NAME OF THE REPORT

Fabrico Automatica

Report submitted to the
Indian Institute of Technology Mandi
For the course of

Design of Practicum (IC201P)

by

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Dr. Srikant Srinivasan & **Dr. Chayan k Nandi**

INDIAN INSTITUTE OF TECHNOLOGY MANDI

September 2021

CERTIFICATE OF THE MENTORS

September 30, 2021

Certified that the report entitled "Fabrico Automatica" submitted by Rashika Rathi, Nishant Vedwal, Animesh Choudhary, Rahul Saini, Vishal K Singh, Karan Singh to the Indian Institute of Technology, Mandi, for the course "Design of Practicum (IC201P)", performed under our supervision, is a record of bona fide work and we consider it worthy for evaluation.

Dr. Srikant Srinivasan	Dr. Chayan K Nandi
(First Mentor Name)	(Second Mentor Name)

DECLARATION

I certify that

a. The work detailed in this report is original and has been done by ourselves under the general supervision of our supervisors.

b. We have followed the guidelines provided by the Institute in writing this report.

c. We have conformed to the norms and guidelines given in the Ethical Code of Conduct of the Institute.

d. Whenever we have used materials (data, theoretical analysis, and text) from other sources, we have given due credit to them by citing them in the text of the thesis and giving their details in the references.

e. Whenever we have quoted written materials from other sources, we have put them under quotation marks and given due credit to the sources by citing them and giving required details in the references.

Rahul Saini
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Nishant Vedwal
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Digital signatures of the Students

Acknowledgment

We would like to thank our mentor **Dr. Srikant Srinivasan** & **Dr. Chayan K Nandi** for their contributions, constructive criticism, recommendations, encouragement, & cooperation in ensuring that this practicum course yielded the desired product designation.

Abstract

Fabrico Automatica, a cloth stand which controls itself based on the direction of sunlight, or intensity of wind, or rain. It can open or close like a capsule itself based on that or can change its direction to avoid excessive heat, wind, or rain.

Equipments like **solar sensors**, **raindrops detection sensor**, **wind direction detector** & **Circular cloth stand** is to be used for this product. Solar sensors will detect the intensity of sunlight & raindrop detector sensor will detect the intensity of rainfall. Wind direction detector mounted on the top of the metallic cloth stand will detect the direction and speed of wind. And according to these numerical values, a limit will be set exceeding which the capsule will be formed for protecting the clothes. Thus, this capsule like structure will prevent the clothes from colour fading caused by excessive sunlight, being wet by rain, blown away by wind. It'll help a person to leave their home for many days without being tensed of what will be the condition of their hanged clothes because of the weather. It's cost will be around Rs. 1200 i.e., 200-300 rs. Greater than the normal cloth stand. So, it's **highly economical** given its usefulness.

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Chapter 1
Introduction

In this fast moving world where people does not have time to eat, drink or do the basis activities of the day, finding leisure time to do the household chores like cleaning the clothes and then drying them is really hard to find and on top of that if something stains your cloth while they are drying out under the sun will make things even worse. So one might think to dry his/her clothes indoors but this thought can affect their health very badly. Researches have shown that wet and moist conditions like these give rise to the growth of moulds, which affect some people through allergic reactions. People with asthma and other lung related problems are the worst hit by this, it can trigger the symptoms to the next level. So the best way to get rid of both of these problems are to get keep an eye on the clothes that are hanging outside and take them back whenever there are unfavourable conditions.

1.1 Motivation

Imagine washing your clothes for 2 hours and then as soon as you let them outdoors to dry, and rain drops starts to come down and these rain drops does not come alone, they bring dust, leaves and other particles with the wind and it stains your clothes, now this requires you to re wash your clothes which will take another hour of your day and you still are not sure if it is going to be safe to put the clothes outdoor to dry under the sun.If your clothes are coloured fabric then putting them under too much of sunlight can affect them and they will lose their vibrant colours and will start to look dull. These are unavoidable situations unless you have a smart cloth hanging machine which will let your clothes dry under the sun in ideal condition and will also protect your clothes from other factors that can ruin your hard work and put stains on your clothes.

1.2 Objective

The Objectives required from the desired product are:

1) Ample amount of sunlight should be given to the clothes to dry, giving less amount will keep the clothes in a moist situation and providing more exposure to sunlight will make the vibrant colours of cloth to fade away and make them look dull.

2) There should be outer protection of clothes from the external factors like rain, dust winds, leaves and other particles that sticks to the clothes and leaves stains on the clothes and forces us to wash them again.

3)Sometimes there are high speed winds which removes the clothes from the hanging position and take them to other location and the clothes can get dirty from this or even worse the cloth can be lost from these strong winds, so there should be protection for these strong winds as well.

4)Keeping an eye on the cloth hanging machine is really hectic work, so it's better to connect this machine to a mobile app, which will tell you the running time, wind speed, rain forecast and other weather info which will help one to keep their clothes fine.

1.3 State-of-the-art

There is an existing solution to the problem but it fulfills only the sunlight aspect of the problem, it does not take care of the rain and wind part of the objective.(Kumar et al. 2016) The report of the product was published in 2016 by R. Senthil Kumar and his team built a system of automated sensors which could sense the sunlight, humidity in the atmosphere and then move in the optimal direction for the clothes to let dry.

1.4 The product

The product that we came up with is going to fulfill all the objectives that are mentioned above. Our product "Fabrico Automatica " is a cloth stand which can control its movement based on the direction of sunlight's intensity, wind speed or rain. Our product will use sensors of total three kinds which includes the solar sensor, raindrop detection sensor and wind direction sensor. It will sense these three outer features and based on this it will either change its direction or close like a capsule saving the cloths from the outer harm that can stain the cloths or harm the cloths. This capsule-like structure will prevent the clothes from colour fading caused by excessive sunlight, being wet by rain, or blown away by wind. It'll help a person to leave their home for many days without being tensed of what will be the condition of their hanged clothes because of the weather.

Chapter 2
Methodology

2.1 System level proposed solutions and its feasibility

2.1.1 SWOT analysis

Strengths:
1. Useful: Prevents clothes from getting bleached, dampened, blown away.
2. Economical: Costs around 1200.
3. High aesthetic appeal. Shaped like a robot with cylindrical body and rotatory head.
4. No market competitor.

Weaknesses:
1. Needs maintenance i.e., metallic capsule can get rusted, those sensors can require replacement with time.
2. Will need charging for running those sensors & encapsulation.

opportunities:
1. Growing demand: Most of the people stay away from home while working. So, they will be willing to buy it. So that they won't have to be worried about their clothes getting bleached by the sun for too long or if the weather is bad (then to be blown away or get dampened by the rain). They won't have to ask anyone to take care of their clothes left on the cloth stand.

Threats:
1. Entry of competitors
2. People might not buy it because they are accustomed to using the ropes for hanging & drying clothes. Only some percentage of the urban population is likely to buy it, who works & stay away from their home for a longer duration.

3. Strict safety requirements needed. Though they will be insulated for prevention from any shock.

Things that can be dealt with right now:
1. Stainless steel can be used for preventing rusting. Cheaper solution is coating the metallic capsule with paints.
2. Solar cell can be used for automatic charging of the batteries needed for running those sensors & encapsulation.
3. Special consideration will be kept for insulating this product as a whole from everywhere to prevent any electric shock.
Things that need to be looked into further:
1. How we can increase its usefulness?
2. what can be done so that those sensors doesn't need frequent checking on their working condition.
3. what other material can be used in replacement of metallic cover. So, that it can be more light & cheaper.
Things to consider for the future include:
1. To make it more economical by using some other material for capsule, using sensors which needs lesser replacement.
2. Make it controllable by an application in our phone.

2.1.2 Risk analysis

Technical Risks

- Quality and durability of Sensors:The durability and quality of the overall product very much depends on quality and durability of sensors so low quality sensors will lead to a low quality product.
- Battery drainage : Due to the limited battery capacity, the product may stop functioning abruptly.

External Risks

- Heavy rain or wind may physically damage the product.
- Customers may not prefer this product's utility over its higher cost.

Organizational Risks

- The cost of the product may exceed the budget due to ineffective cost planning strategies.

2.1.3 Working principle: system level approach

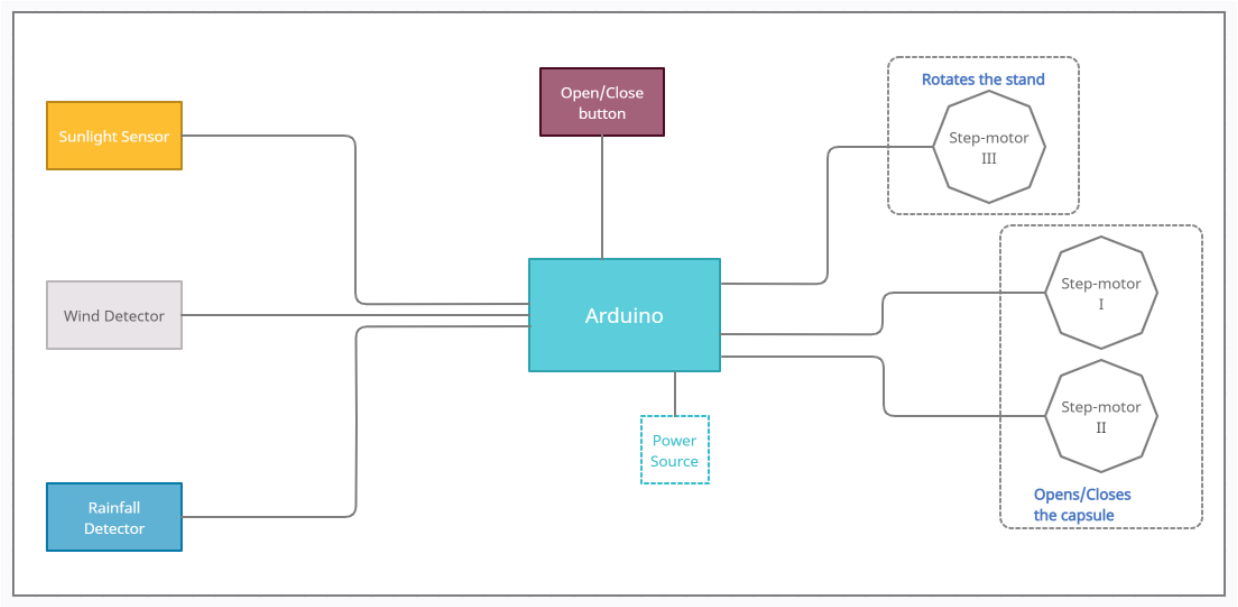

Figure 2.1: Block diagram of the working

There are three sensors. Each sensor is responsible for detecting different environmental factors and sending the readings to Arduino in a timely manner. Arduino code contains the action of closing and opening the capsule. It does so with the help of two step-motors. Depending on the values read from sensors the Arduino will decide what action to take. Set of actions contains only two actions. One, instruct step-motors to close the capsule. Another, to open up the capsule. The first step-motor spreads the sheet in a horizontal plane. The second step-motor covers up the vertical plane. The order of execution of motors depends on whether the capsule is opening or closing. The action to open/close the capsule can also be performed with the help of a button. Arduino also contains the code to rotate the stand in a timely manner. So that every part of it gets equal sunlight.

Measurements of sunlight: There are various ways to measure sunlight intensity. Considering the required sensitivity of the sensor, we will be using

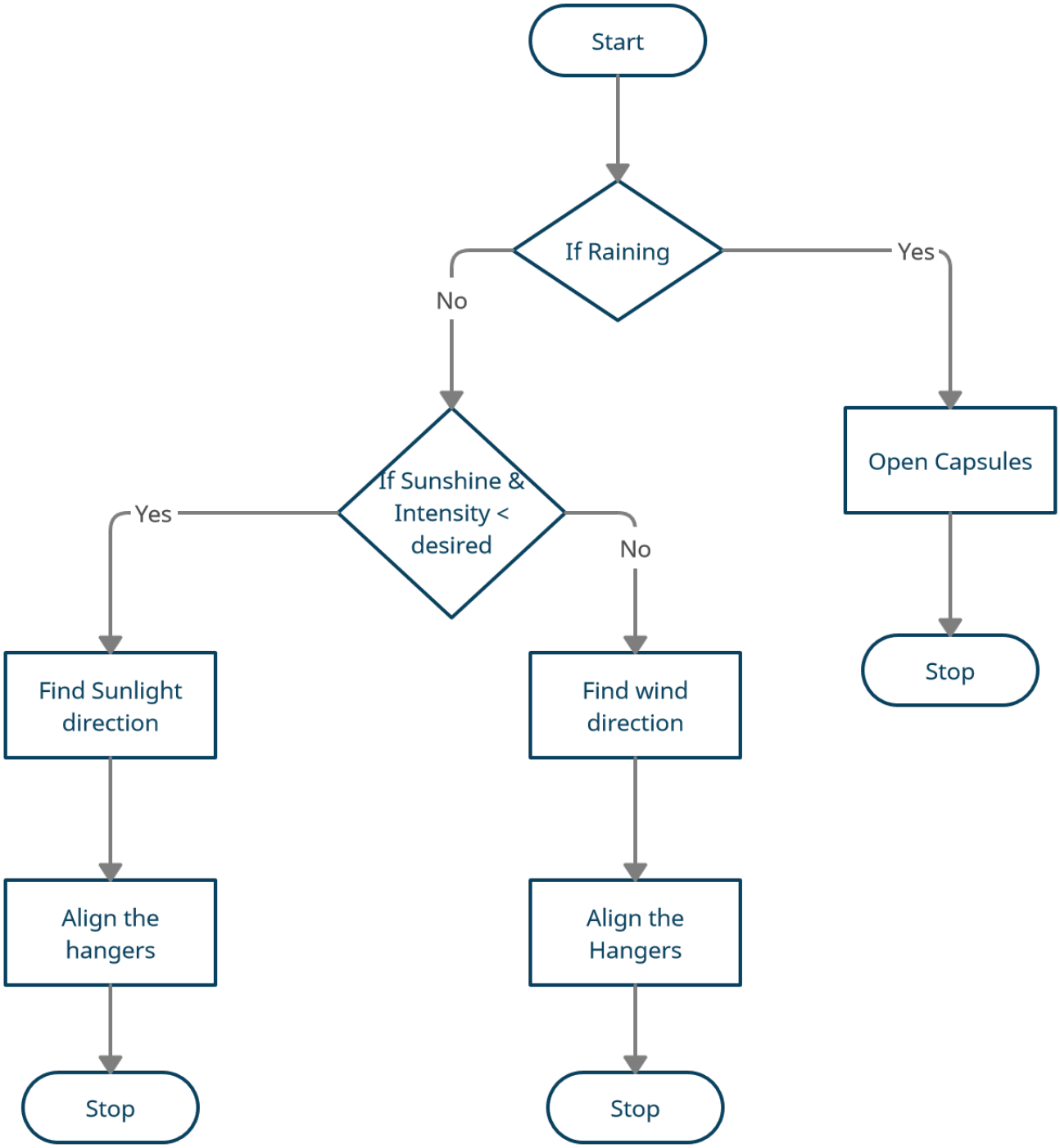

Figure 2.2: Flow chart of the working

Photo-resistors for this purpose. It changes the resistance depending on how much light hits it. For a lot of light, the resistance is low. And in darkness, the resistance is high.

Measurements of wind speed: Our purpose is to detect whether the speed of wind is above a limit or below it. Since, a windy wave tends to apply a force on everything that comes in its way, we'll use an Anemometer to measure the speed. It is designed in such a way that irrespective of wind's direction, It will rotate at a constant speed. Since we are not interested in the direction of wind, this makes this device best suited for our use-case.

Detecting the Rainfall: This is done with a normal rain sensor which gives more resistance to the current passing through it, if it is wet. And less resistance otherwise.

Equal sunlight distribution: Any non-moving stand would never ensure the equal sunlight for each part of a cloth and all the cloths. We chose a cylindrical shape for the stand. This shape slowly rotates with the help of a third step-motor. This guarantees that in any given hour, every cloth will be in touch of direct sunlight for an equal interval of time.

Opening and closing of the capsule: The opening and closing mechanism is performed in two steps. There is a separate step-motor designated for each step. In the opening of the capsule, first the step-motor I covers the horizontal top circle of the cylindrical stand. In a closed position, this top part stays in the shape of a pizza slice. This allows more sunlight to the right to the clothes. As a second step, the second step-motor opens up the covering material which was earlier in a rolled state at the top. It seems that It would practically work, but we can only find out after implementing it. This part contains a high probability of going through a lot of changes while execution.

Arduino and everything combined: Arduino reads the values from the sensors and the button. It decides what actions to take depending on the thresholds set for each sensor and the input from the user via the button. The thresholds will be decided at the time of practicality after doing some experimentation.

Other considerations: Every part of this smart stand will be able to sustain extreme situations. For example, Wind sensor wouldn't break in the high speed wind. This will be ensured by separate limits testing of each part before assembling them. Arduino would be protected from the water from the clothes and the rain. This can be achieved by adding it to a sealed container, because nobody needs to see this other than the repairing time.

2.2 The design

2.2.1 Electrical/Electronics aspects

For the electrical aspect, we will use sensors like solar sensors,wind sensors,and other with arduino.
1.**Rain sensor:** Rain sensors work on the resistance principle. If the rain water drops fall on the sensors then accordingly resistance increases and decreases under some limit. then it send closing signal to arduino for covering up the cloths. We will fit approximately two or three sensors according to the length of the sensors. so that it will cover the domain if rain comes to at an angle.
These good rain sensors available in market ranging between 200-500rupees.

2.**solar sensors:** solar sensors are sensors use if the light intensity of sun goes beyond some particular value upto which clothes can be fade by the sunlight, then it will automatically send the closing signal to the arduino for covering the cloth.
We will fit the solar sensors on the top of the stand. so that it will easy for the sensor to come in contact of direct sunlight and send signals to arduino.
There are easily available many good solar sensors which we can be use for this project ranging between 100 to 500 rupees in market.

3.**Wind sensors:** we will use the anemometer as a wind sensor. It will send signals to the arduino and tell the current wind velocity and direction of its blowing. then calculation will taken care by the arduino whether it should cover up the cloths or not.
we will fit the anemometer at the top of the cloth stand. The cost of good anemometer lies within the range of 1000 to 3000 rupees.

4.**Arduino:** Arduino is very easy and capable to establish hardware and software connection. It take input as electrical bits, and send output signal in electrical form. signal sent by solar and wind sensors processed by arduino then according to that it sends the output signal of covering up the cloths. it will do all the calculation whether solar and wind intensity is under the range or not, and other calculation for wind and rain signals .e.g., if wind velocity or solar intensity is more than some specific range then arduino will send the closing signal to servo motors otherwise it will wait for other signals.

2.2.2 Software part

Algorithm and its analysis

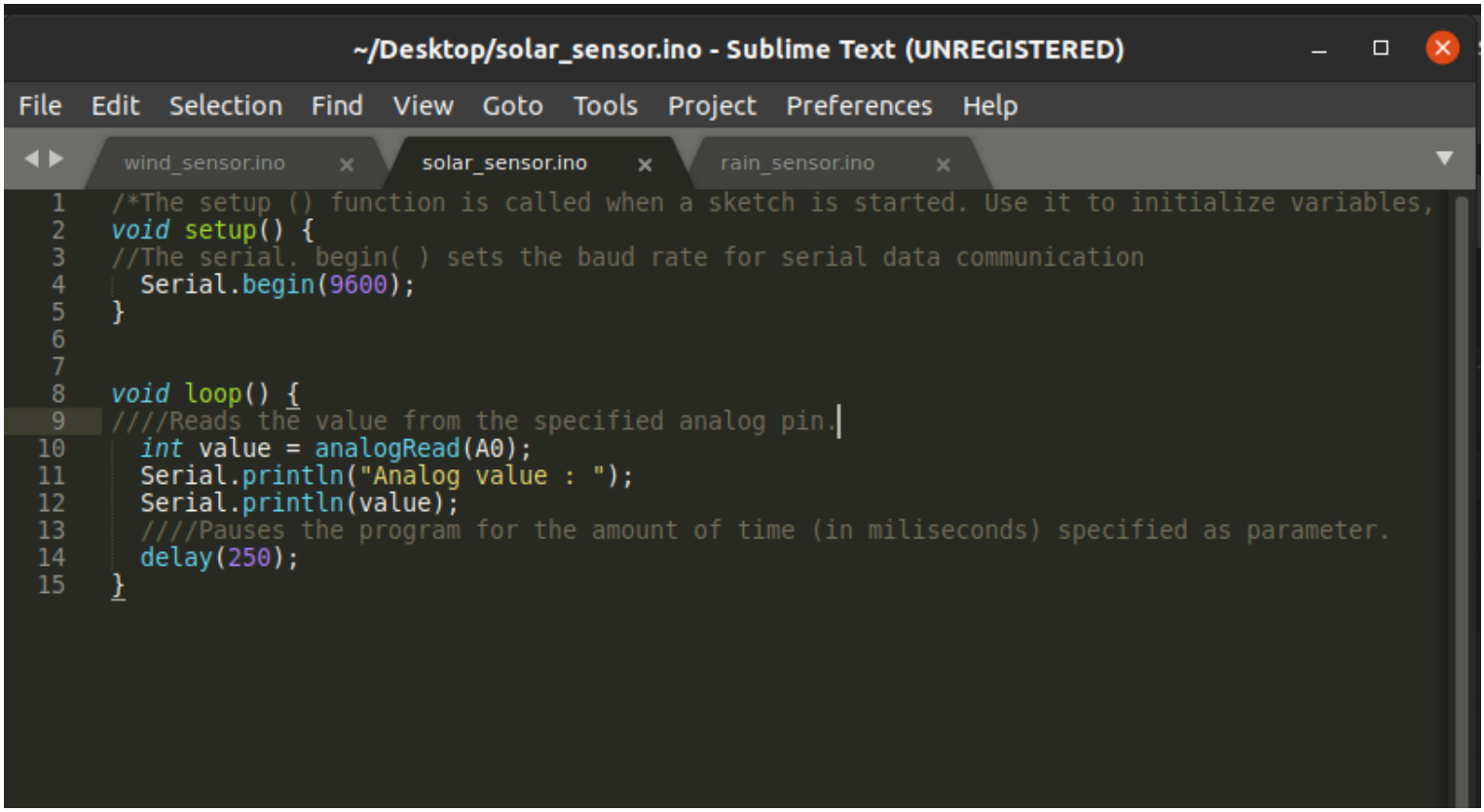

Figure 2.3: Arduino Code for Solar Sensor

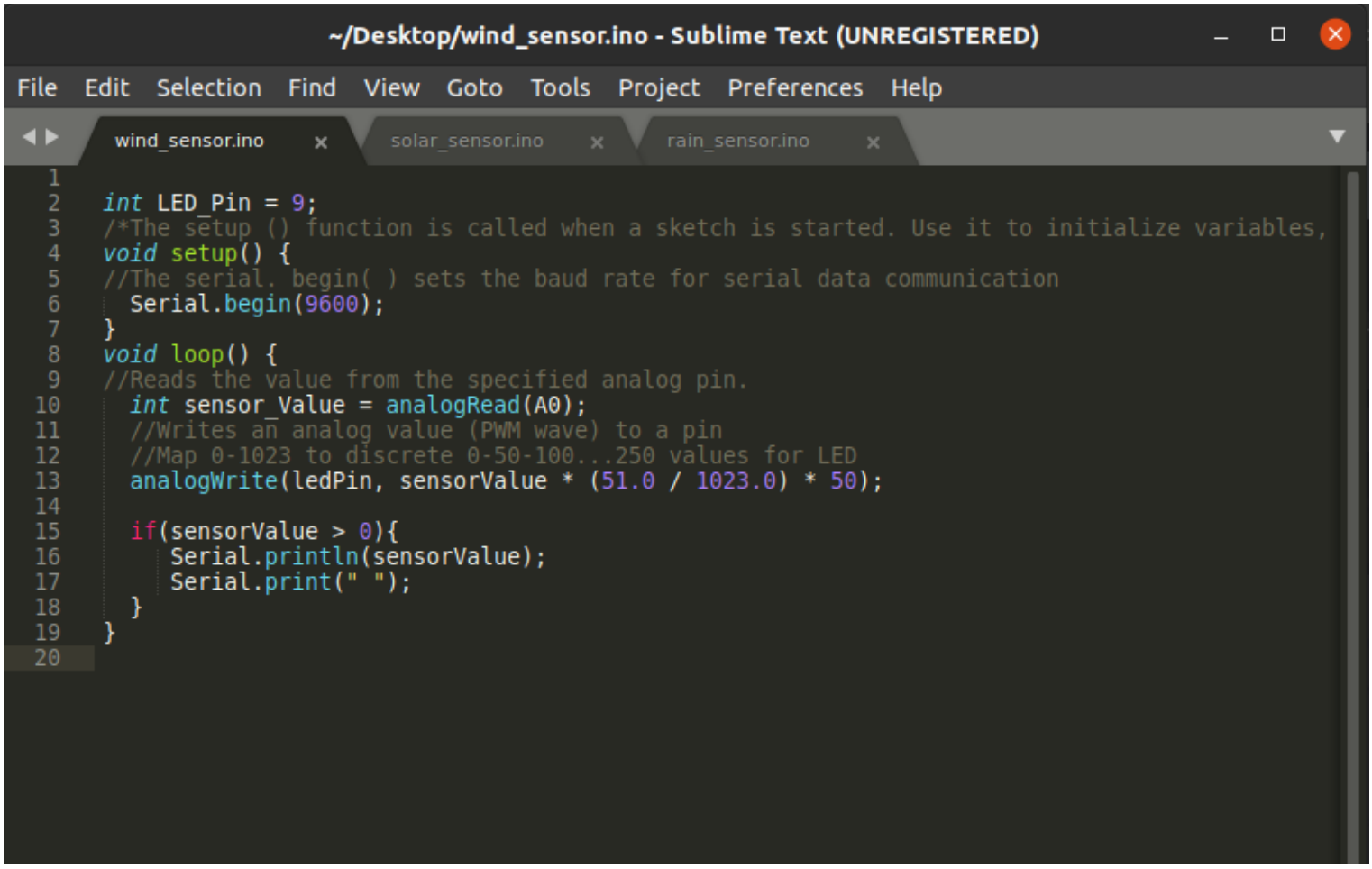

Figure 2.4: Arduino Code for Wind Sensor

1. **Algorithm for different sensors.**

i.wind sensor

ii.solar sensor

iii.rain sensor Images explaining the concept get shifted to next pages.

2.2.3 Mechanical aspects

Solid-works: Orthographics

Solid-works: 3-D view

Images get shifted to next pages.

2.3 Results and discussions

2.3.1 Figures and Tables

2.3.2 Designs discussed

These are the different designs proposed for the capsule.

One part design: This design was initially proposed to cover the cloths when needed. The idea was to have a closed umbrella attached at the top of stand. Normal umbrella is of semi-spherical shape. To provide better protection we would extend the design more towards a full sphere, but it wouldn't be a complete sphere either. This design was not strong enough to sustain the heavy weathers.

Two parts design: Two rings at the top and bottom of the stand. This is what was finally implemented. More details about the design can be found in the earlier sections.

These are the different designs proposed for the Cloth stand.

Rectangular: Automatically faces the direction of sun to maximize the amount of sunlight falling per unit area. This can be achieved with the help of four photo-resistors facing four different directions. Direction of the sun can be

figured with the help of amount of sunlight falling on these four sensors. Rotation would require more area than the area in which the stand would actually fit in. Users wouldn't consider that. So we moved to next cylindrical design which is more easy to rotate in small areas.

Cylindrical: This design would share the sunlight equally among all the cloths irrespective of the direction of sun. This is achieved by rotating the stand at a very slow constant speed. More details about the design can be found in the earlier sections.

Among the proposed designs, we have decided to go with two-parts design for the capsule and Cylindrical shape of stand. These designs take-up less area and are easy to extend as the product gets complex.

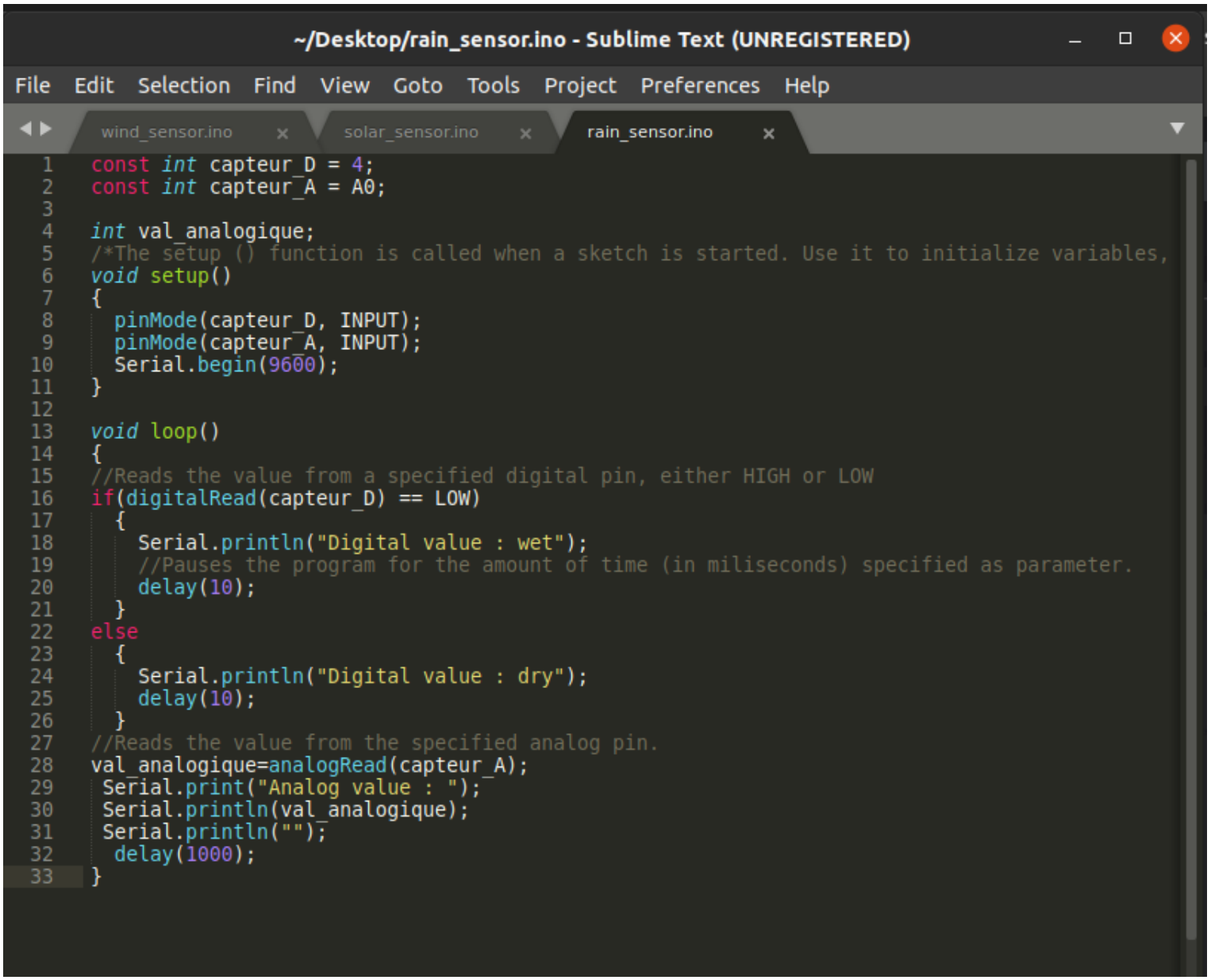

Figure 2.5: Arduino Code for Rainfall Sensor

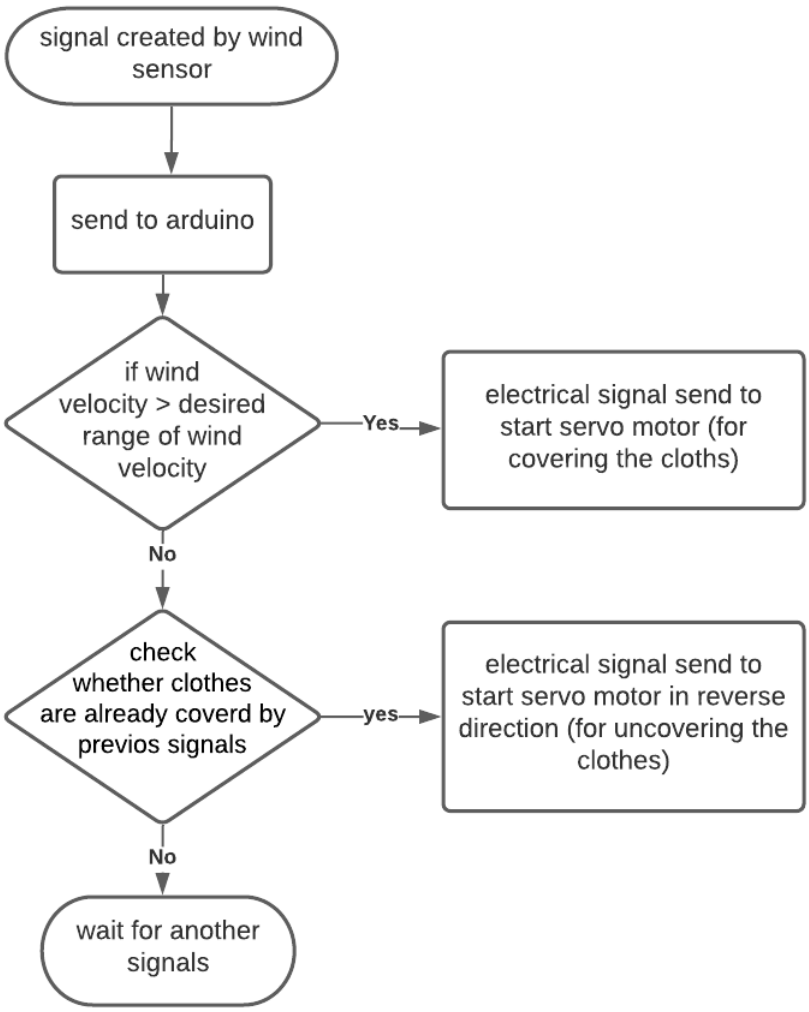

Figure 2.6: Algorithm of working of wind sensors

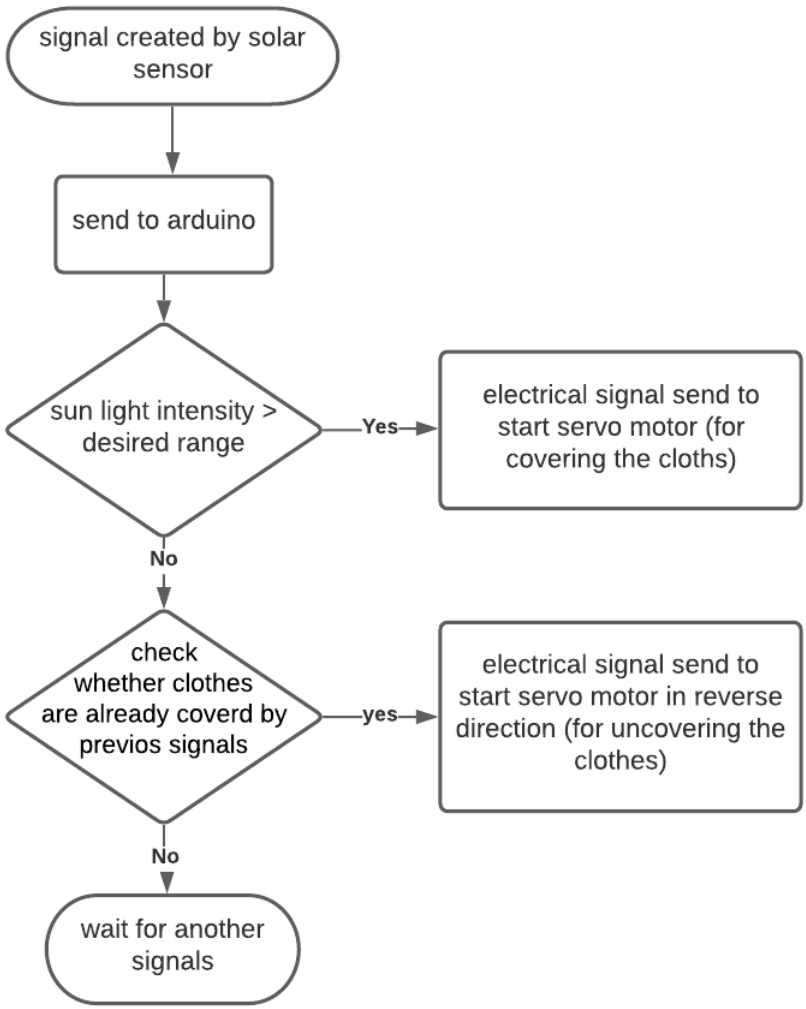

Figure 2.7: Algorithm of working of solar sensors

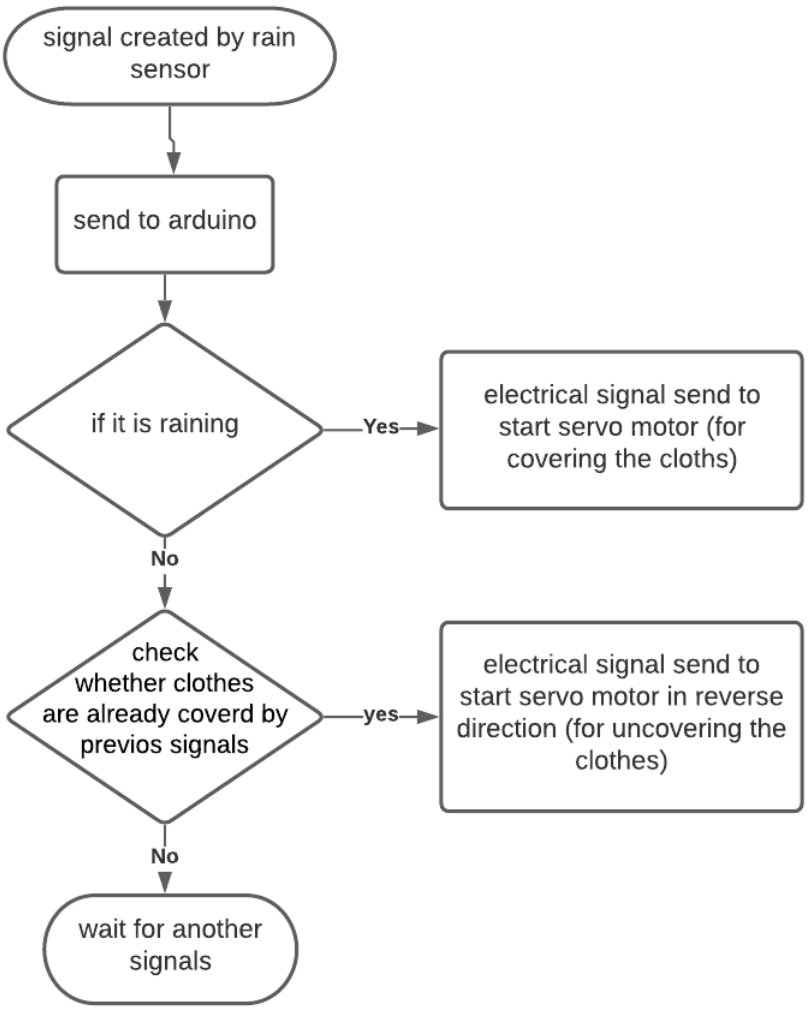

Figure 2.8: Algorithm of working of rain sensors

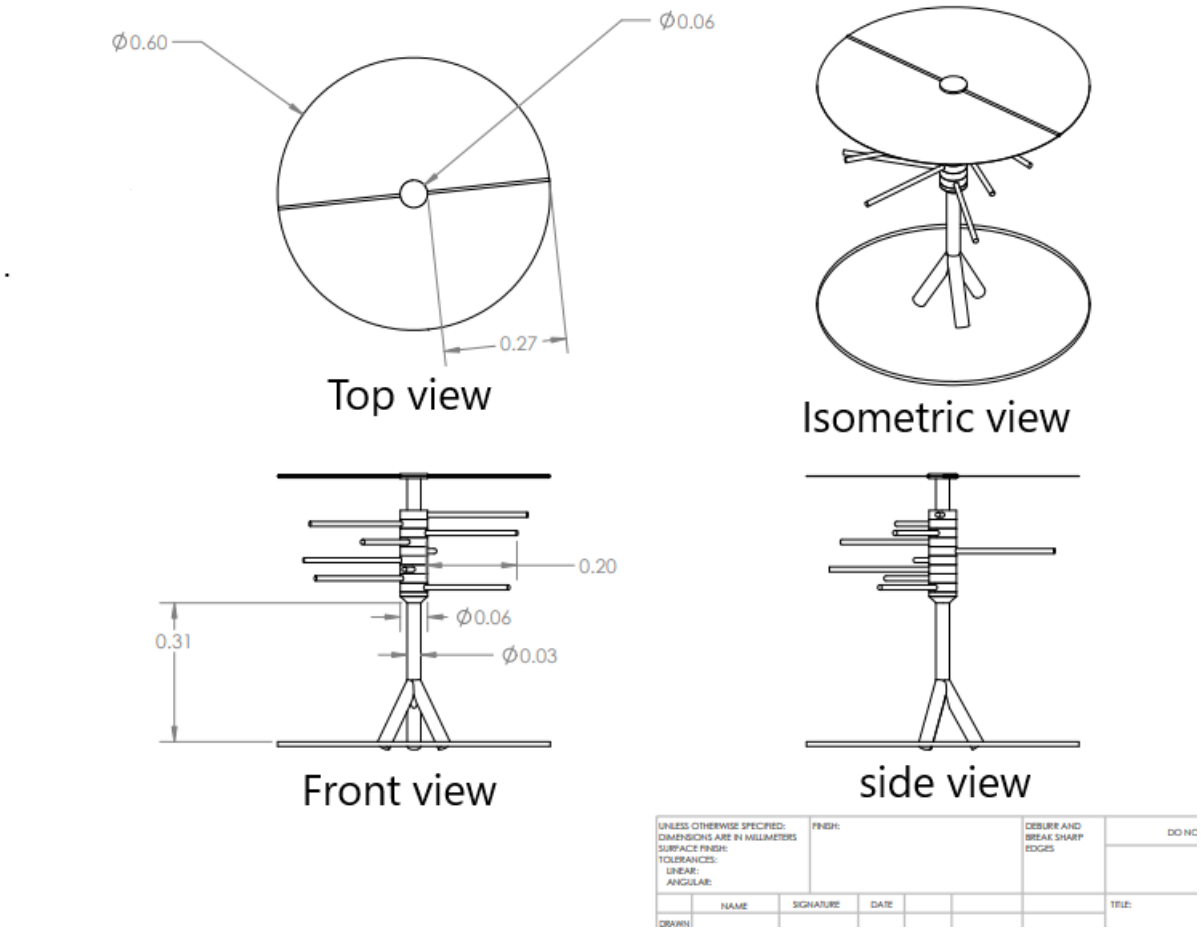

Figure 2.9: Orthographics View

Figure 2.10: 3-D View

Sensors	Threshhold Value(To be decided on experimentation)	Result if (Given Value >=Threshold Value)	Result if (Given Value <Threshold Value)
Solar Sensor	-	Capsule Closed	Capsule Open
Wind Sensor	-	Capsule Closed	Capsule Open
Rainfall Sensor	-	Capsule Closed	Capsule Open

Figure 2.11: Result Table

Chapter 3

Execution plan

3.1 Ready for execution drawings

Following are the ready to execute drawing for all the electronic & electrical part, mechanical components part and finally a combined ready to execute drawing with the main working explained.

3.1.1 Electronic and electrical

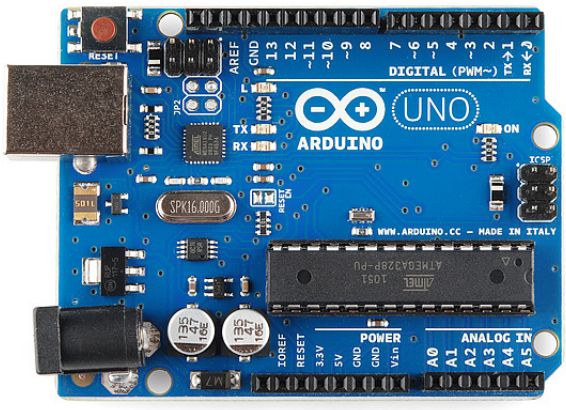

Figure 3.1: An Arduino UNO board

An Arduino Uno board connected with sensors for sensing sunlight using a sunlight sensor, a wind detector sensor for detecting the speed and direction of wind flowing, and a rain sensor for sensing if it is raining are used in the projects so that we can manage our cloth stand accordingly with the signals obtained from the sensors. The Arduino Uno board will be the project's heart and will play a significant role throughout. It will send signals in order for the needed mechanism to function. The Arduino board is being connected with

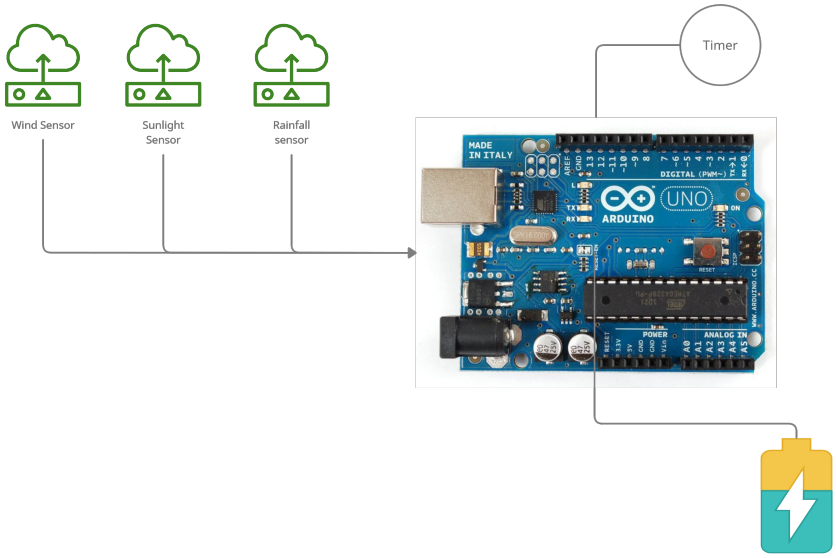

Figure 3.2: Electrical and Electronics connections that ready to execute

a rechargeable battery in order to make the Arduino function properly. The Arduino is also connected with a timer, which the user can set according to their convenience and the Arduino will send a signal when the timer reaches its limit.

3.1.2 Mechanical Components

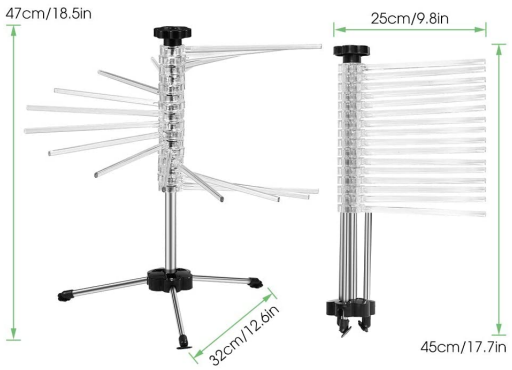

Figure 3.3: A cloth stand

A cloth stand with several hangers attached to it, as well as a few step motors, are the primary mechanical components utilized in the project. The top and bottom of the cloth stand are covered by two circular disks. When it rains, a waterproof curtain-like material will protect the cloth stand from moisture and rain. The hangers will revolve in the direction pointing towards

Figure 3.4: A step motor

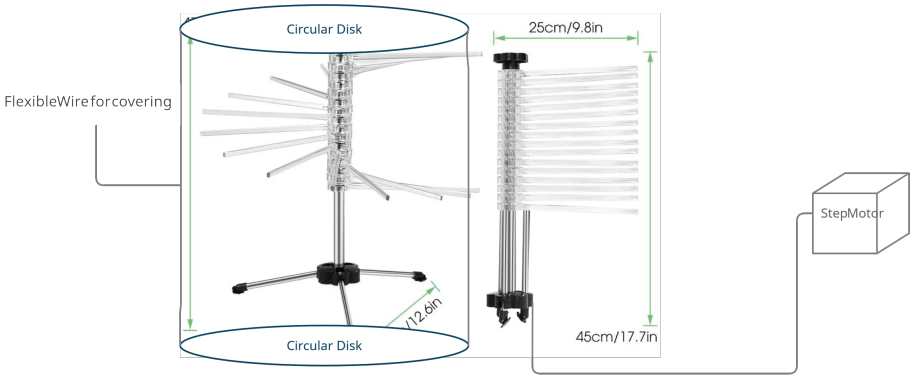

Figure 3.5: Mechanical component connections ready to execute

the sun owing to a mechanism that includes a rotor that receives a signal from our Arduino Uno. A step motor will also be linked to the cloth stand, which will power the hangers and the capsule.

3.1.3 Assembly of the product

The entire connections are displayed below in the final construction of the project after combining the electronics and mechanical components. The entire procedure of the automated cloth stand will be managed by an Arduino Uno board. The Arduino is powered by a battery that can be recharged. It will take signals from the relevant sensors linked to different nodes of the Arduino to acquire information about humidity, sunshine, and wind speed; the signals are being combined and supplied to Arduino to make the figure clean. We can also set a timer for when we want the curtains to be closed, and Arduino will send a signal to the, let's say rotor1, which will shut the capsule using a linked mechanism. This rotor will also close the capsule when it rains. The rotor, let say rotor2 in the lower portion, will alter the direction of the hangers in the direction of the sun and wind if the intensity of sunlight is less than the desired, if not then the rotor1 will close the capsules. Inputs to both the rotors are being

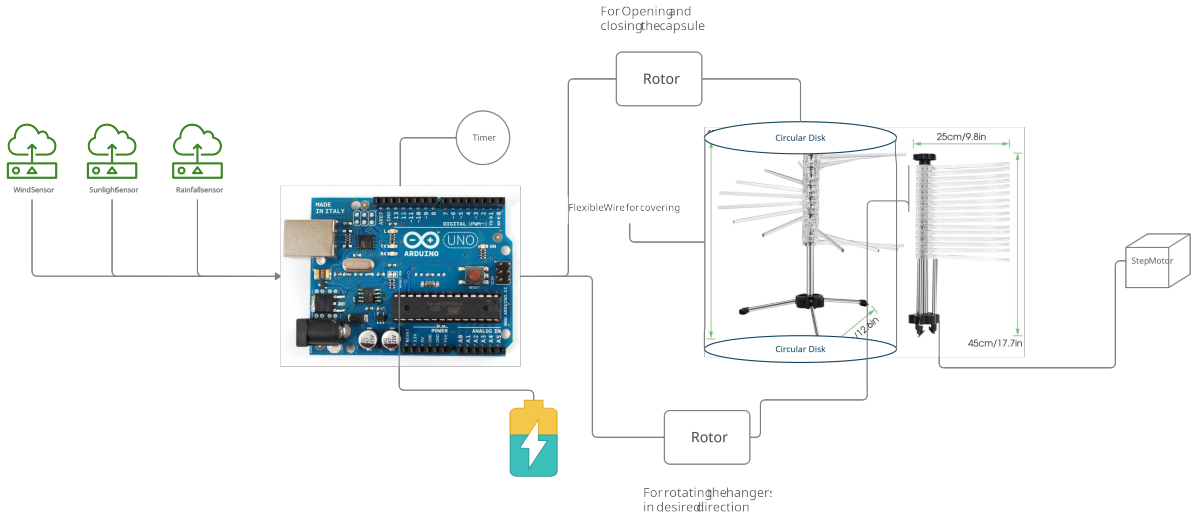

Figure 3.6: Assembly of the project

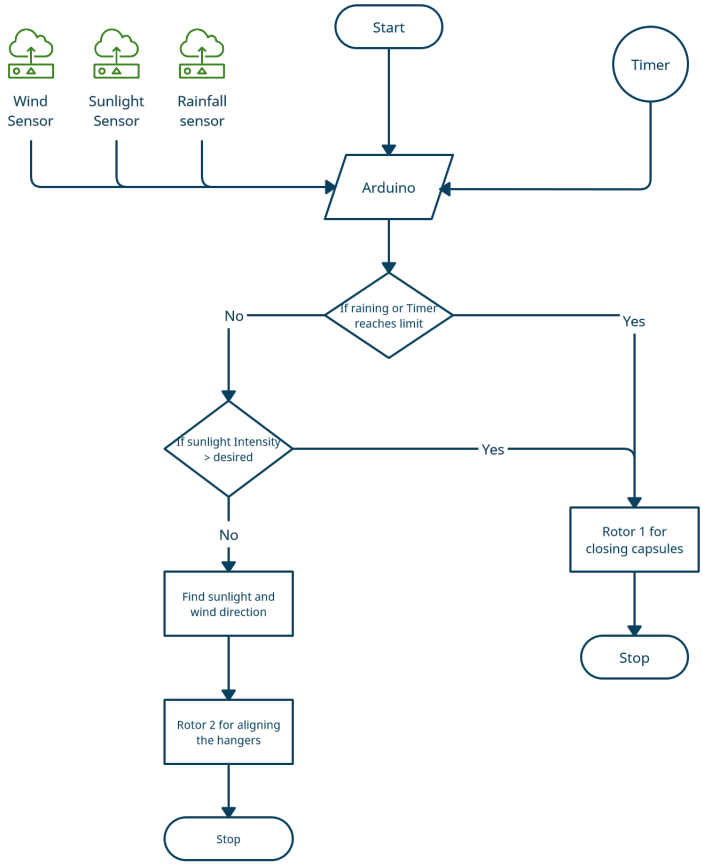

Figure 3.7: Flow chart of the working after assembling the components

taken from a single point from Arduino for clarity of figure. A step motor is also linked to provide power to the cloth stand, which is used to open and close the capsule. Working of the assembly of the components can be easily understood by looking at the flowchart attached.

3.2 Expedited execution plan

Equipment required:

1. metallic sheet to be used for capsule fabrication.
2. solar sensor
3. Wind Sensor
4. Raindrops Detection Sensor
5. Circular Cloth Stand
6. Thin wires - 10m long

Fabrication of the capsule will take 2-3 days. Then assemblage of these equipment can be done in 4-5 days. Welding and positioning the sensors can take time. Wind sensor is to be mounted on the top and solar sensor & rainfall detector are to be mounted horizontally on the stand at the top position below wind sensor. Capsule is to be made up of two parts one placed at the top & other at the bottom. Each of them will be of circular sector shape while folded & will just acquire height when it'll open up to cover the clothes.

Flowchart of functionalities of the "fabrico Automatica":
So, this product assemblage or formation will take 6-8 days.

3.3 Contributions

These were the few ideas which we discussed together to come up with the best possible design for our product. Cloth stand product idea for protection from sun, wind, rain.
Cuboidal cloth stand with rectangular sheet for covering.
Circular Cloth stand (final design)
Cylindrical Covering for circular stand
Circular Sector with height for circular stand
Positioning of sensors so that they can observe the weather change easily.

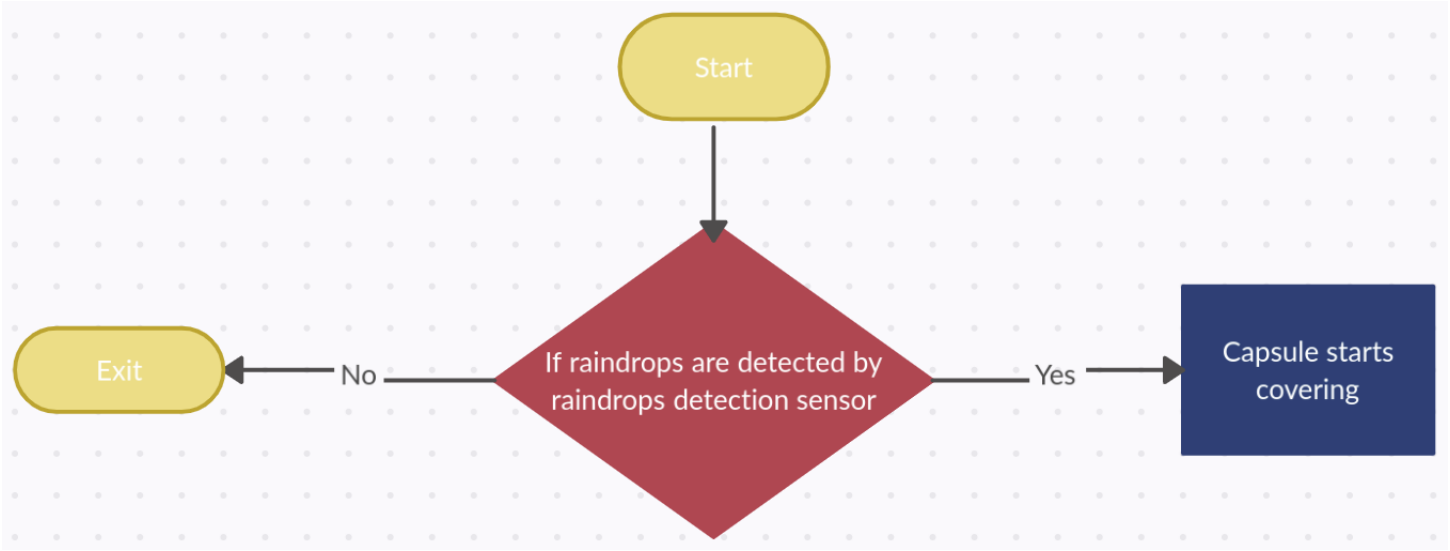

Figure 3.8: Flowchart of rainfall detection functionality

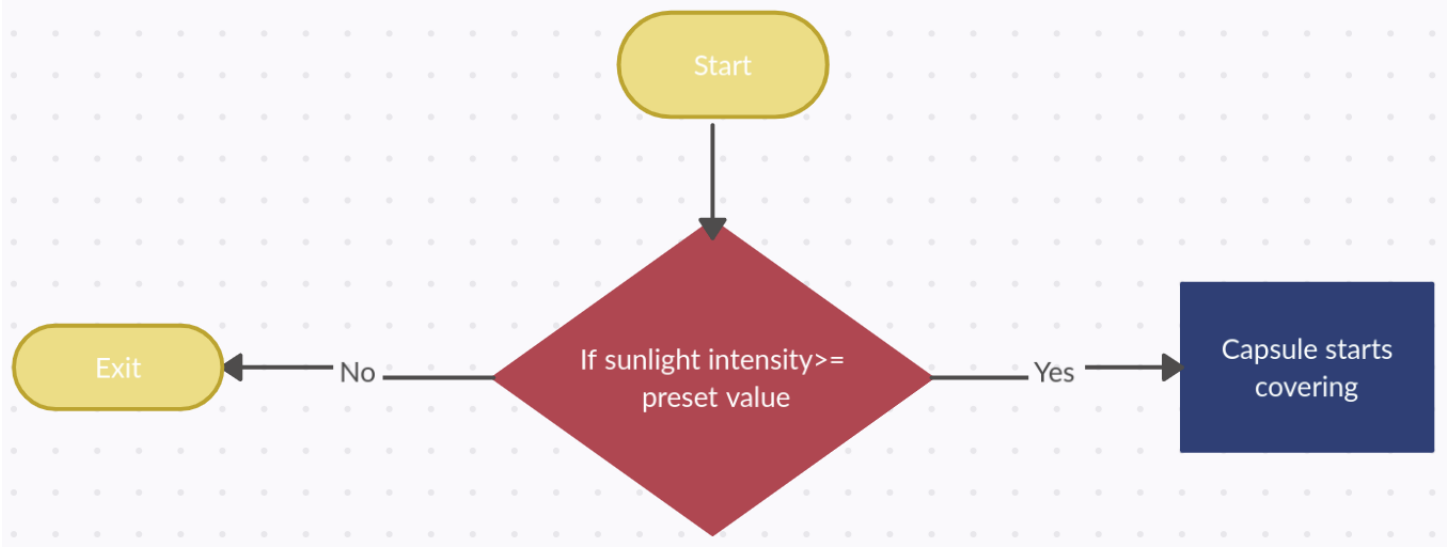

Figure 3.9: Flowchart of excessive sunlight detection

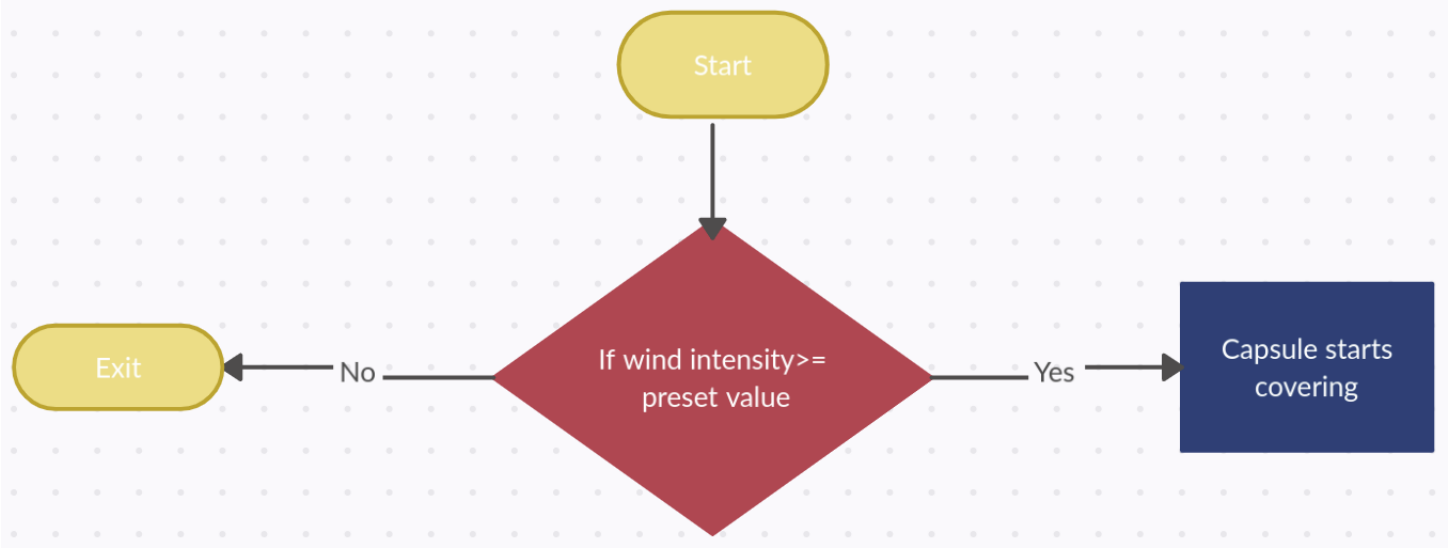

Figure 3.10: Flowchart of windy weather detection

At last: Wind detector decided to be fixed upon the top position.
For the solar sensor, we first decided to fix it on the vertical line of the stand but then that can be covered by the clothes. So, we agreed upon positioning the solar sensor and rainfall sensor at two separate circular sectors attached below the wind sensor but above the clothes hinge. All of these sensors will be powered by a common battery. And according to certain preset values for their measurements they'll send the signal to the capsule, which will start unfolding if the value read by these sensors exceeds the preset value.
So, during fabrication all of us will weld these components (after cutting them into the circular sector shape) together at the above mentioned positions & will then link these components through wire.

Work Contribution:
1. The introduction to the product and the research about the existing products similar to ours is done by Animesh Choudhary
2. The System level approach working principle is handled by Rahul Saini.
3. The Execution Plan with ready for execute drawings of our product is handled by Nishant Vedwal.
4. The Electrical and Mechanical Aspect of our product with detailed 3D model is given by Karan Singh.
5. The SWOT, software part (algorithm & its analysis), formatting is done by Rashika Rathi.
6. The results(designs discussed) and risk analysis of our product was done by

Vishal Kumar Singh.

3.4 Conclusion

Given the more limited reaction time, the planned framework ended up being fast. It's truly helpful on the grounds that the framework is completely automated & amazingly dependable, even in changing climate conditions, on account of the modern sensors. Since these keen sensors are low-power gadgets, they devour less power, and they can be arranged as an independent framework by joining a PV System (Photovoltaic system). Since the framework is so basic, it tends to be mounted wherever.

Bibliography

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