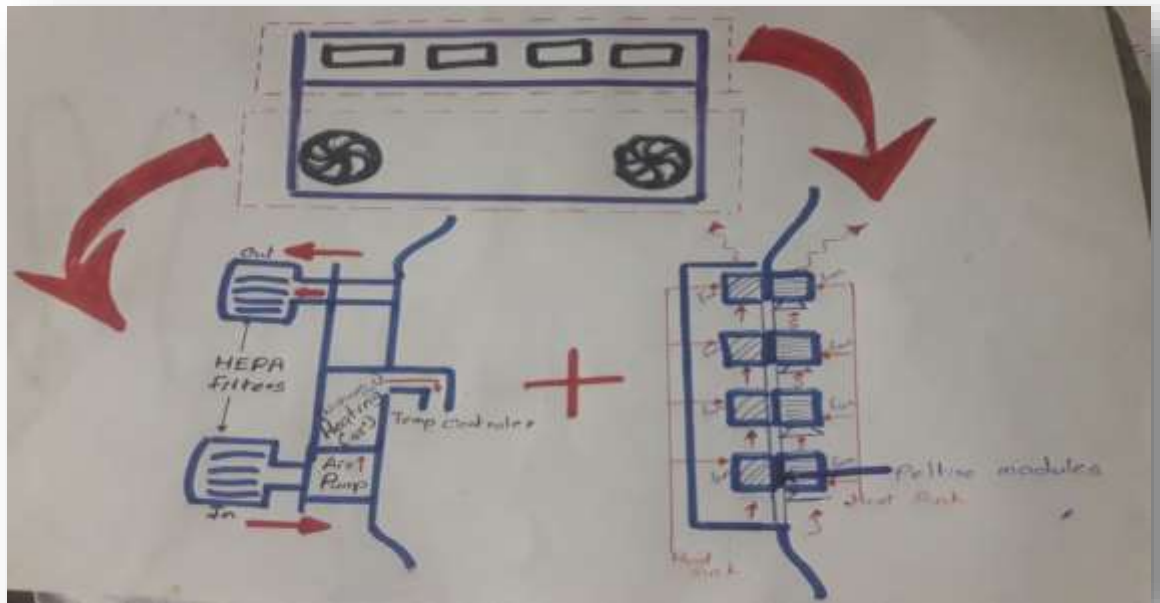
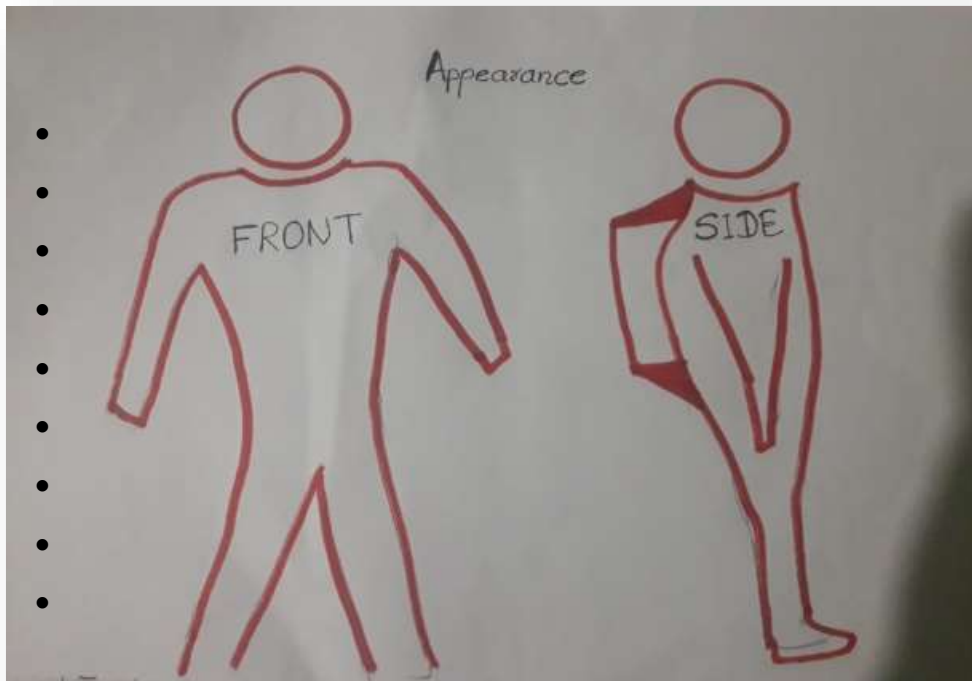


Figure 3-1 sketch diagram



• **Figure 3-2 Appearance**

3.2 Expected Features of The Suit

- Cooling the inside of the suit up to desirable temperature
- Avoid the entering of the virus in to the suit

3.3 Advantages of the proposed methodology

- Can wear more time period than hazmat suit
- Increase the comfortability of the persons who wear this suit
- No need any expert knowledge to operate this suit.

3.4 Drawbacks of the proposed methodology

- Little bit heavier than normal Hazmat suit.
- Need to connect power cable.

4 REQUIRED MATERIAL

- 2 HEPA filters
- Nichrome heating coil with core
(the material that we going to use is electric resistance and use temperature controller here)
- Centrifugal air pump
(<https://www.aliexpress.com/i/32965573987.html>)
- 1 timer module
- Four Peltire modules
- 8 small heat sinks
- 8 small 12v fans
- Wires
- Pipe(flexible hoses)
- 12V 20A switching power supply (this part is separate from the suit)
- Thermal paste
- Spun Polyethlyene (tyvek)
- Temperature controller

5 Plan for budget

	Rs.
• 2 HEPA filters	5000
• Nichrome heating coil with core	2000
• Centrifugal air pump	3500
• 1 timer module	960
• Four Peltire modules	3800
• 8 small 12v fans	3200
• Wires	800
• Pipe(flexible hoses)	600
• 12V 20A switching power supply	4500
• Thermal paste	400
• Spun Polyethlyene (tyvek)	4000
• Temperature controller	870
TOTAL	29630

6 Future expansion plan

This solution can be applied not only persons who treat patients but also patients.

Under this situation the persons who want treatments for some other diseases, may not be safety in hospitals. So this solution can used for patient's bed and an air bed bag. Because of this, patients can safe from this viral effect and can stay in hospitals too.

And also this solution can be used for ambulances as smart sterilize air bag.

7 Time Plan

After receiving the require materials we can work on this following time plan.

	Week1	Week2	Week3	Week4	Week5
Observe the current situation.					
Identify the problem.					
Draft the project proposal					
Submit the project proposal					
Step 1 Finding the suitable Hazmat suit and sketch the covering for system.					
Step 2 Starting work on cooling system					
Step 3 Starting work on filtering system					
Step 3 Finalize the covering and assemble the parts					
Step 4 Finish the system					
Step 5 Testing					

8 DISCUSSION

Today, covid19 virus has been a global problem. Because of this dangerous virus the world's population is rapidly reducing and a large number of deaths have already been reported. In many countries a large number of covid19 patients have been hospitalized.

At present there are no any factors founded to kill this virus and there are only control conditions. According to these conditions, the most present new ideas and inventions. Their main target is to protect people and stop the spreading of the virus.

The people who treat viral affected persons are the closer ones in this dangerous situation. So they have to protect from this than others. And these people work more hour in this uncomfortable environment.

They wear some special suit called Hazmat suit to protect from this virus. They have to wear this suit in a long period of time. This is very hard thing and also this hardness may badly affect their mental and physical health

So the suit that we design gives best solution for this problem. By using this suit they can keep their mind in good mental and physical health.

9 GROUP MEMBERS

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