Easel gear Design

Team 27 Hozhoni Art B

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ME476C-003

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Contents

ABSTRACT

This engineering activity is done to provide the Assistive Device for the Art studio with an auto-adjustable Artist Easel, which will help in artistic therapy of disable peoples. This device will help them in doing art in a comfortable position without out any requirement of force for the adjustment of height adjustment of the canvas of whatever is being done on the Easel. The easel is equipped with a rack and pinion mechanism to rise and lover the canvas.

PROJECT SCOPE

During the initial phase several meetings were arranged with the staff and clients of Hoszhoni Foundation. A brief note was taken on the problems being faced by the disable people at the studio, and their needs. The collected data was shared with the Dr. Trevas for further guideline. It was found that adjustment of the easel requires force and multi hand gripping, while this is not easy and sometimes impossible for the disable peoples and disable people suffer from working in uncomfortable postures. To solve this problem, we planned to automate the Easel using a geared motor.

This modification would prove helpful for the disable people and and will help them to adopt this mental and physical therapy in exchange of easy pleasure.

PROBLEM IDENTIFICATION

As it has been cleared above, the easel requires an electronic actuation system which should raise the canvas supporting structure up and down. The actuator could be linear or a geared motor. The linear actuators are expensive in comparison with the geared motor, but the geared motor assembly is relatively complex than linear actuator.

In our project, we have chosen the geared motor, with a pinion at its one end which will rotate against a rack fixed with the canvas support.

MODIFIED AUTO-ADJUSTABLE ARTIST EASEL

For this activity, a general design for Easel is picked from internet and carefully examined for physical changes that could be required for the addition of motor and gear. A sliding bearing was also to be used for frictionless sliding of the Canvas support.

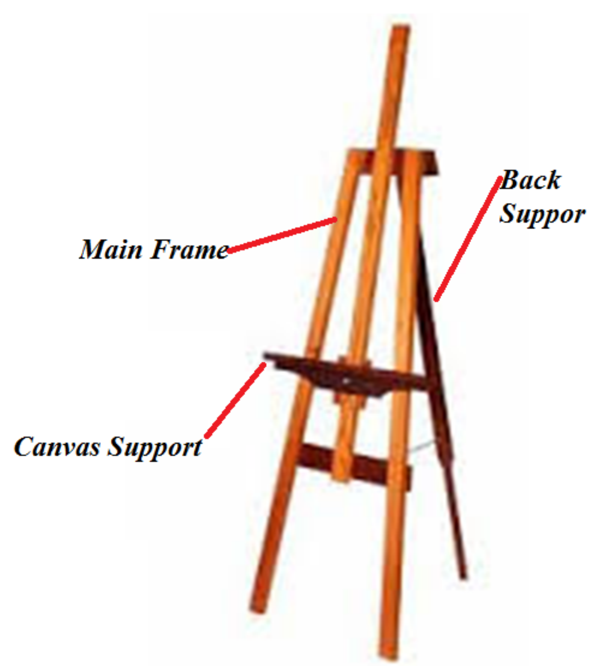

Figure 1: General Easel Design

DESIGN JUSTIFICATION

For auto lifting, a rack is attached to the Canvas support, while a geared motor is fixed on the main structure. The geared motor has a pinion at its shaft and this pinion rotates on the rack and rack then pushes the cannas support up or down.

The figure below shows the rack and pinion along with the geared motor. Another structural entity mentioned in the figures is the Tilt Lock; this lock is to fix the rotatable rear support at a particular angle to tilt the easel at suitable angle.

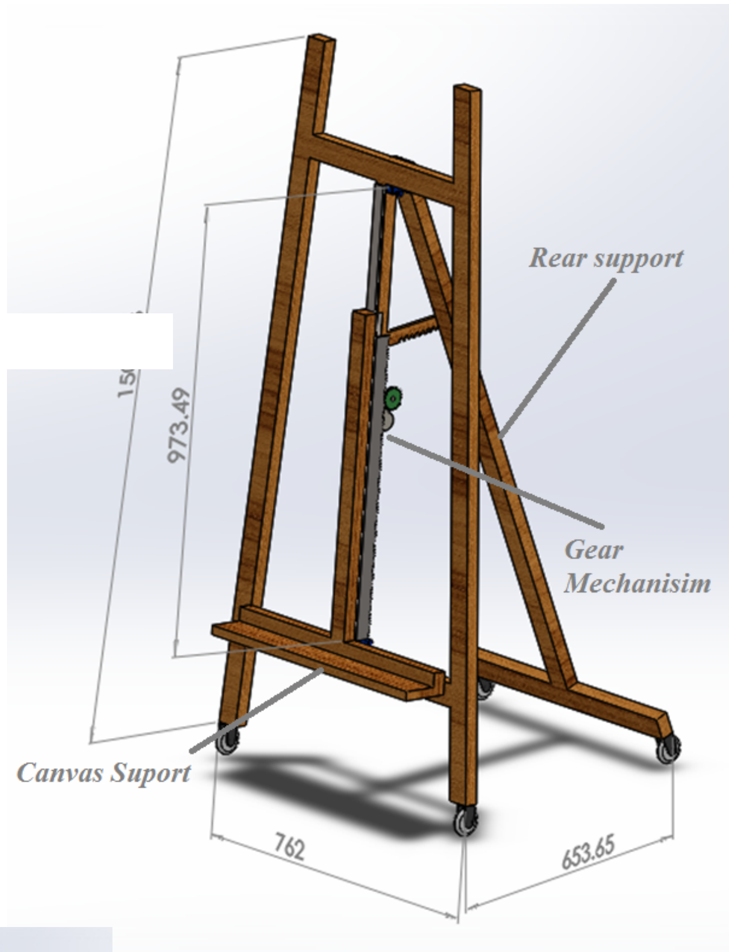

Figure 3: Ergonomics

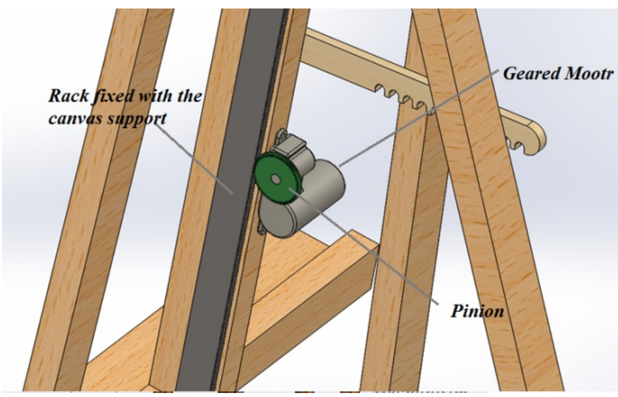

Figure 2:rack and pinion assembly

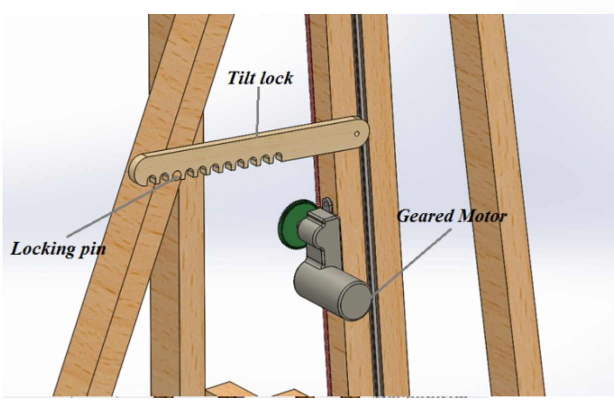

Figure 4: lock for rear support

As there is a range of sliding motion beyond which, canvas board is not free to move. When this limit is reached during upward or downward motion. Motor should automatically turn off. Otherwise physical damage can happen. To achieve this objective, two limits switches are fixed with the main structure/frame, which will break the power supply, whenever activated.

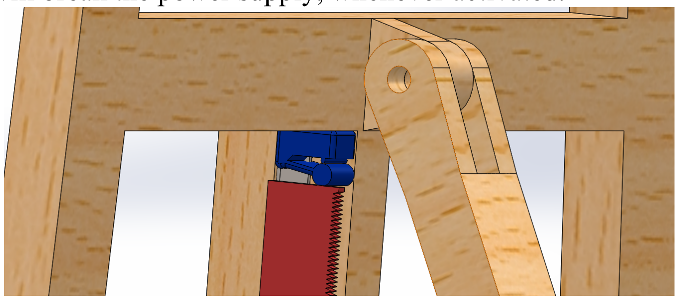

Figure 5: limit switches in blue color

Another thing to be decided was the suitable range of adjustable height. Ergonomic data collected in our visits of the art center and information from internet says adjustments around 300 mm are quite reasonable.

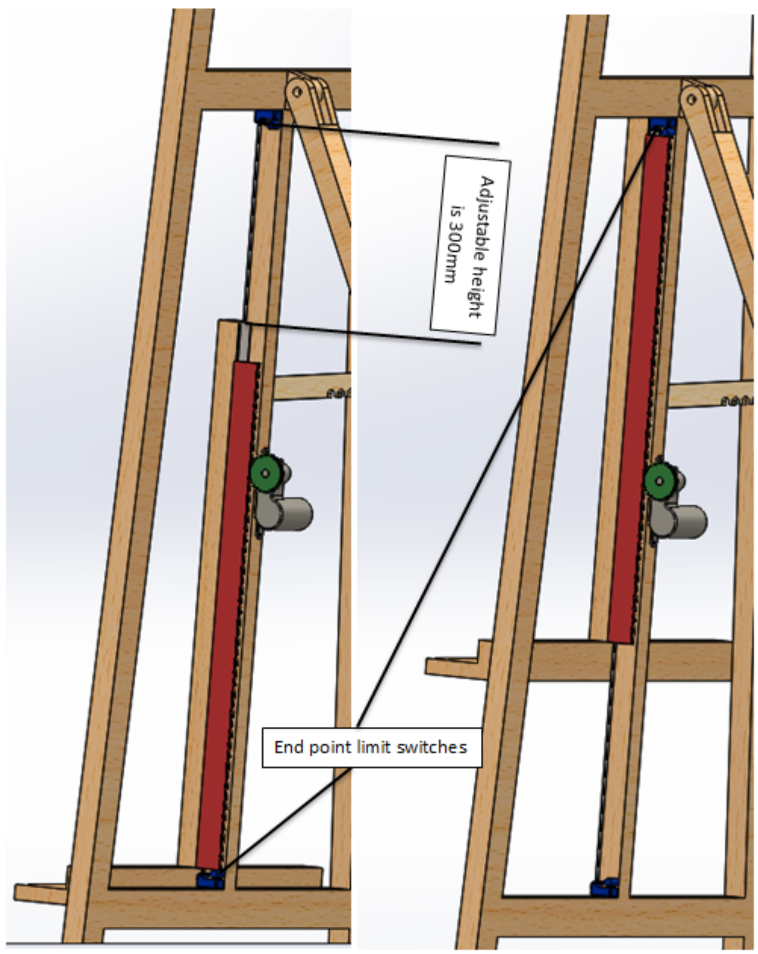

Figure 6: Showa the adjustment range and position of limit switches

GEAR MECHANISM:

As briefly described in previous sections, the up and down motion of the canvas will be due to the rack and pinion mechanism. The pinion will be mounted on a geared motor. The geared motor will rotate the pinion at very slow speed and the pinion will push the rack up and down. The power and other mechanical calculations for the gears are done in a separate section.

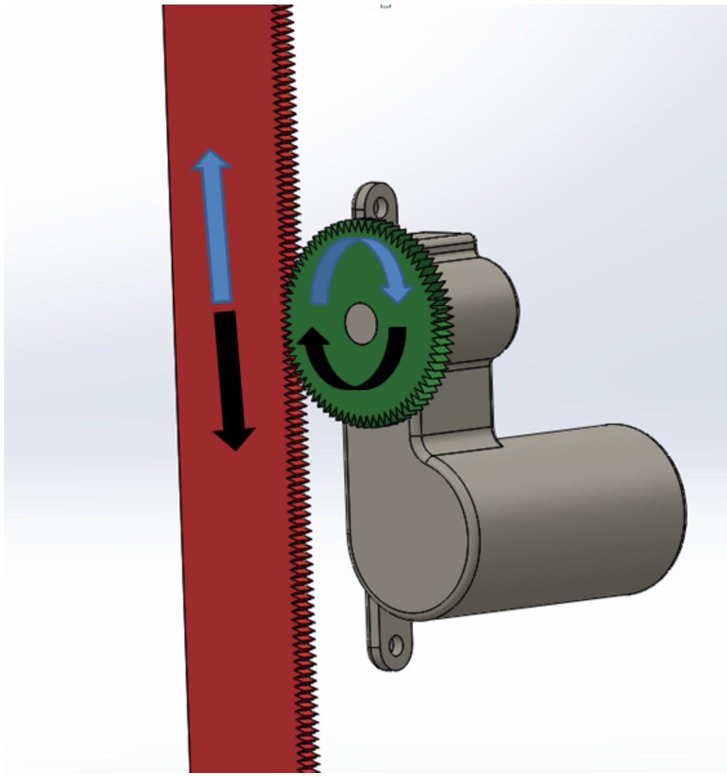

Figure 7: motion of rack and pinion

Another important consideration for gear selection is that gear should be unidirectional input gear, i.e. it should rotate only if it is driven by the motor side. A bidirectional input gear will be unable to hold the canvas as it will rotate under the weight of canvas after the motor is turned off.

A worm gear will be a perfect choice for this application.

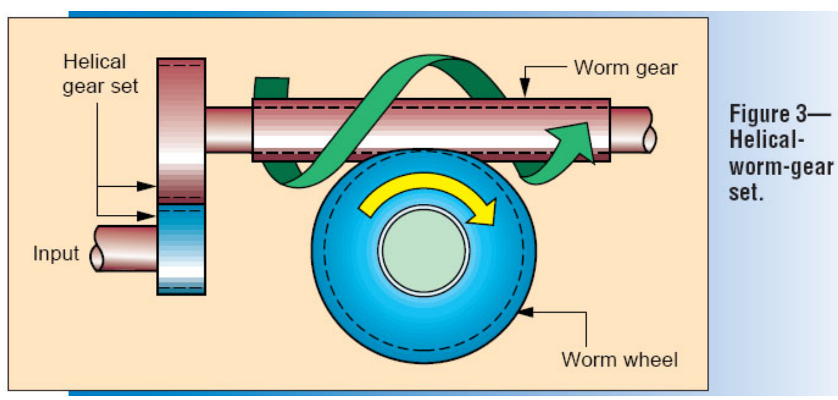

Figure 8: working of a worm gear

GEAR DESIGN:

For the gear design and the motor selection we have to consider following things

- Weight of the structure
- The minimum speed of the up-down motion

In our design the maximum weight of the structure (canvas support frame + canvas board + slider bearing) will not be more than 30 newton. Now the selection of pinion is based on the RPM of available geared motors. Lover the rpm, greater could be the diameter of pinion.
Let us consider, the normal time for up-down motion should be 6 seconds. And distance to be traveled is 300mm which will be the circumferential distance travelled by the pinion during rotation.

$$D_{pinion} = \frac{distance\ to\ be\ travelled \times 60sec}{\pi \times RPM \times time\ to\ travel\ distance} = \frac{300mm \times 60sec}{\pi \times 25RPM \times 6\ sec} = 38mm$$

From here we can easily calculate the torque on the output shaft of the gear.

$$\tau = F \times r = 30N \times .038m = 1.14Nm$$

Same way we can calculate the motor power
As the desired RPM are 25 and torque is 1.14Nm,

$$P = \frac{2 \times \pi \times N \times \tau}{60} = \frac{2 \times \pi \times 25 \times 1.14}{60} = 2.9W$$

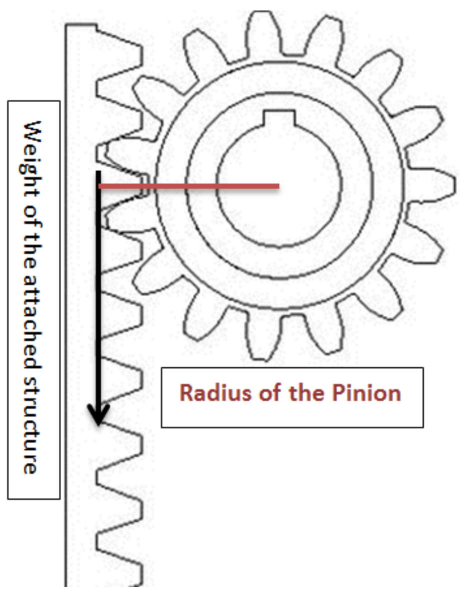

Figure 9: torque at the shaft of pinion

Figure 10: worm gear motor

SELECTED GEAR MOTOR

The motor we found suitable is a 6V-24RPM DC geared motor which could be used for this application.

Source: http://www.ebay.com/itm/24RPM-Low-Speed-1-875G-DC-12V-Motor-High-Torque-Turbo-Worm-370-Geared-Motor-/161862724391

OTHER DESIGN FEATURES:

Wheels at the bottom are added for easy mobility of the easel

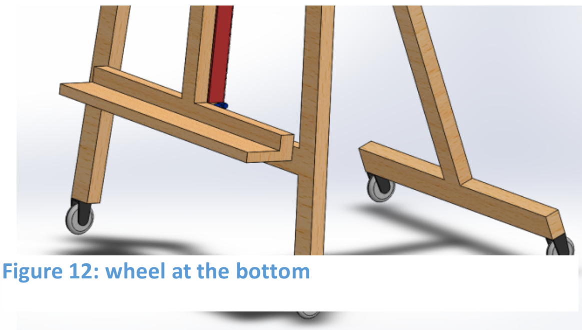

Figure 12: wheel at the bottom

An interface locking leaver is added to lock the hinged rear support at any tilt angle.

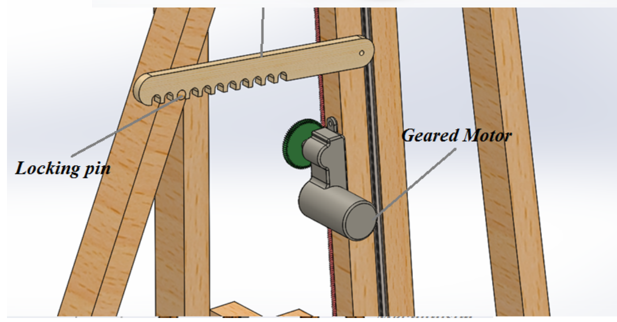

Figure 11: rear support locking mechanism

INFLUENCES AND FUTURE HORIZON:

The automation of easel could prove a great support for the mental therapy of disable peoples through arts and pleasure. It would attract more handicapped peoples to find pleasure in arts. This automation could prove the pioneer in the automation of art industry and other products. Though the design is simple but it could be further improved by sung advanced control electronics like introduction of a Bluetooth remote controller and microcontroller to make it indigenous self-adjustment.

References:

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http://www.brighthubengineering.com/machine-design/60527-basic-worm-gear-design-calculations-using-agma-empirical-formula/
[3] Ergonomics for Artists: Prevent Neck Strain and Correct Forward Head Posture [Access-Online]
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Appendix:

CAD Model & Drawing:

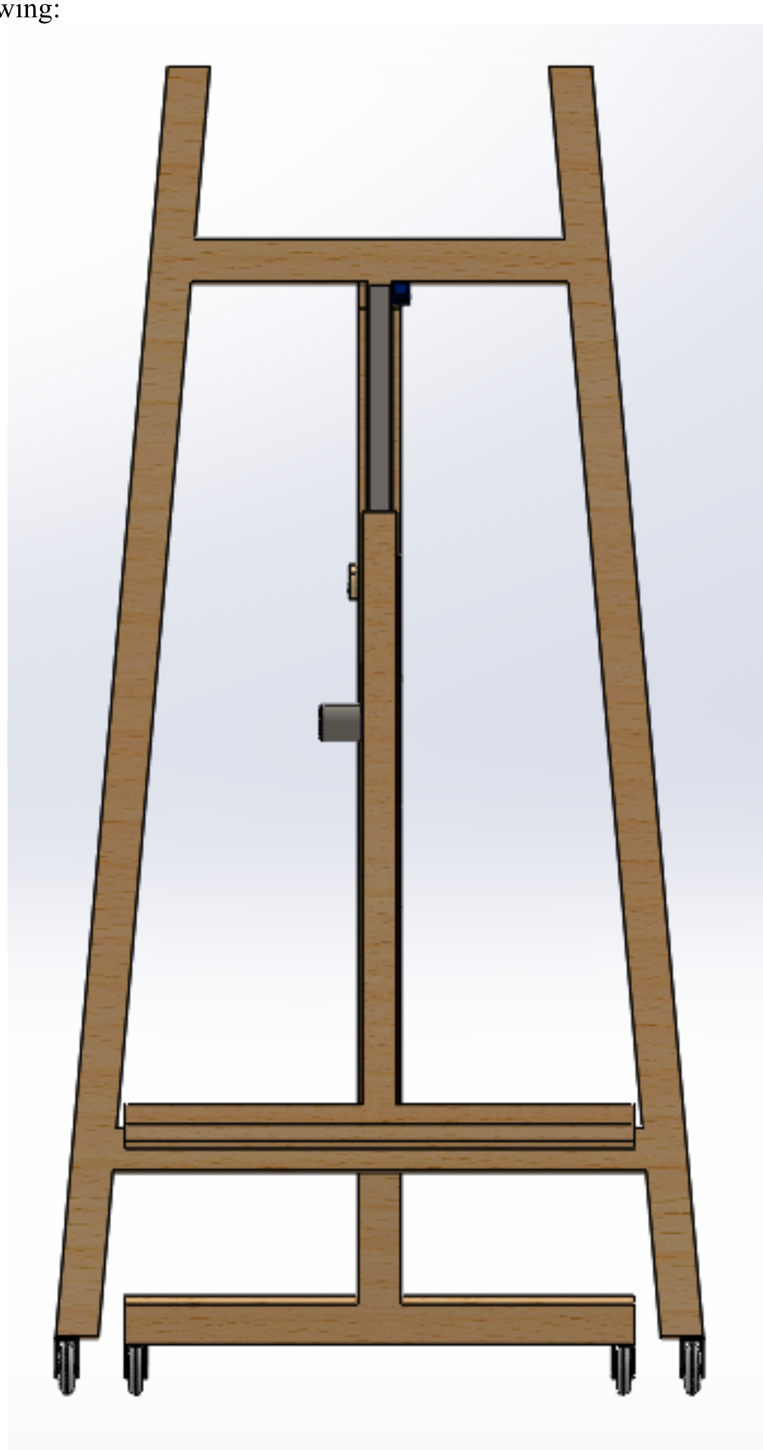

Figure 13: Front view

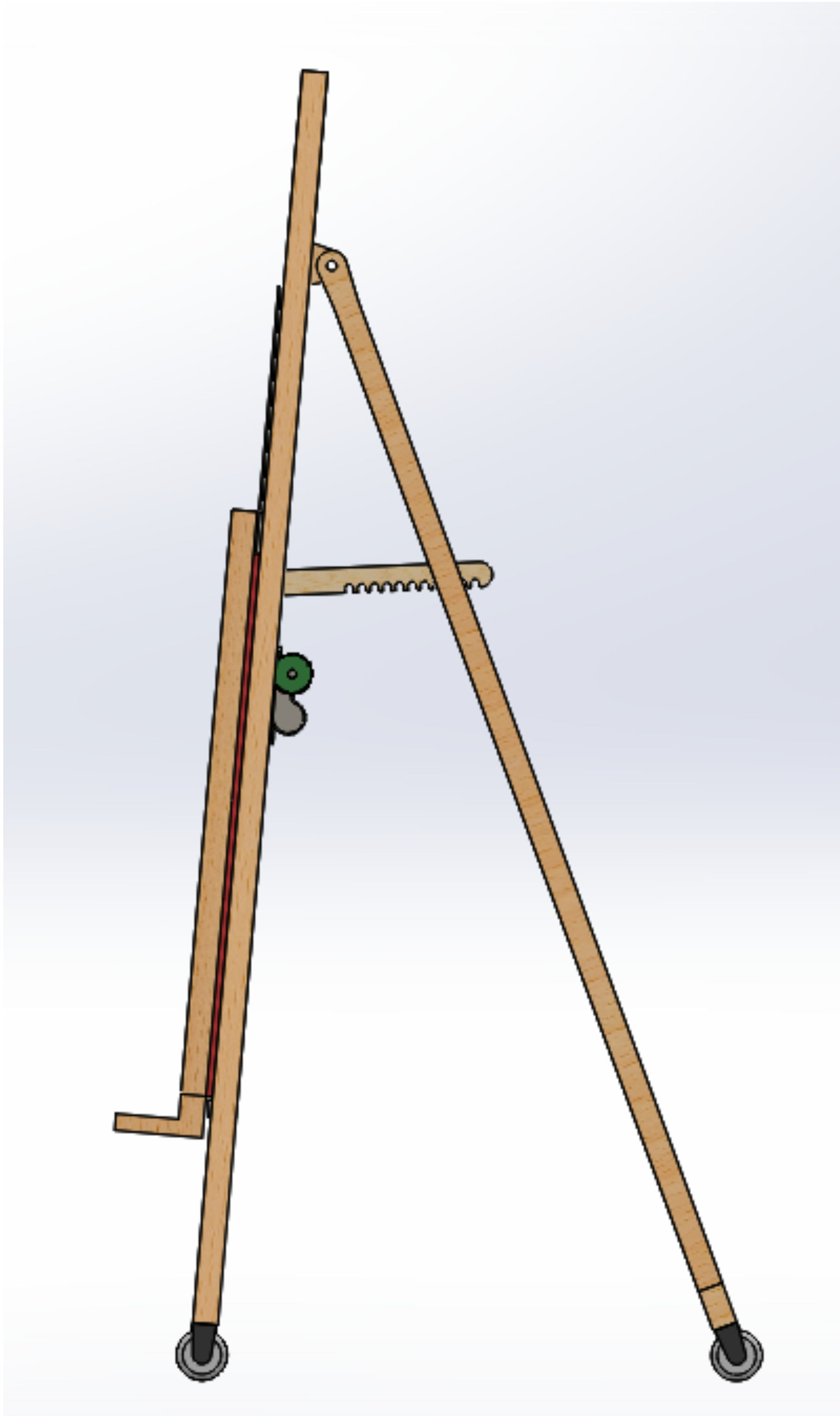

Figure 14: Side View

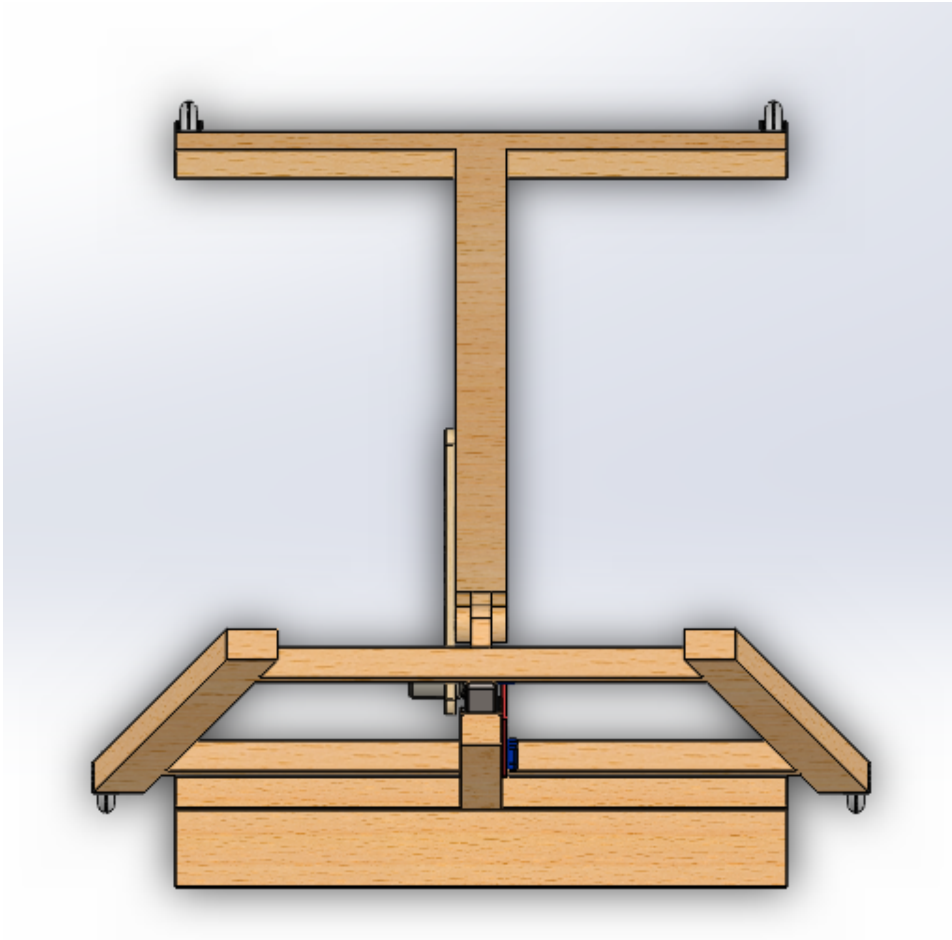

Figure 15; Top view

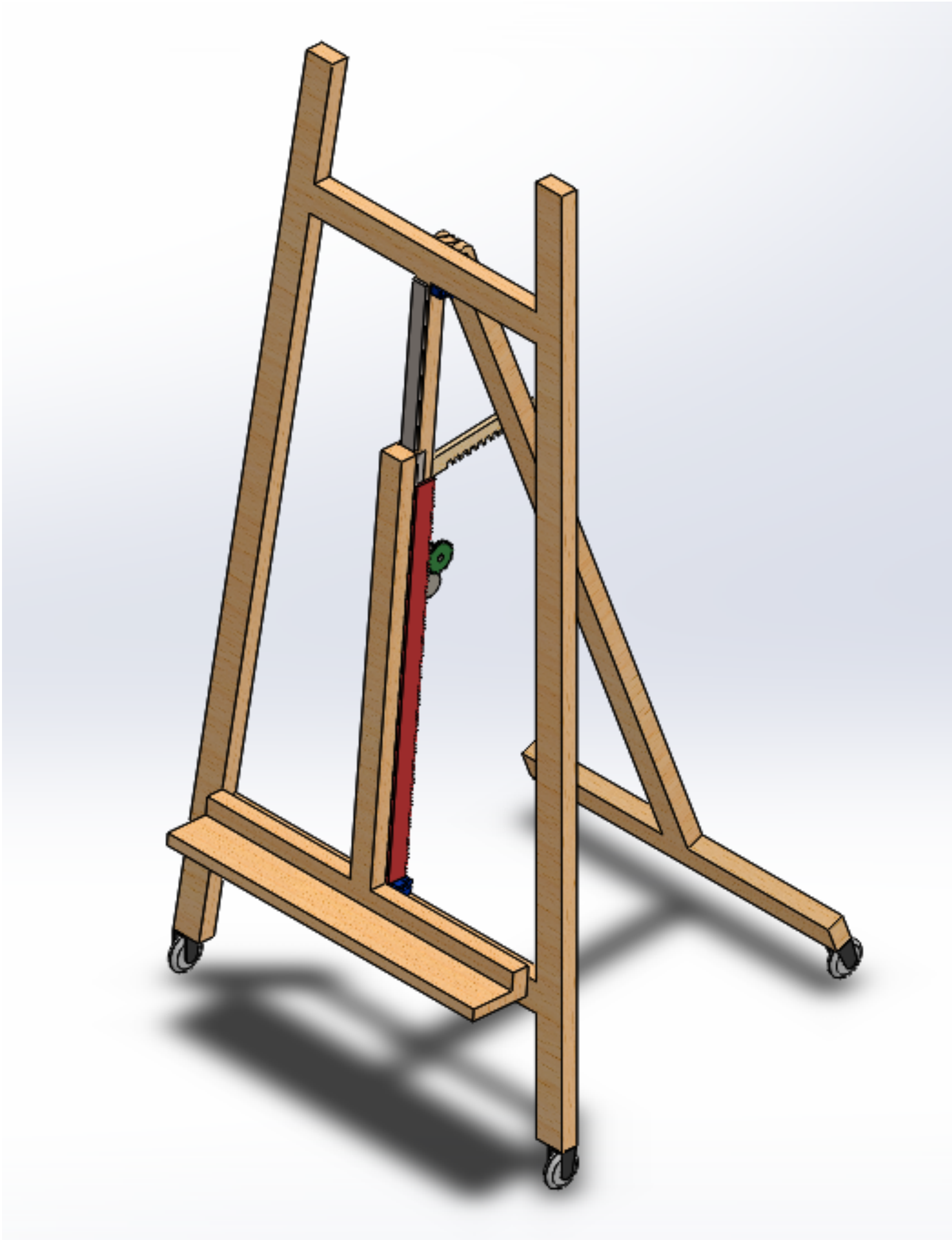

Figure 16: Isometric view