Design and Modeling of Automated Rain Sensing Umbrella

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Abstract- Automatic sensor based umbrella can be used during rainy, summer, snow fall and dense foggy season. It can helpful to not only save the life of cloth, street vegetable the vegetables, fruits but in some situations also save the human life. The idea is to design an umbrella that can be open and shut automatically with the help of Arduino programming. In present research work is come over with a smart rain sensing system can detect the rain and opens up the umbrella's link support. A raindrop sensing system is adding in this smart system, which gives a reading proportional to the amount of rain pouring on it. The smart system consisting of a rack and pinion system, the rack is fixed to umbrella such that when a sensor senses the exceeding value of raindrops, it gives a signal to the pinion attached to a motor. Then the motor starts rotating and the umbrella get opens. The aim of present study is complete controlling, design and modeling of umbrella. The result of this research is an appropriate technology to promote the ergonomics with multidisciplinary approach for the customer.

Keywords – Rainy Season, Automatically Rain Sensor, Arduino, CAD, Crop Saving System

I. INTRODUCTION

Natural resource elements are associated with day to day activities such as rainfall and sun light which is having both positive as well as negative impact on our lives and property. The sun emits ultraviolet energy which is one of the sources for vitamin D, staggering the growth of oncogenes and also used by plants during photosynthesis which is indirectly source of food for all living creature. Rainfall also having its very negative impact and such as destruction and damage of nursery bed herbs or plants and various ornamental flowers, skin disorder in humans, fever and sickness, and increase in mortality of living stocks, structural and materialistic deformation of properties such as fabrics [1]. A larger number and various types of structural and control system have been proposed in the past for particularly management, regulation, controlling and moderation of weather element to the life and property, but the retractable roof is the most suitable form for moderating these weather elements (Rain and Sunlight). Unlike permanent structures for the same purpose, the self-adjustable system only acts when a threshold is attained [2, 3].

The problem identified in previous model was for the continuous power supply so our designed model can be installed anywhere. It could be possibly access to renewable source of energy like sunlight which is cheaper and

cleaner source of energy. The problem associated with the proper design of the umbrella which can be possibly be made portable and easy to use is also there and other components with that which are to be protected from the extreme weather conditions. The design proposed for many systems uses retractable roof of wooden which can possibly be damaged by rain so proper material selection has to be done for longer life [4, 5].

Sunlight and rainfall Activated Retractable Illustrates through his paper that natural climatic elements like sunlight and rainfall has a very huge importance in our day to day life. These two weather elements have both positive and negative impacts in our life. These two weather elements have some positive consequences so they cannot be ignored completely [6, 7]. To avoid the complete isolation of sunlight and rainfall a system is developed which will economical and give space reuse whenever the threshold value exceed then roof automatically gets open up. An Algorithm is developed by the author to facilitate the automatic working of the roof whenever the intensity of these two weather elements exceeds the preset value. In this system author has used an LDR sensor to detect to intensity of sunlight and ultrasonic and rain sensor for detection of rainfall intensity and pressure which will be helping in smart decision making.

This system has a programmable device arduino which will help in controlling of stepper motor for opening and closing of roof and two switches aiding for better control in all direction. 'Smart Automation System Using Arduino and Rain Drop Sensor' illustrated in his paper that during rainy season the crops gets affected due to unexpected rainfall or even with hailstorm sometime in order to eliminate such things he developed a system to protect it from heavy rainfall [8]. The basic idea behind this research is to protect or to save the crops along with the rain water harvesting system. The rain sensing device along with the soil moisture sensing device is used in this system which will help in opening and closing of the automated roof.

Automatic Rain Water and Crop Saving System discuses in his paper that agriculture is one of the most important sector as it employs more than 45% of working population. Agriculture sector contributes a   larger section in our country's GDP so its really important to look what are the factors affecting it in some way. Due to heavy rainfall farmers across globe face a lot of problem which affect the total income and productivity of the farmer and field respectively as unexpected rainfall washes off the grains and cereals. So if they have to protect the crop a system can be developed which will ultimately look after the fields or the harvested crop and protect them from extreme condition of weather and also helps in rain water harvesting [9].

The problem stated above which is faced by people in day to day life by the extreme condition of weather leads to immense amount of problem in our lives. These problem are not only associated with money value but it also with emotional wellbeing of the person as loss of essential can lead to emotional breakdown of person. Various technological cannot be made to eliminate these problems completely but at certain extent to minimize the total cost. The equipment which is to be developed should be economical and easy to use. So that implementation of it can be done on larger areas. The Purpose this research is chosen to improve the design of the preexisting umbrellas. Often times when rainfalls a person must constantly adjust the head of the umbrella to block the rain as it falls at different angles due to the wind. Our idea intends design a smart umbrella to be an extension to current umbrellas that will automatically adjust the head of the umbrella to block the maximum amount of rain according to the wind direction and speed. The designed system which is proposed should be light in weight, cost effective, and easy to attach to existing products in the market still existing adhesion problems. The modeled describes about all the important components which in turn will be used for making of system.

II. BLOCK DIAGRAM FOR PROPOSED MODEL

The basic idea in order to develop the smart umbrella which is intelligent as well as automated, it has to be made by the involvement of many microprocessors and sensors along with proper mechanical structure A rechargeable battery was used as the power supply which can be plugged into a powered charging point. The sensor was interfaced to the Arduino Uno as indicated in the chart and described in the following section. The working of the model is dependent on the intensity of rain. The water sensor on the sensing the intensity in real as rain intensity increased and becomes more than the previous value then produce the signal to motor controller to start motor which ultimately opens up the umbrella.

Present work is propose an automated rain sensing umbrella which opens up automatically when the rain starts and gets closed when the rain stops. The designed model will not be required any human intervention for controlling of overall system. Whenever the rain falls, the rain sensor detects the intensity of the rainfall and sends the information to Arduino. The information collected by the rain sensor is processed by the Arduino and send the processed information to the servo motor to take the desired action. The rain sensor consists of digital analog output pins from where the intensity of the rain is calculated. The information which is sent to the microcontroller is responsible for controlling which leads to folding and unfolding of the umbrella and based on the intensity of the rainfall. The LCD will show the intensity of the rainfall.

The Arduino coding is used to set the threshold values and the amount of the power required to open umbrella. Formulating the basic idea of model can help to further with the design the model and the components which will be ultimately required for the fabrication of the system at very minimal cost with better efficiency.
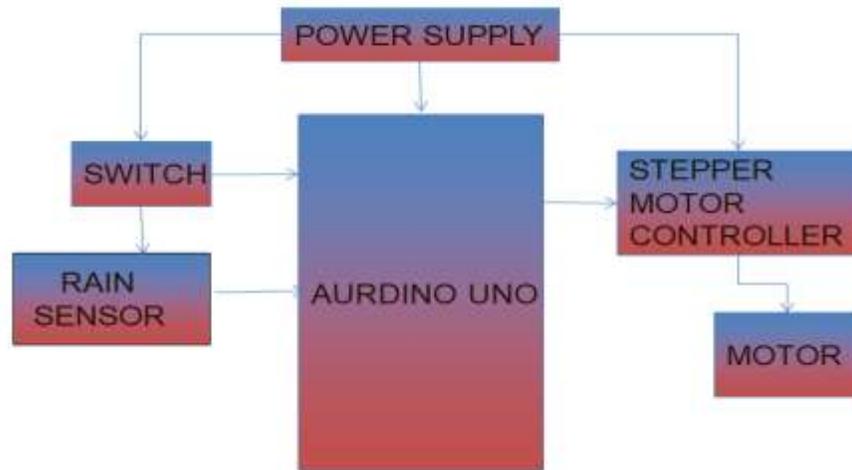

Figure 1: Proposed block diagram for rain sensing umbrella modeling

III. COMPONENTS TO BE REQUIRED DESIGNING AND 3D MODELING

*Designing Parameters***:** Following calculated values have been used for design the related components of umbrella.

S. No	Part	Quantity	Dimension
1	Base plate	1	(100mm-breadth,120mm-length) Thickness -10 mm
2	Middle rod	1	Length (460mm)
3	links	12 (Each)	Length (300mm)
4	Top support plate	1	Slot Diameter (60mm)Thickness (20mm)
5	Fasteners(nut and bolt)	18 (Each)	Nut & Bolt Diameter (5 mm) Bolt length (20mm)
6	Rack	1	Length (100mm), teeth (30)
7	pinion	1	Diameter(50mm), teeth (42)
8	Umbrella (length)		500mm
9	Area covered by Umbrella		0.384 m² approx.

SOLIDWORKS is leading CAD modeling software which has more user-friendly modeling options which is most suitable for 3D modeling. It helps to experiment with very features or dimensions of the product, and ultimately helps in producing better 3D models and detailed pictorial representation of mechanical components drawings. Present work is completed using SOLIDWORKS 2018 for designing our basic proposed model in order to get elementary idea before the fabrication of the proposed prototype. All the Parts which will be used for making the final Product is designed and then assembled to show the actual dimension of product. The model proposed is designed and represent the very fundamental idea about the overall structure of the system which will constitute different parts and reflect the total idea about the things required while fabricating it. The isometric view of components and description about them is discussed below:

Base Plate: This was the first part designed to provide a base support as it will be carrying and upholding the overall weight of the structure. So, it is really important to give proper dimension and choose the proper material to it for long life. The hole is made in the base plate which will be welded with the middle rod. The given component is shown in Fig. 2 (a).

Middle Rod: Middle Rod portion supports whole of the body as per the design as it will help in opening and closing of the umbrella by the action of rack & pinion as they do the sliding action whenever it is directed to do so. Middle rod supports links which are intermediate for that action of umbrella. Middle rod will be the hollow pipe of metal which will be joined with various other components. The isometric view of designed part is shown in Fig. 2 (b).

Support Clamp: Support clamp will be helping in holding stepper motor along with the Rack & Pinion. These clamps should be properly fixed with middle rod portion so that there is no problem due to the working of motor which might lead to vibrations. Support clamp is part of assembled model which has a very significant role. Support clamp will be chosen depending upon the life and properly clamped. The isometric view is shown in below Fig. 2

(c).

Top Support Plate: The top most portion of the proposed model consists of this plate which will be holding the covering material and will be attached with the other links for the expansion of cover. The cover should be of proper attachment and this will help in holding it together with the middle rod. The isometric view of the component is shown in Fig. 2 (d).

Rack and Pinion : A rack and pinion are a special type of linear actuator which are comprised of a circular teethed gear and a linear slab of teethed gear which in turns helps to change the rotational movement into linear motion. These are used in our model for working of umbrella automatically by using the motion produced by motor. The rack and Pinion selected should be cheaper and economical as well must have long life. The isometric views of Pinion and Rack are shown in Fig. 2(e) and Fig. 2(f) respectively.

Link Support: There are two different links are used as per the proposed model one of the link will be connected to the middle support which will be sliding by the push developed by sliding action. The other link support the covering material which will expand after the umbrella opens up. Both of the links are to be made of a good material so that there must be long life to proposed model. These are probably being made up of mild steel. The isometric view is shown in Fig. 2 (g).

Middle Support for Link: As per the model assembly the middle support is connected with Rack & Pinion which will be pushing it to upwards whenever there is motion from the motor which ultimately lifts up the links attached to it. Middle support is the main part which will help in umbrellas closing and opening action. Middle portion will be clamped with links for opening and closing. The isometric view is shown in Fig. 2(h).

Hexagonal Nut and Slotted Chesses Head Bolt: Nuts are the mechanical components generally they are termed as fasteners having thread inside a hole. A bolt has external threads which are normally used along with the nuts. Bolts are very similar component to screws. As in the proposed model different points are to be linked together that's why the bolt and nut are chosen of a particular type. The isometric views are shown in Fig. 2(i) and Fig. 2(j) for the same.

(a)   (b)   (c)   (d)

(e)   (f)   (g)

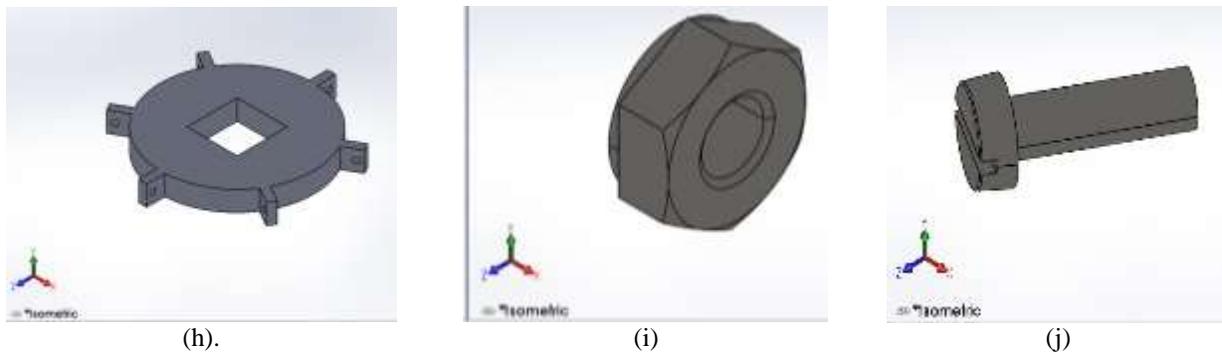(h).   (i)   (j)
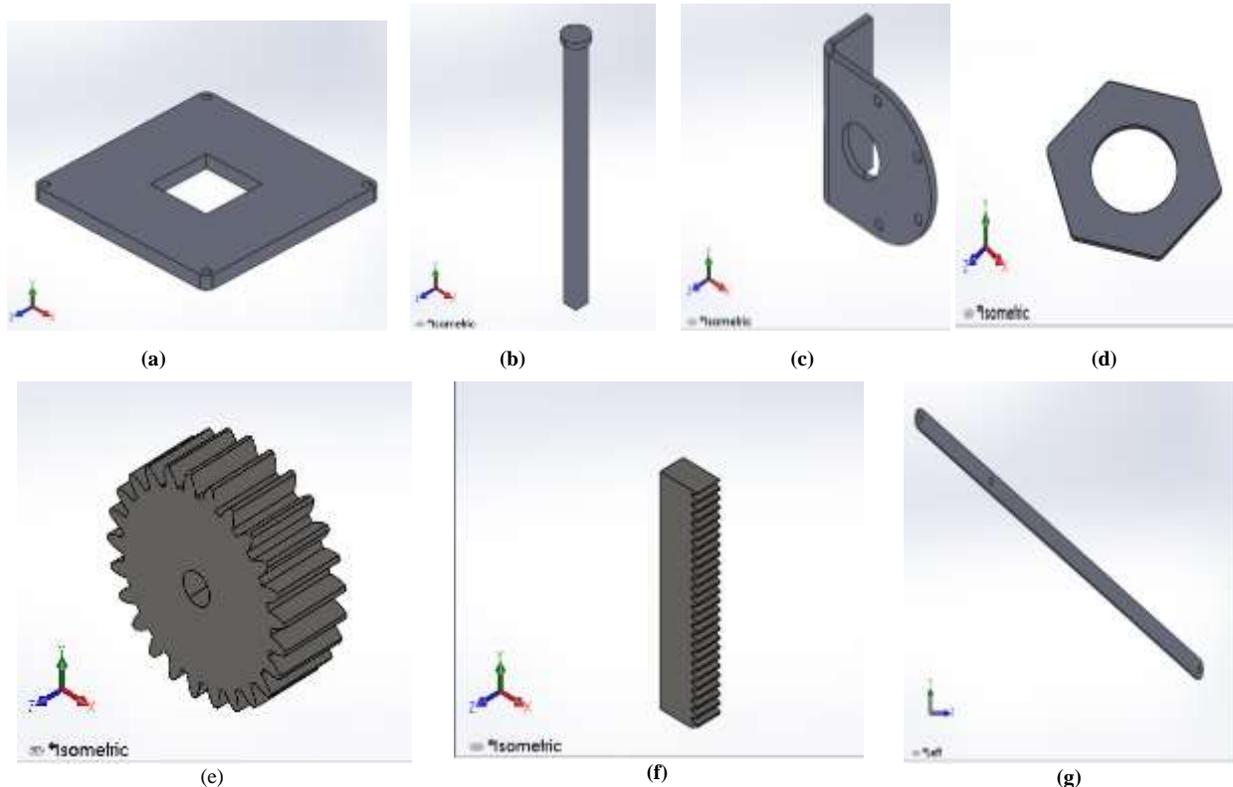
Figure 2: 3D models isometrics views of (a). Base plate, (b). Middle rod, (c). Top support clamp, (d). Support plate, (e). Pinion, (f).Rack, (g). Link support, (h). Middle support, (i). Hexagonal nut, (j). Slotted chesses head bolt

V. REQUIRED COMPONENTS FOR PROTOTYPE MODEL

There are various components which are required for the making the mechanical structure of umbrella automated, the opening and closing of umbrella is dependent on the environmental weather conditions which will be assessed by the sensors and for direction to open up umbrella an Arduino is to be used and for imparting motion DC motor will be employed whose rotational motion will be changed into translational by rack and pinion and for automatic working one power source will be also used.

DC Motor: DC motor is the electrical equipment which is converting the electrical power into mechanical output. The Photographic view is showing in Figure 3(a). All these devices are based on electromagnetic principles for the production of forces which in turn produce rotational motion. DC motor is used along with Rack and pinion combination to translate its rotational movement into translational motion. DC motor will only be activated whenever the rain sensor detects the water from the precipitation. DC motors are used in various kinds of appliances depending upon the need of size and power capacity required like from a toy to big machines. DC motor which is been used in our system imparts 100 rpm and requires 12 voltage for proper functioning.

Rain Sensor: A rain sensing element senses water as it falls on it due to the precipitation. Rain sensor used in model will ultimately be acting as intelligent part of model which will collect the real time data from the surrounding to direct the controller for unfolding or folding of the umbrella. The rain sensor as shown in Figure 3(b), is used in present work is of analogue type which has detection area of 40mm*16mm and operating voltage and current are 3-5 volts and lesser than 20mA. It contacts humidity 10-20% levels. If the model size is varied then accordingly rain sensor of the bigger size and larger capacity will be employed in the system.

Arduino Uno : Arduino Uno is the principal electronic constituent which can be programmed for various process it adds up special intelligence to system and been widely used outside the world for various purposes. Arduino Uno (Atmega328) as shown in Figure 3(d), used in present act as a controller it will be programmed according to the rain sensing element having a particular threshold value. The programming of Arduino is done in Arduino IDE software. Arduino has reset button also to change the preset program. Arduino requires a continuous power supply for working of it which can be provided by battery or by a USB cable.

12V 1.2Ah Sealed Lead Acid Battery: Its plays a very vital and crucial role in the working of the model as there must be a continuous supply of power to the system. In present work the 12 v batteries is used to supply power to both DC motor as well as the Arduino Uno circuit which will in turn be producing signals whenever there is bad climate around. To the umbrella, this battery as shown in Figure 3(c), can possibly be attached with the renewable source of energy like solar power for the longer term of use with cheaper cost. As this is the prototype the requirement of power or energy can change as per the designed size of model.

PCB Board: PCB has various different lines and pads which are connected together internally whenever two or more components are required to be in use in circuit. PCB helps in routing power and signals between different distinct or similar electronic units. For implementation of automatic system in our working model which is proposed is as showing in Figure 3(d). PCB will constitute of various components like diode, transistors, LCD display panel, Arduino Uno arranged in a particular fashion so that they can direct motor when to open up and to remain closed. These elements act as a control unit to the system detecting the extreme rainfall or the hailstorm.
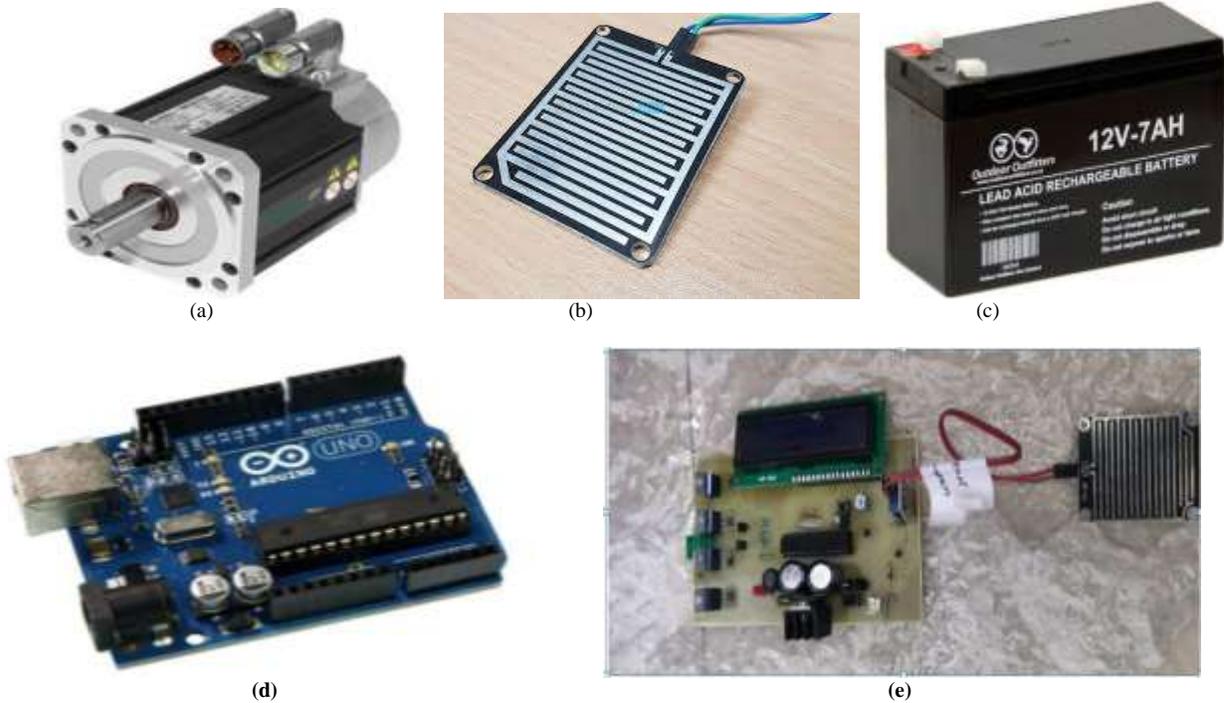
Figure 3: Photographic views of (a). DC Motor, (b). Rain sensor, (c). Sealed Lead Acid Battery, (d). Arduino –Uno, (e). PCB Board

VI. ASEMBLING OF RAIN SENSING UMBRELLA

The model proposed is designed and represent the very fundamental idea about the overall structure of the system which will constitute different parts and reflect the total idea about the things required while fabricating it. The modeled design is shown is as assembled view Figure 4 which includes various parts. All the components which are designed and in the quantity they have been used is mentioned in below table which give us basic idea of required quantity of each constitute to proceed with development of model. The complete model is showing in Figure 5. Each part has its own importance which ultimately adds significance to the model.

Figure 4: Isometric representation of 3D assembled model where all the parts are assembled without cover
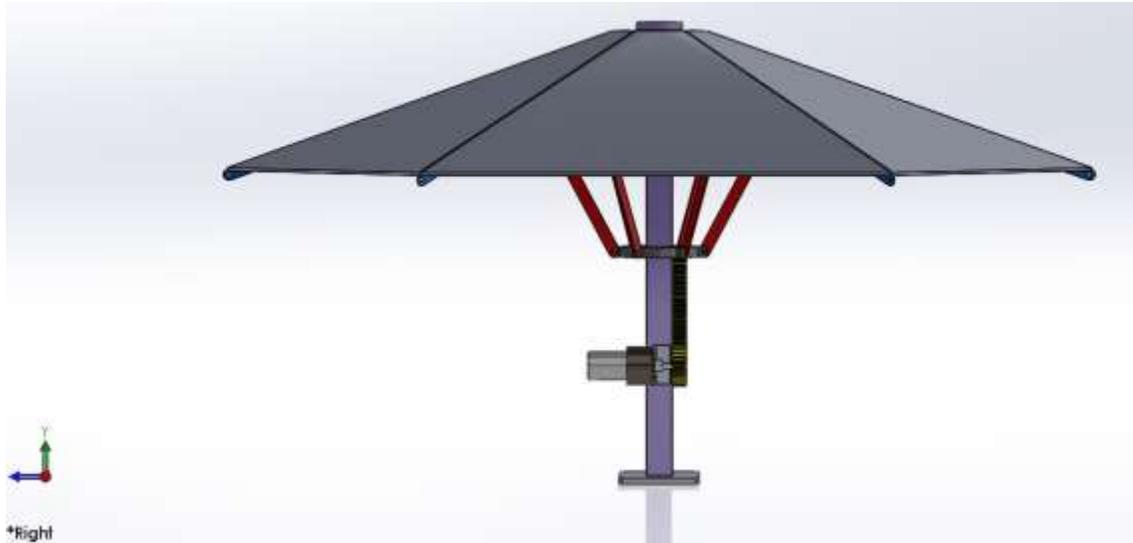
Figure 5: Side View of the model with the Top cover

VII.CONCLUSION

After completing the present work with all the process involved in designing the automated umbrella which can be of reasonable cost analysis and effective way to providing the shelter and safety to the object and goods with high intensity of power and this type of umbrella should be used in the various place in village to protect crops and the vehicles, etc. It can be applies at large scale area for reduced human work. It included the rack and pinion gear which changes the motion rotation into reciprocating. It also used in future after some of modification algorithm can be developed to coordinate Working system of rain to identify weather condition based on set value. The designed system prototype can be used along with the renewable source of energy. The designed model is not only smart but also intelligent as it will take decision about folding and unfolding of umbrella. The system can be control by Arduino and stepper motor used for folding the roof with two or more switch fix along with the knowledge of next future direction.

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