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Climb Assist Vehicle For Robotic Arm

A High Voltage hazard protection device.

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Abstract —*This paper describes of a robotic vehicle, which is used to procure overhead transmission maintenance. As in, in most of the developing countries this maintenance is carried out mainly by two methods, which include a crane with special lift bracket for personals is employed and A skill of pole climbing is employed by individual engineer which necessities use of safety ropes and braces. In both of the cases the safety level of personnel is highly sensitive as well as causes of accident are quietly. This paper provides solution to this flaws and to overcome from this we have designed a assisting robotic vehicle which climbs up the utility pole with manual controls and with the help of this maintenance can be performed with top accuracy and utmost safety.*

Keywords- *Pole climbing bot; Climbing Assist Vehicle; Hazard Protection device; Safety Utility robot; Semi-autonomous vehicle.*

I. INTRODUCTION.

While working for ABU ROBOCON competition, fortunately we were lucky enough to become members of the team and participated for the event for different themes since year 2014. By the end of 2015, a new theme was launched which was based upon **Clean Energy Recharging the World,** while working on its one of the task of climbing the pole we started to explore in vivid directions apart from the theme itself and the application of the task in reel world.This led me to find real applications of such machines and issues related with the present machine.

After studying various conditions and environment in difficult walks of life, we found that in India and also in many parts of the world likely in developing countries, an electrical engineer climbs a utility pole to repair or to find the fault in low voltage and medium voltage lines. These utility poles are categorized based on their voltage lines; following table explains different types of voltage lines. [1]

Table 1: Types of Transmission Lines.

Low voltage	Less than 1000 volts
Medium Voltage	Between1000 volts (1 kV) and 69 kV
High voltage	Between 115000 volts (115kV) and 138 kV
Extra high voltage	Between 230 kV and 800 kV
Ultra high voltage	Higher than 800 kV

In the above table, the voltage lines from high voltage line to ultra high voltage lines are not in the scope of study as generally they are more reliable and because of high voltage, sufficient care, precautions and tools are employed. But on the other hand, less precautionary measures are heeded to medium and low voltage lines especially in the case of low voltage line. A standard procedure for pole climbing is followed by two methods

- A crane with special lift bracket for personals is employed and
- A skill of pole climbing is employed by individual engineer which necessities use of safety ropes and braces.

In case (a) the crane serves a very good purpose for lifting and lowering the personal, but it is an extreme dangerous conditions, in case of an operator error, unstable ground and in other miscellaneous conditions. Also this is limited to the road accessibilities to the point of maintenance, where as in case (b), it is employed the most of the time in developing and developed nations which differ with respect to specialized climbing assisted tools and safety considerations which is missed a many a times in developing countries.

Because of case(b) employed largely, as defined previously there arises a need of man less apparatus to conduct all or few of pole top operations in electrical engineering. A robotic arm is now a common site in most of the automation industries also the cost of such a robotic arm or a specialized grippers is going down day by day.

Now the problem remains on the questions of elevation such as customized arm/grippers over the top of the pole so as it can perform in regular maintenance by ground control or in a monitored display. The various types of utility poles for overhead transmission are used based on the type of voltage line ranging from low voltage to ultra high voltage lines. The classifications [4] of different types of utility poles are as follows, they are:

I. Wood poles
II. Steel tubular poles
    a. Swaged type
    b. Stepped type
III. RCC and PCC poles
IV. Poles made of Rails and RSJ. (I- section).
V. Poles fabricated from GJ/MS pipes
VI. Lattice type structure

Amongst them, RCC poles and poles made of rails(I-section) are widely practiced into day to day life. And as compared to RCC poles, poles made of Rails (I-section) are highly prioritised because of their ability to withstand structural stresses are high. Therefore, here in this article we have considered poles made of rails (I-section) as primary constrain for climbing assisting robotic vehicle.

These poles made of rails (I-section) for overhead transmission lines are categorized by **Indian Standard Medium weight Beams (ISMB)** [2] standards which are ranging from ISMB125 to ISMB250, which are varying with the type of current supply and load carried through line.

At stake, the overhead maintenance is carried out with a standard procedure for pole climbing which is followed by two methods

- A crane with special lift bracket for personals is employed and
- A skilled person of pole climbing is employed by individual engineer who necessities use of safety ropes and braces.

Figure 1: Procedure for pole climbing case (a) and case (b).

In case (a) the crane serves a very good purpose for lifting and lowering the personal, but it is an extreme dangerous condition in case of an operator error, unstable ground and in other miscellaneous conditions. Also this is limited to the road accessibilities to the point of maintenance, where as in case (b), it is employed the most of the time in developing and developed nations which differ with respect to specialized climbing assisted tools and safety considerations which is missed a many a times in developing countries.

Because of case(b) employed largely, as defined previously there arises a need of man less apparatus to conduct all or few of pole top operations in electrical engineering. A robotic arm is now a common site in most of the automation industries also the cost of such a robotic arm or specialized grippers is going down day by day.

Now the problem remains on the questions of elevation of a customized robotic arm/grippers over the top of the pole so as it can perform in regular maintenance by ground control or in a monitored display with utmost safety. Hence for a designing point of view of climb assist vehicle for robotic arm, Robotic arm IRB 140 dimensions are considered for reference[3] as well as sections ISMB125 and ISMB250 are considered as key parameters for robotic vehicle as in they are the minimum as well as the maximum dimension used for utility pole. As shown in figure (2), the sections ISMB 125 and 250 are drawn using Autodesk Inventor as per reference from ISMB standard dimensions.

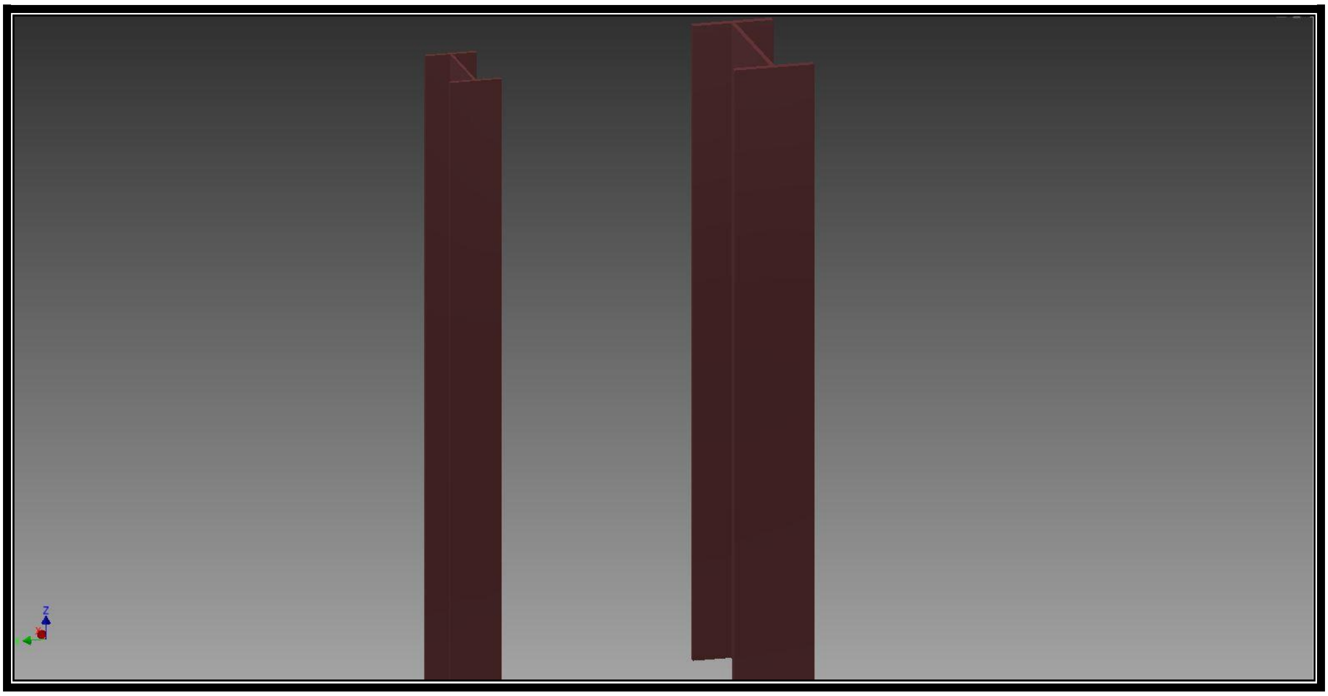

Figure 1: Cross-sectional view of ISMB section 125 and 250 respectively.

II. Designing and Modeling.

On the basis of standard dimensions, robotic arm vehicle's design is carried into two different units namely as,

- Fixed slide and
- Sliding slide.

Both the slides are driving slides, which are driven with the help of a DC series motors that are cabled with a DC power supply.

The assembly for the assisting vehicle comprises of the wheels with the grooves which are embossed with rubber at the circumference which provides grip while climbing the utility pole as well as acts as an insulating material. The corner supports are provided which are used for holding the wheels, motors, sliding rods, bearings, hand wheels and depth control rollers. These depth control rollers act as idler rollers which provide effective guide ways to the robot while climbing the utility pole. The hand wheels are provided in order to adjust the varying length between web and flanges for the different cross sections ranging from ISMB 125 to ISMB 250.The frame structure is provided which is constrained with a base plate through fasteners, where as one of the end side of base plate is welded with fixed slide and other end is constrained with the sliding slides with a slot over the surface of base plate provided with a key. The plate for mounting robotic arm is welded with the frame structure and act as the housing base plate for robotic arm which can be assembled further for fault finding and repairing.

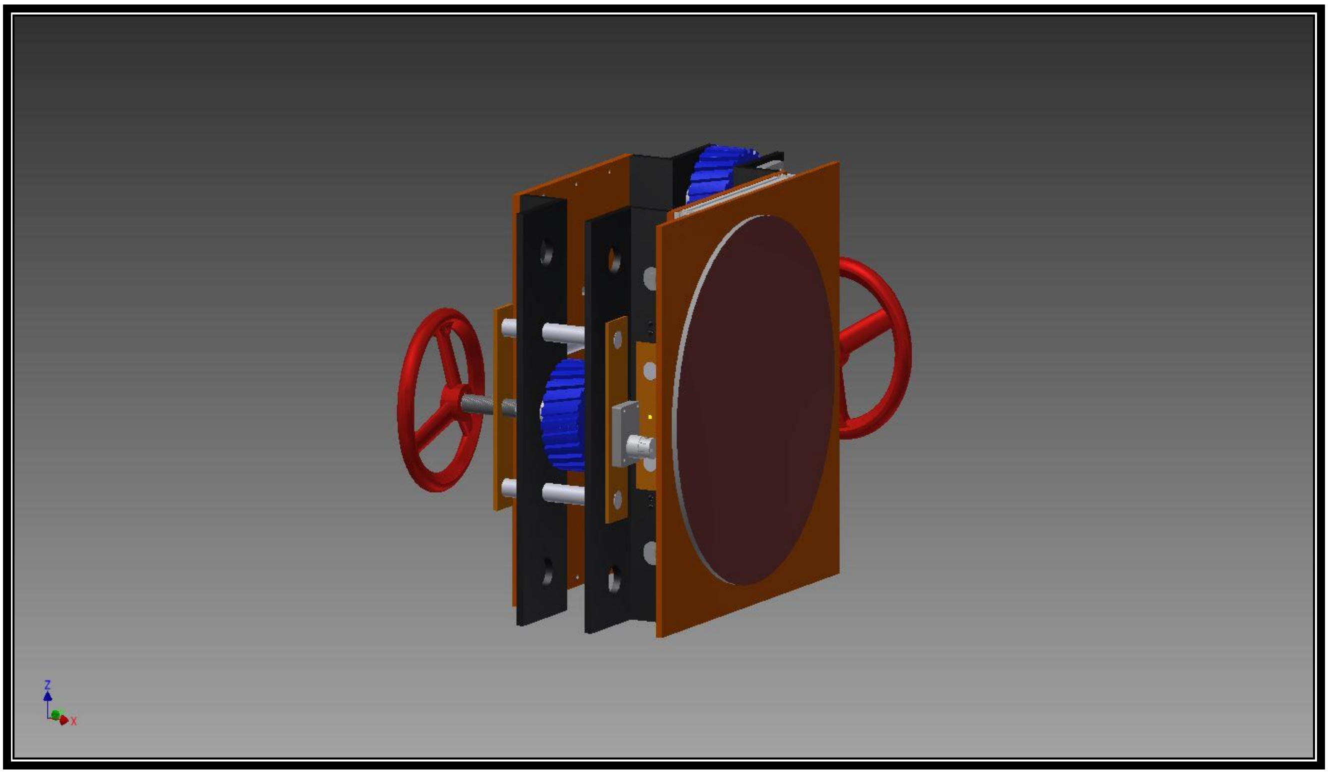

Figure 2: Isometric view of Robot.

Figure 3 describes about the two different units designed for climbing assisting vehicle, i.e. the unit with single driving wheel is explained as Fixed Slide where as the unit with the two driving wheels is said to be a Sliding slide. As shown in the figure the hand wheels are provided with threaded shafts which are constrained with internal threads of plates which assist the unit to adjust its length based on the dimensions of web and flange. This could be explained with help of following figure.

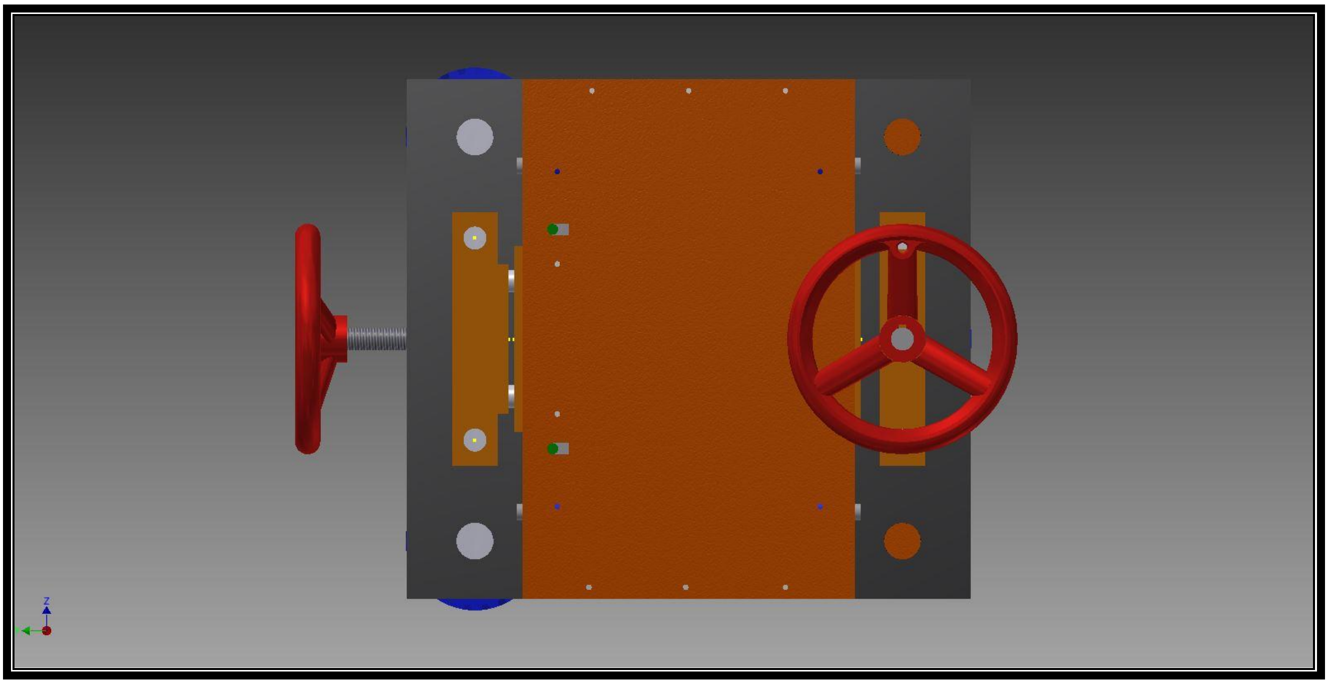

Figure 3: Front End View

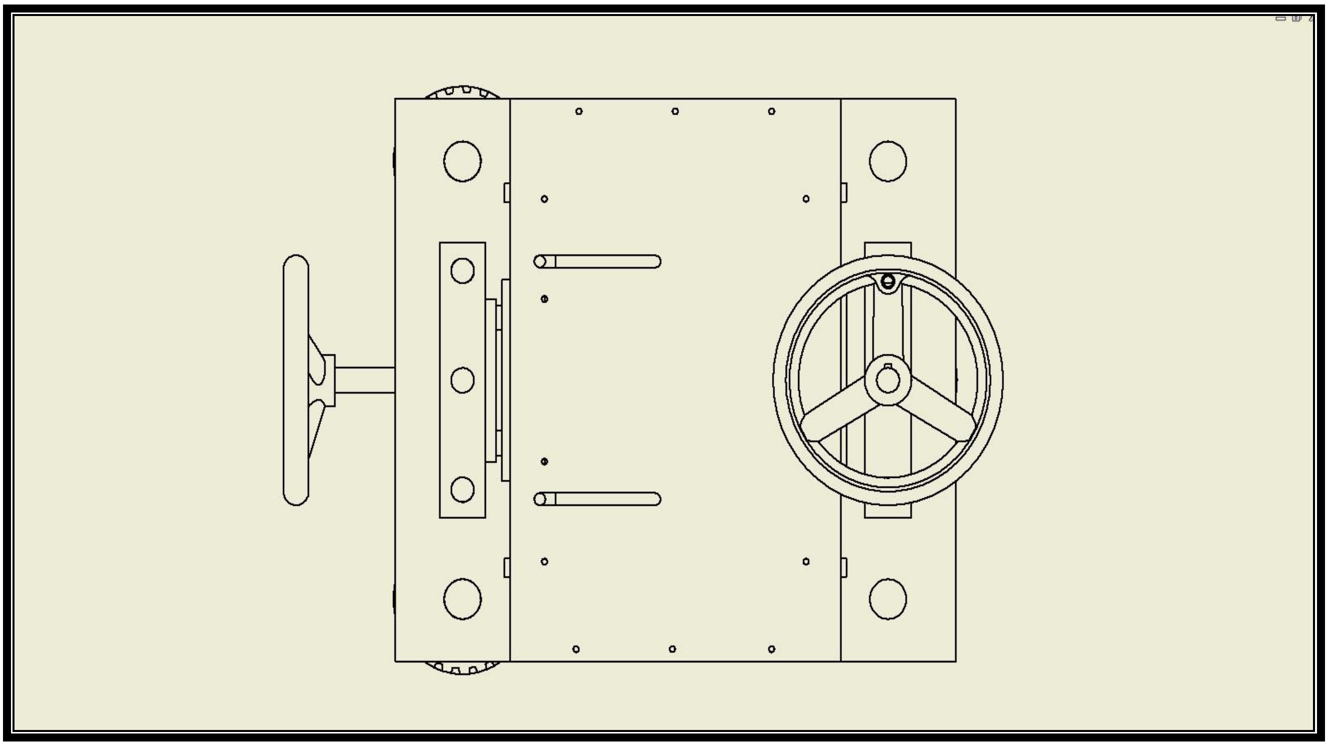

Figure 4: Front End View. (DWG)

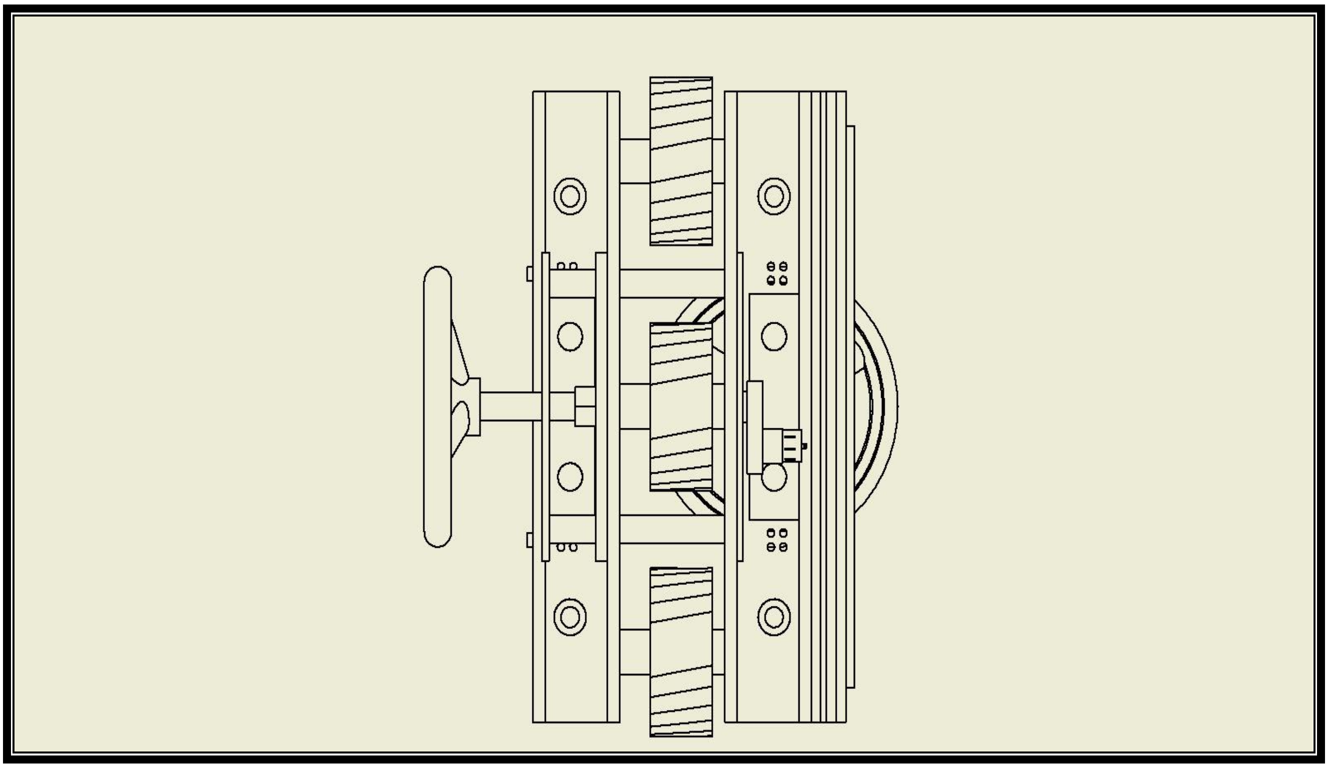

Figure 5: Right Hand Side View (DWG)

As shown in above mentioned figures, the shafts at one end are welded with fixed plate where as near the hand wheel side the shafts are constrained with the help of threads, such that the system can be opened from one side in order to insert the machine to the pole (section) surfaces and further can be fastened up. This could be explained with the help of following flow chart.

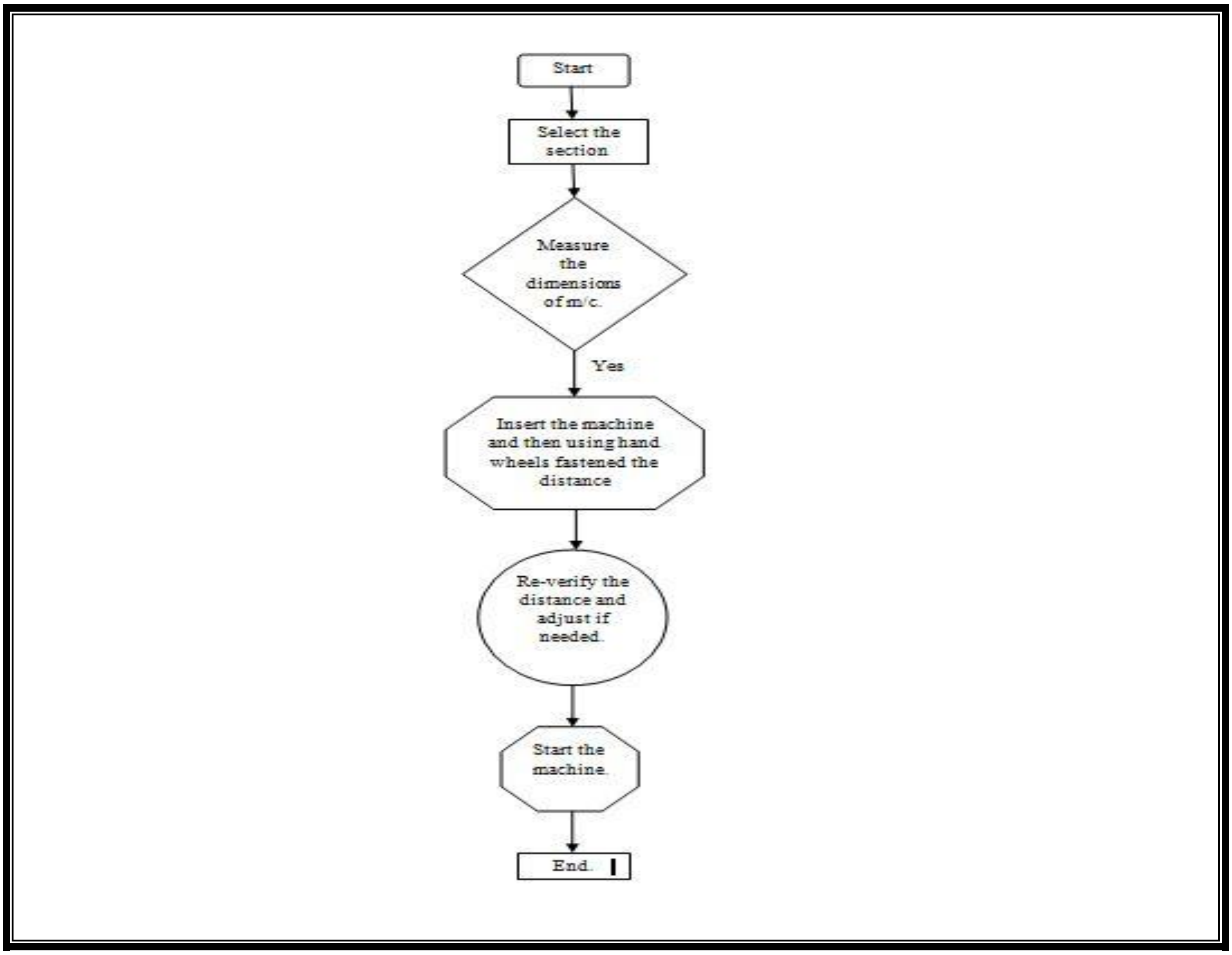

Figure 6: Flow Chart for Assembly of robots for varying Sections

From the above mentioned figures (4to7), the construction of machine can be understood easily, on the other hand the working of the climbing assist vehicle for robotic arm can be explained with the reference to ISMB sections 125 and ISMB section 250 which can be explained with the following figures.

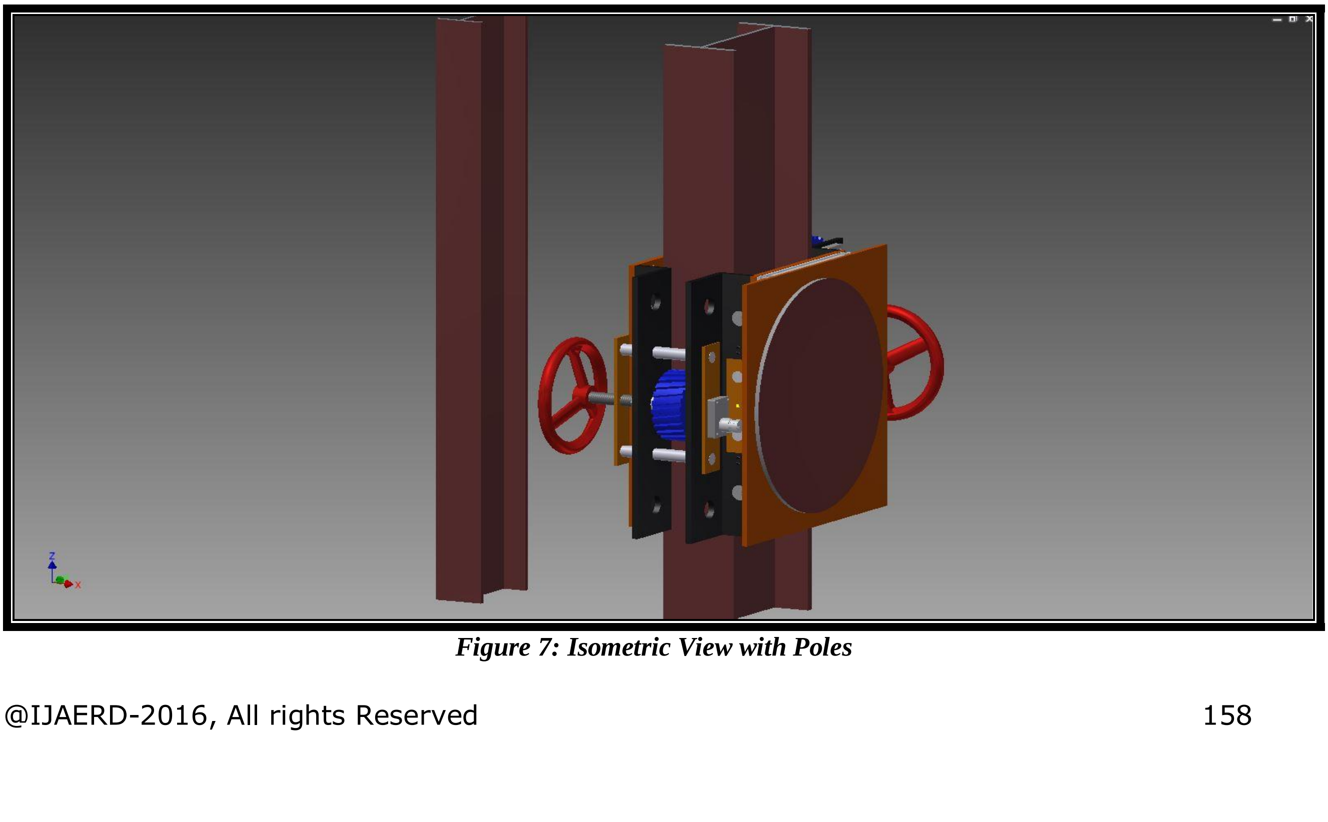

Figure 7: Isometric View with Poles

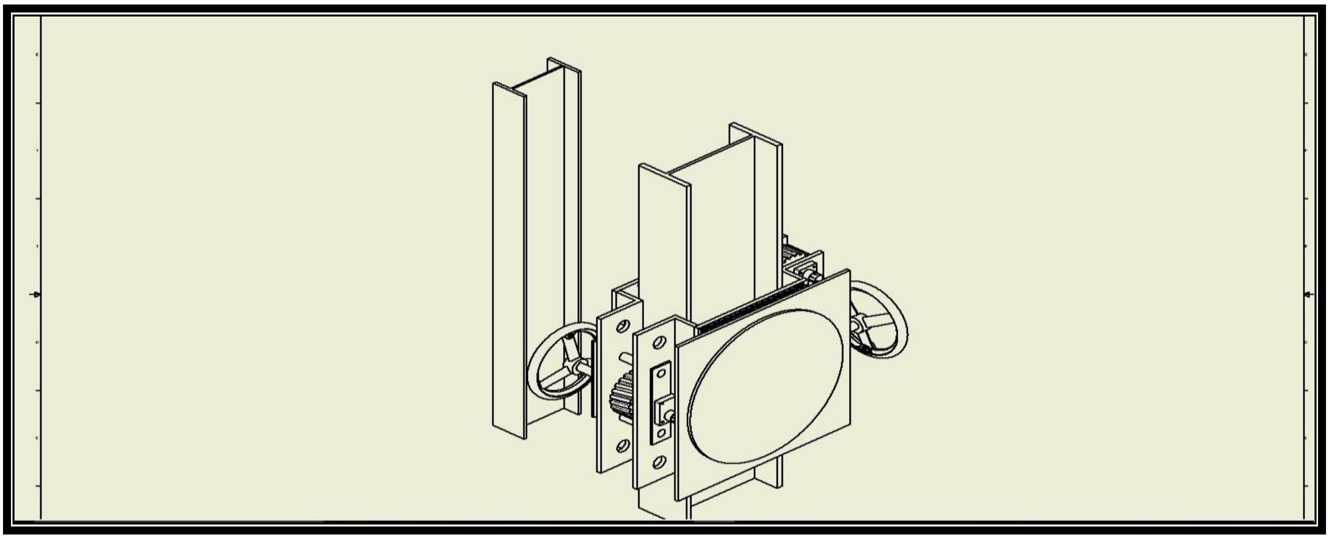

Figure 8: Isometric View with Poles (DWG).

As shown in figure (8to 9), when all the wheels are made in contact with the ISMB section using hand wheel, a D.C power source is applied to motors which in turn tend to produce driving force through the wheel, resulting into elevation of the robot. This can also be explained with the help of following flow chart.

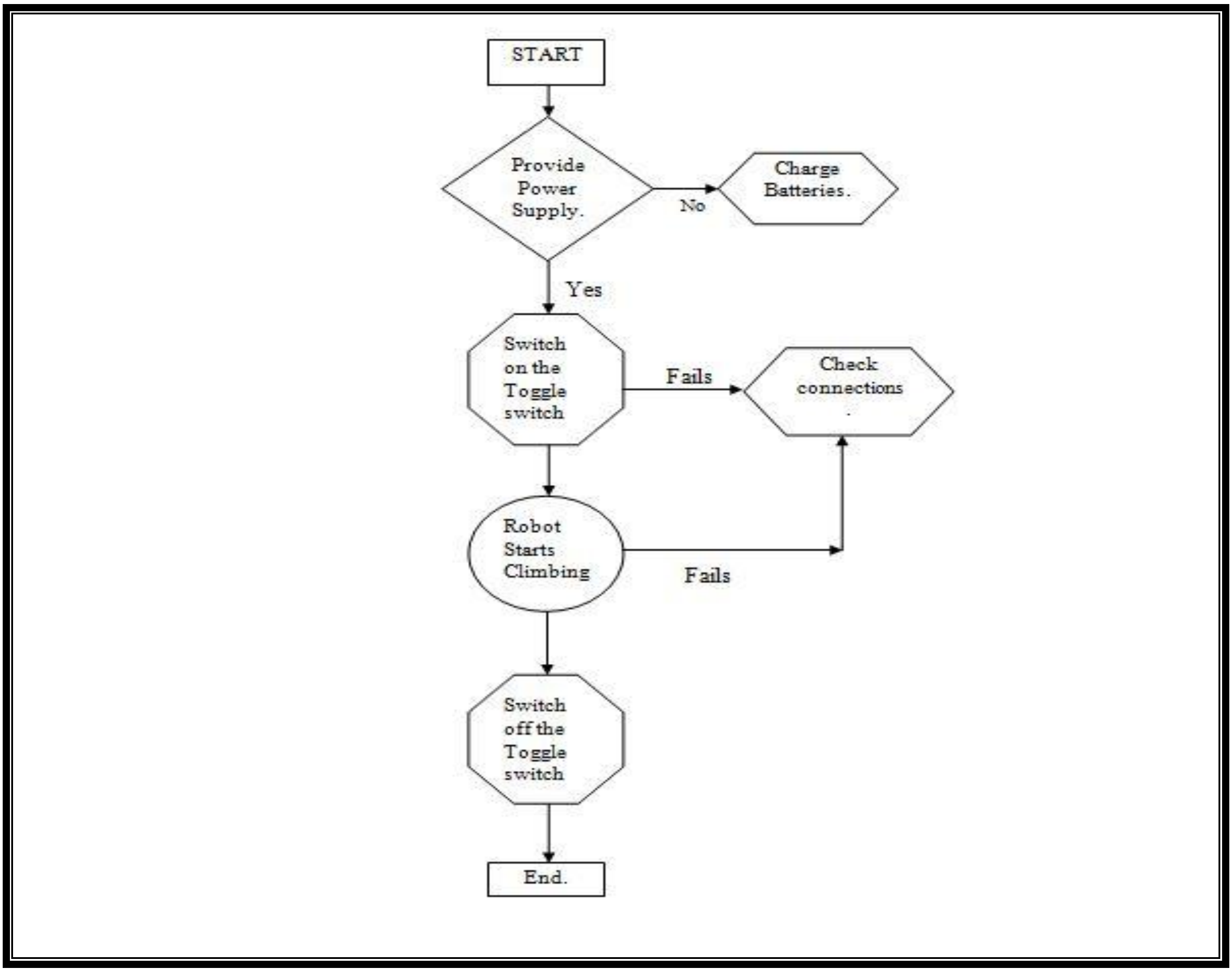

Figure 9: Flow Chart Representing The Process Layout.

Also the thrust and power require to drive the robot can be calculated with the help of following formulas, mentioned into the Table 2.

Table 2: Force, Thrust and Power Calculation Formulas.

As per Newton's law, F= mass * gravitation, N/m2. Mass (m) = mass of body, Kg. Gravitation= 9.81, m/s2.	Torque, T=Force*radius, N.m r= radius of wheel=.06, m F=Force, N/m2.	Power, P= $\frac{2*\pi*n*T}{60000}$, Watt n= Speed, rpm. T= Torque, N.m

The Material utilized for the climbing assist robotic arm vehicle is brass reinforced resin and Bakelite for constant effectors arms of the robot as well as for mounting the base plate between robotic arm and climbing assisting vehicle, where as the frame structure made for holding the robotic arm is made of aluminium material.

III. REFERENCES

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