



# Slinging in Terrain

Self-Leveling Spreader Beam  
for Adjusting the Orientation of an Overhead Crane Load

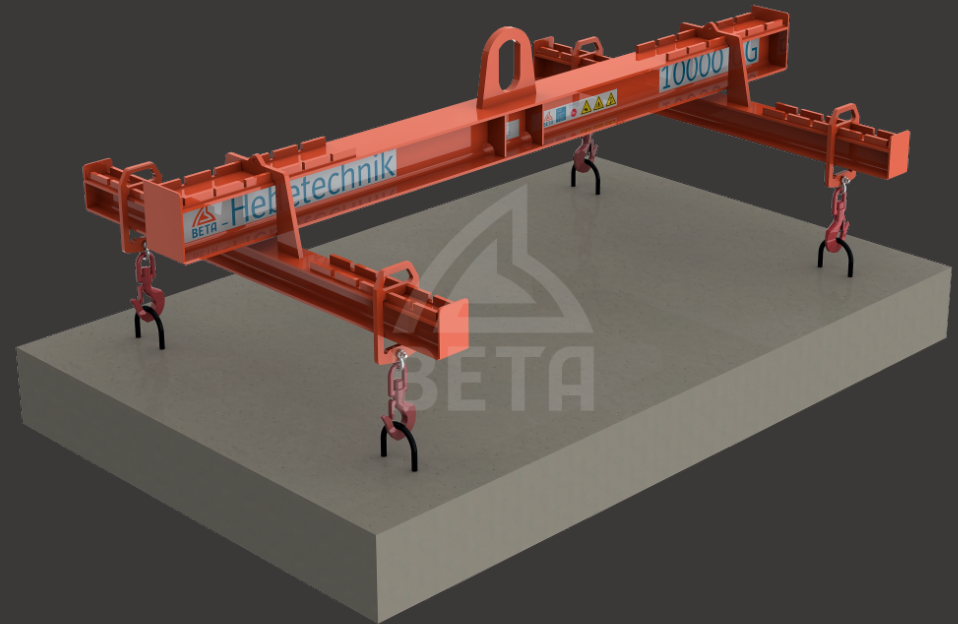
Sean Connor | Mikko Heliö | Aleksi Kuuva | Paavo Palomäki





What already exists?

- H-frame



What already exists?

- H-frame
- Die Turner



What already exists?

- H-frame
- Die Turner
- Spreader Beam with fixed slings



Can something better be made?

- Reorient crane load in-air

Can something better be made?

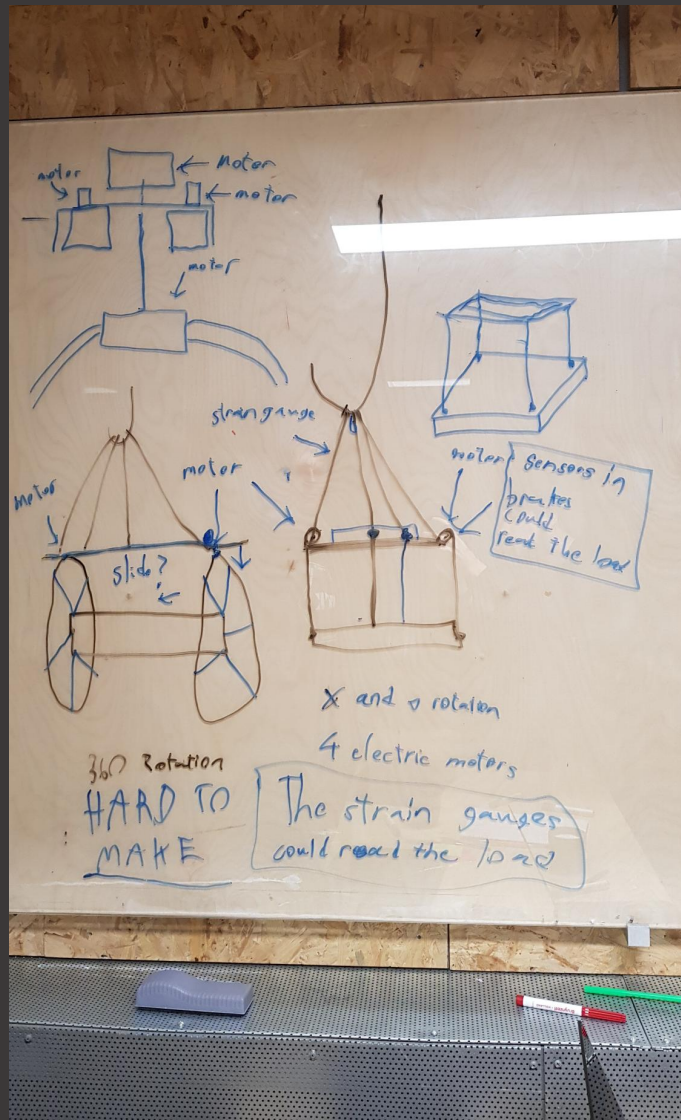
- Reorient crane load in-air
- Remote Operation

Can something better be made?

- Reorient crane load in-air
- Remote Operation
- Automatically balancing

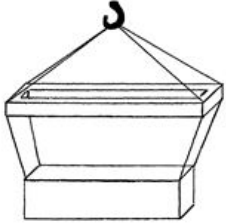
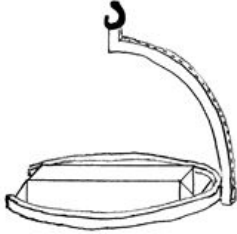
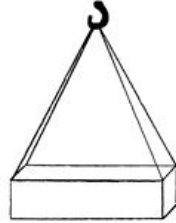
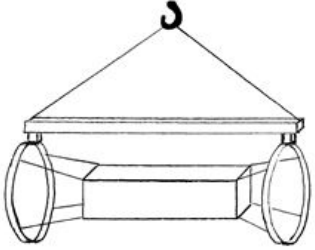
Can something better be made?

- Reorient crane load in-air
- Remote Operation
- Automatically balancing
- Easy to use

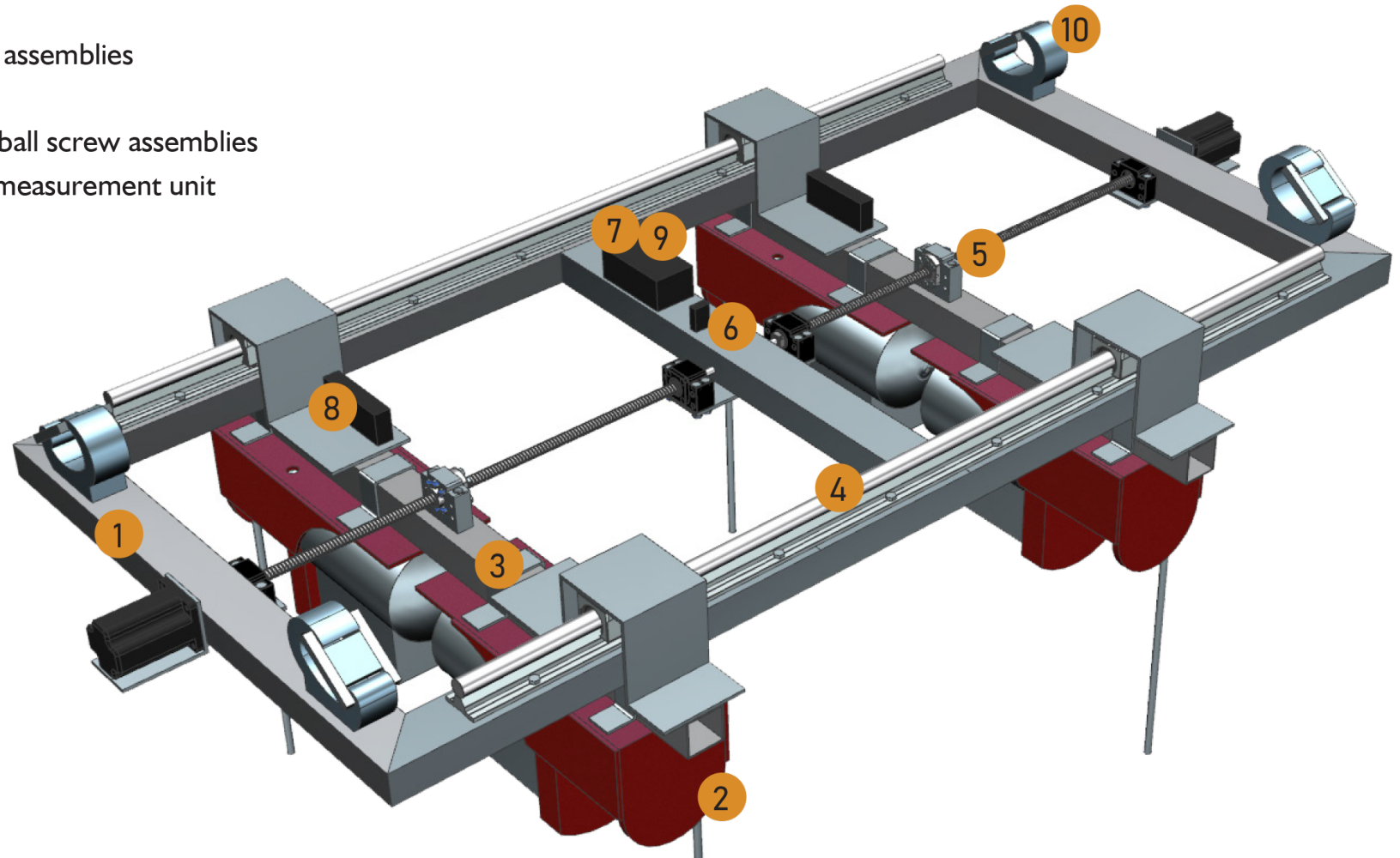
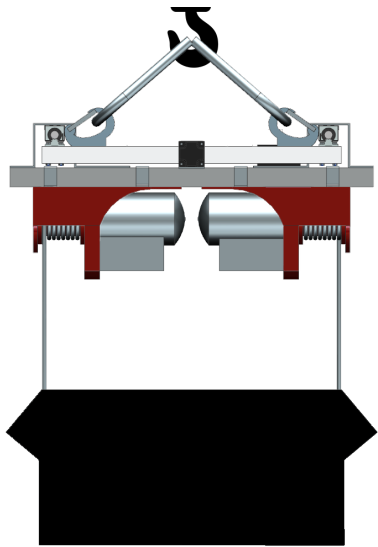


Subsystems

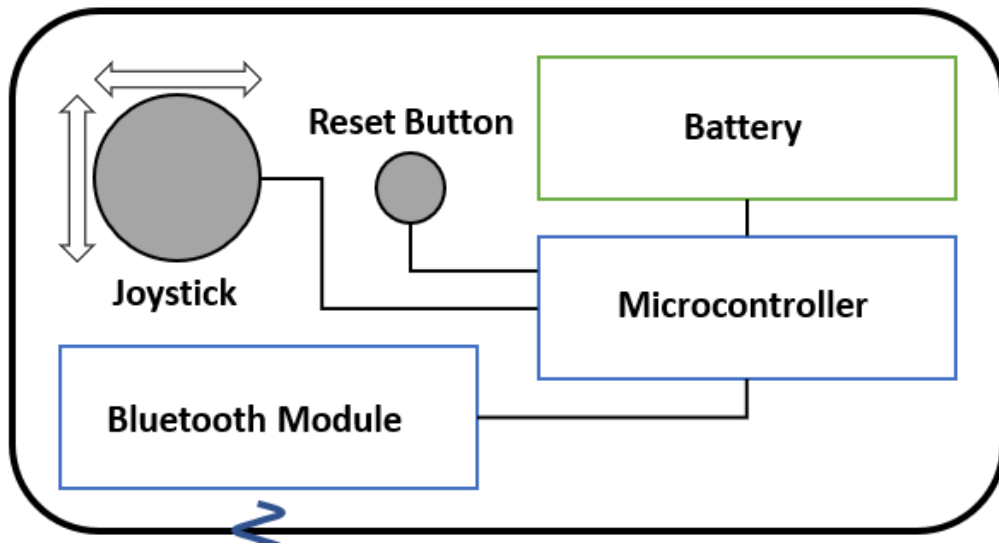
Solutions

|                                   |                                                                                   |                                                                                    |                                                                                     |                                                                                     |                                                                                     |
|-----------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <b>Support frame</b>              |  |  |  |  |  |
|                                   | <u>rectangular</u>                                                                | <u>gimbal</u>                                                                      | none                                                                                | arc-shaped                                                                          | tubular                                                                             |
| <b>Sling shortening method</b>    | Screw                                                                             | <u>rope drum</u>                                                                   | twisting                                                                            | pulley                                                                              | gear                                                                                |
| <b>Number of lifting slings</b>   | 3 pcs                                                                             | <u>4 pcs</u>                                                                       | 8 pcs                                                                               |                                                                                     |                                                                                     |
| <b>Degrees-of-freedom</b>         | 1                                                                                 | <u>2</u>                                                                           | 3                                                                                   |                                                                                     |                                                                                     |
| <b>Hoist method</b>               | straps                                                                            | chains                                                                             | strings                                                                             | <u>cables</u>                                                                       |                                                                                     |
| <b>Orientation sensing method</b> | sensor on load                                                                    | <u>sensor in frame</u>                                                             | inclinometers on the slings                                                         | camera on frame                                                                     |                                                                                     |
| <b>Powering method</b>            | battery on frame                                                                  | cable to crane superstructure                                                      | <u>cable straight from wall</u>                                                     |                                                                                     |                                                                                     |

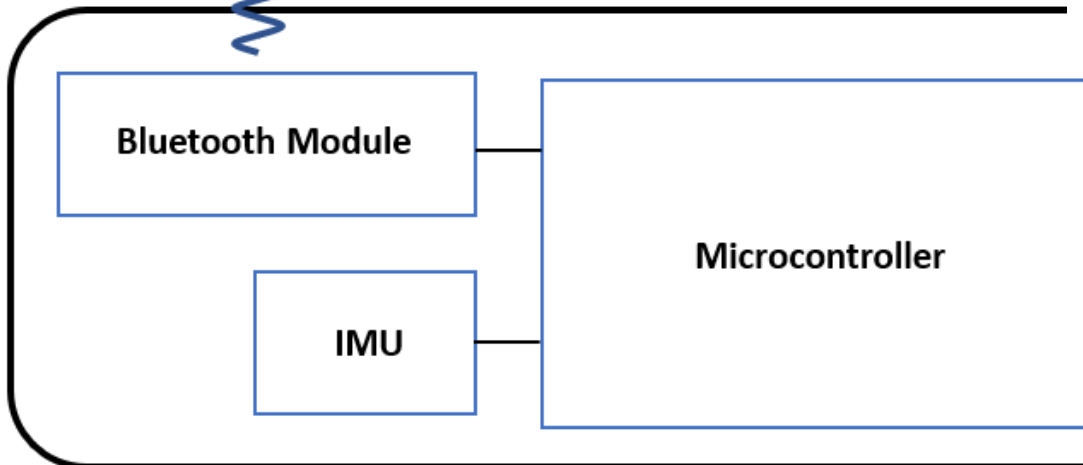
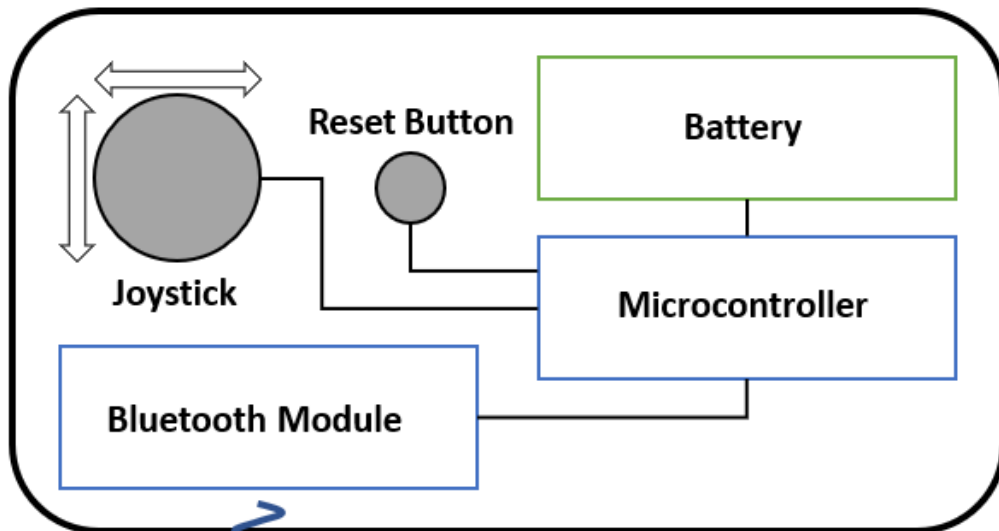
- 1 frame
- 2 4 winches
- 3 2 linearly moving trolley assemblies
- 4 2 linear rails
- 5 2 stepper motor driven ball screw assemblies
- 6 frame mounted inertial measurement unit
- 7 microcontroller
- 8 2 relay modules
- 9 Bluetooth module
- 10 4 hook rigging points



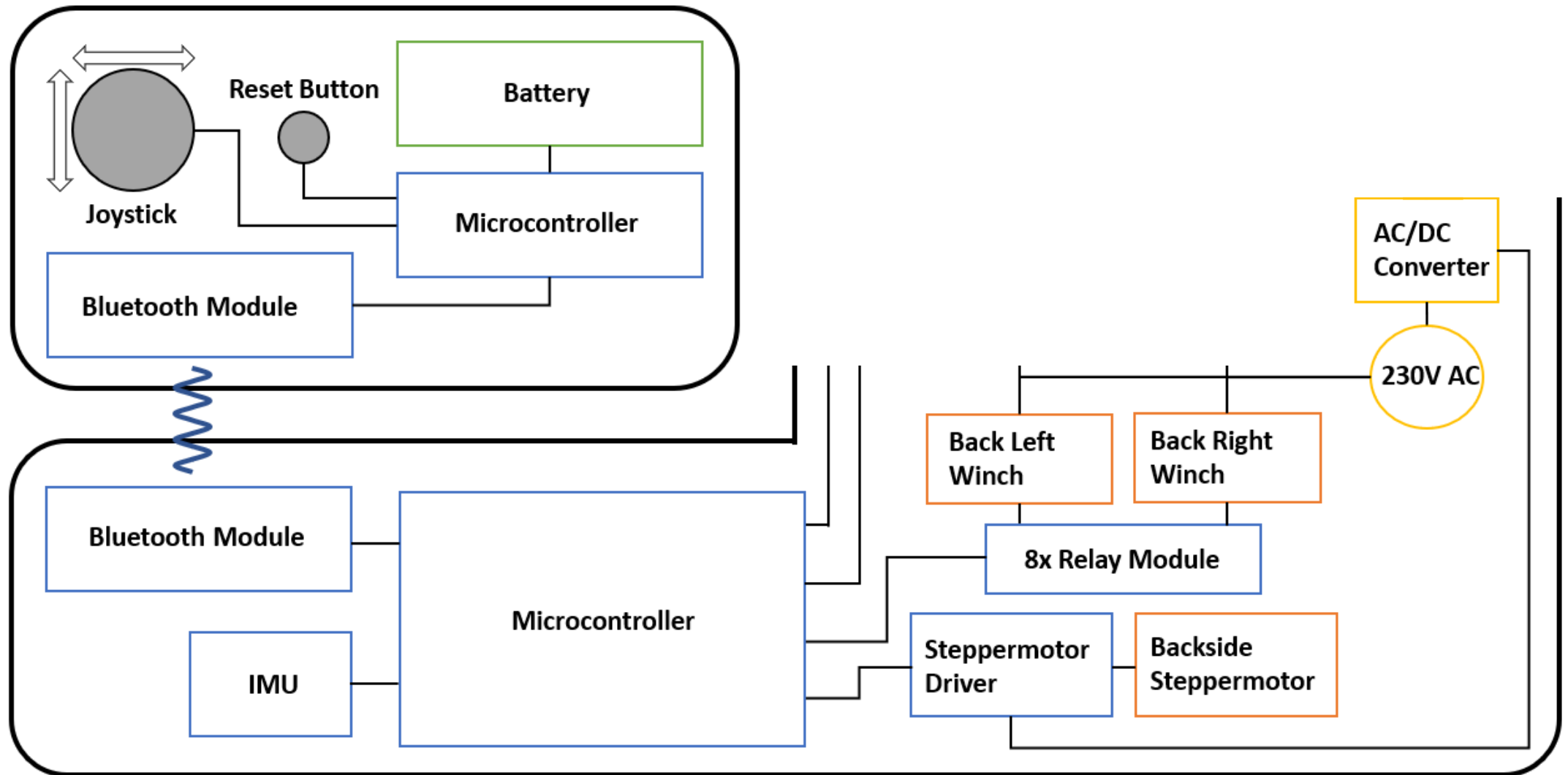
## Controller



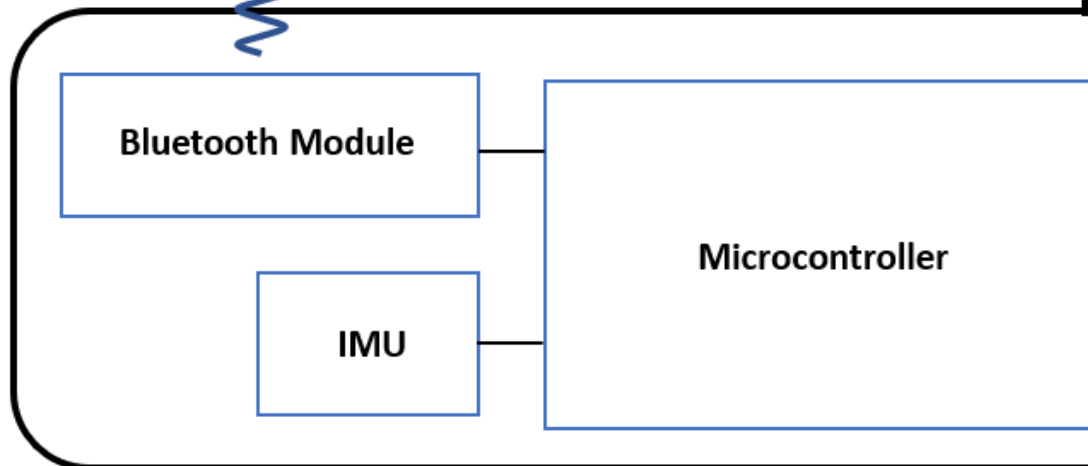
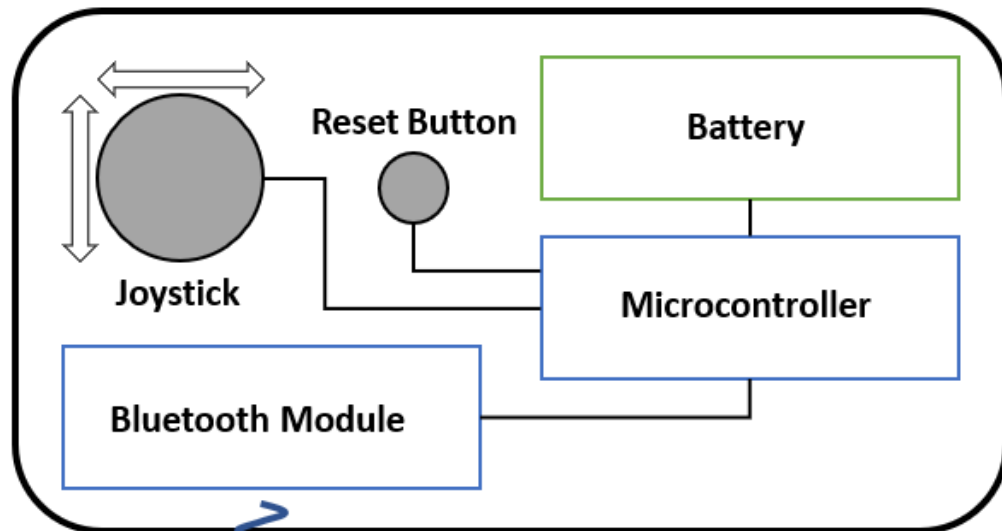
## Controller



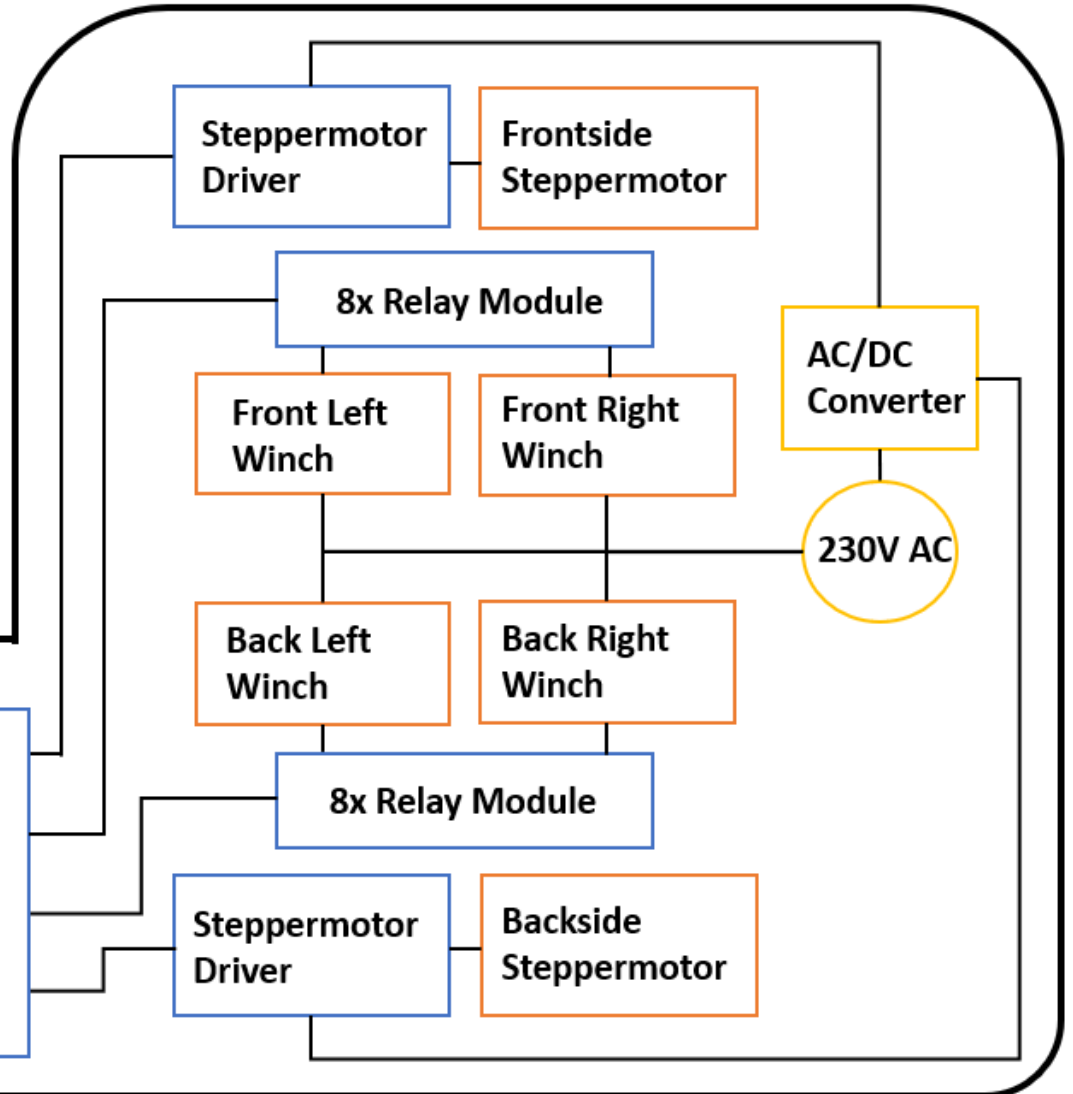
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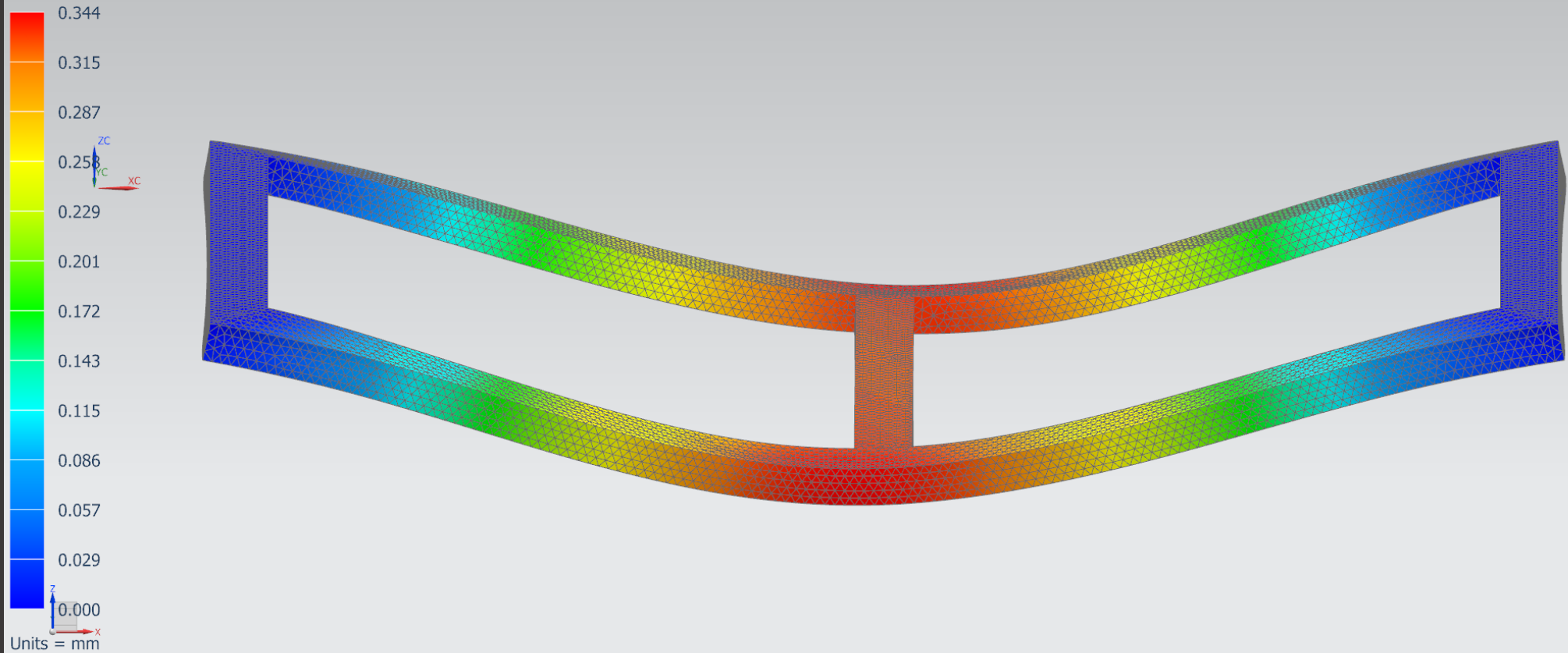
## Controller

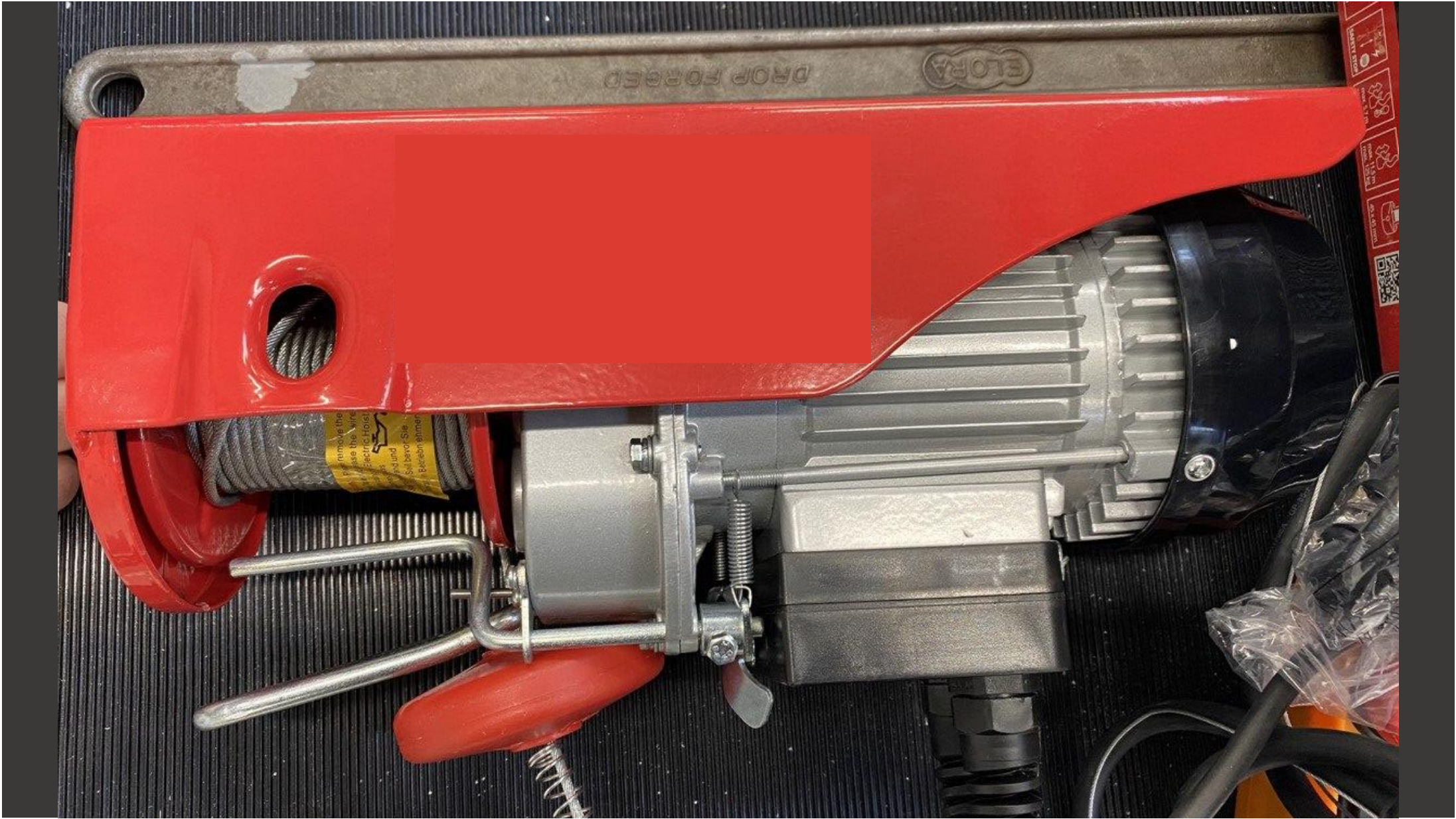


## Spreader Beam

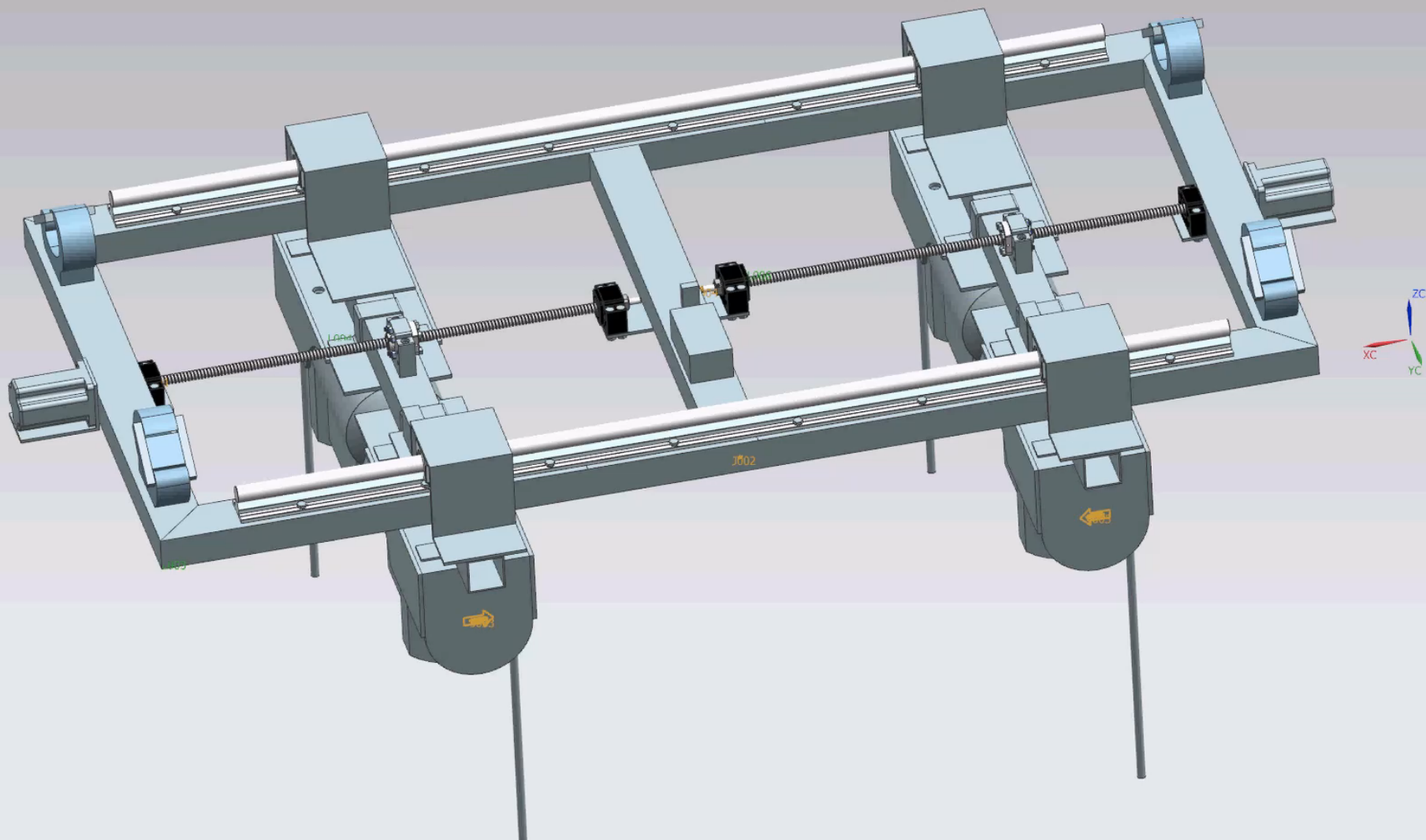


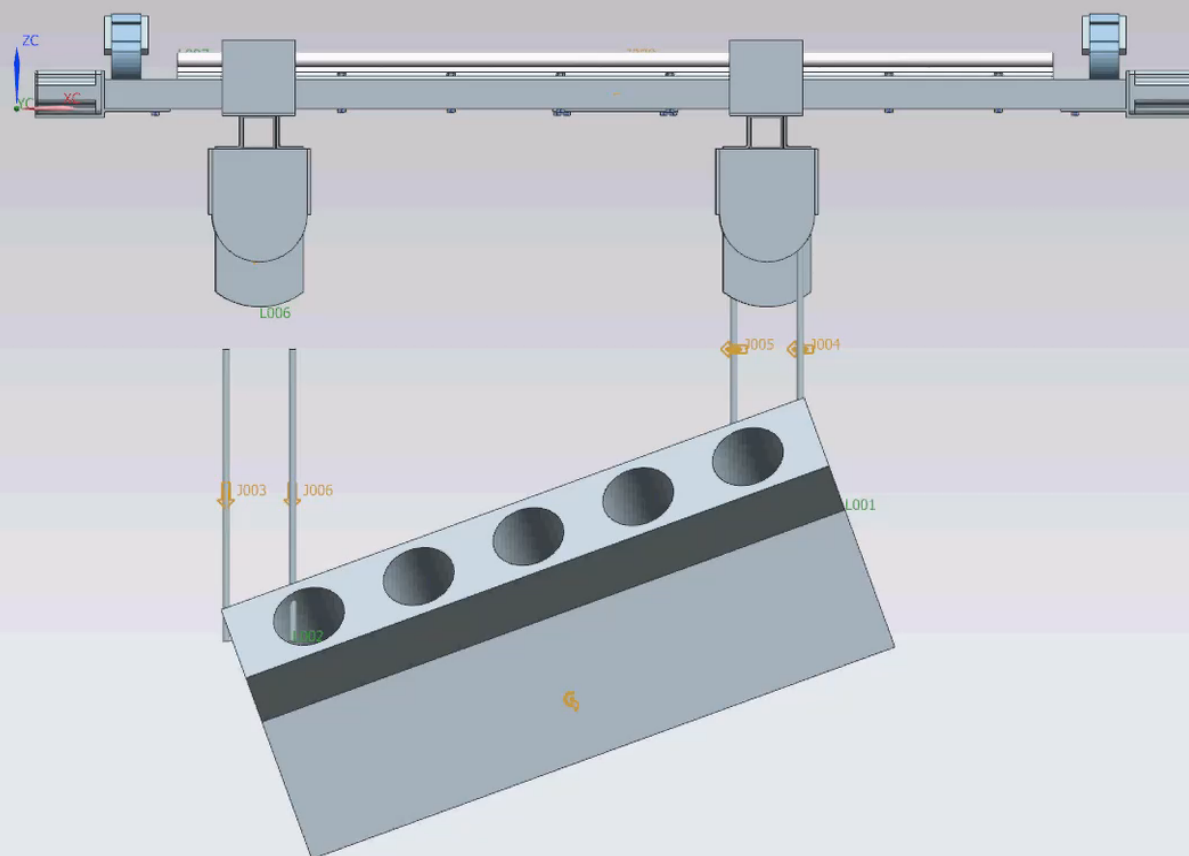
system2\_sim2 : Solution 1 Result  
Subcase - Static Loads 1, Static Step 1  
Displacement - Nodal, Magnitude  
Min : 0.000, Max : 0.344, Units = mm  
Deformation : Displacement - Nodal Magnitude



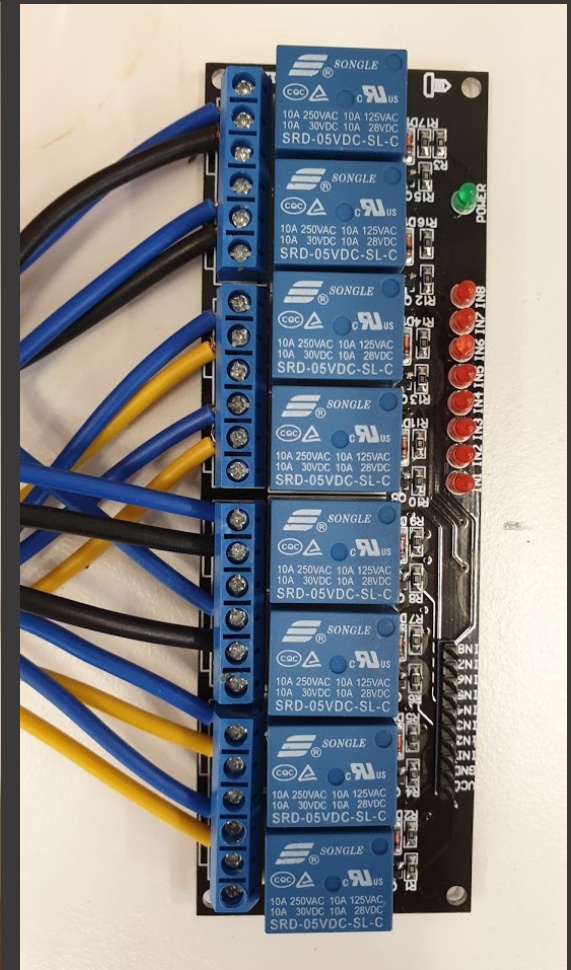
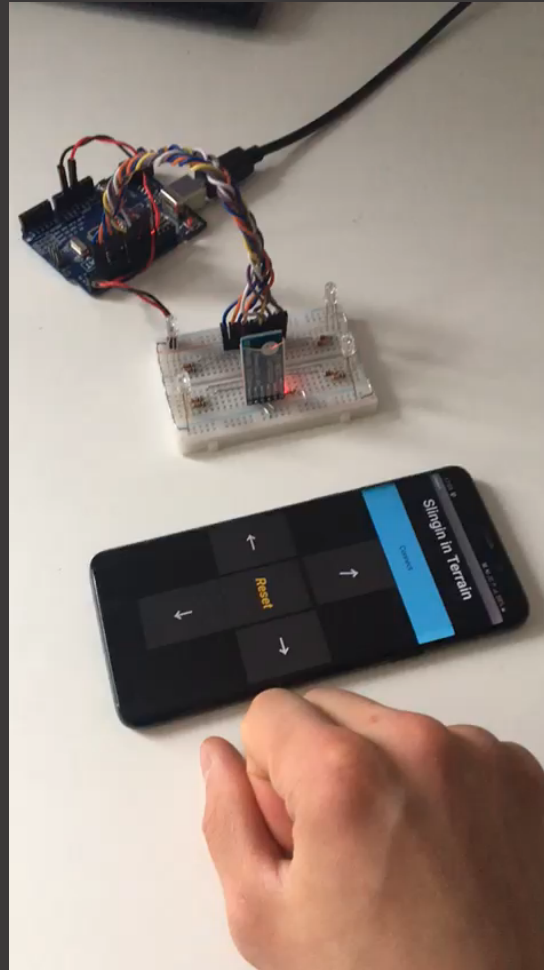


Time 0.000000  
Step 0

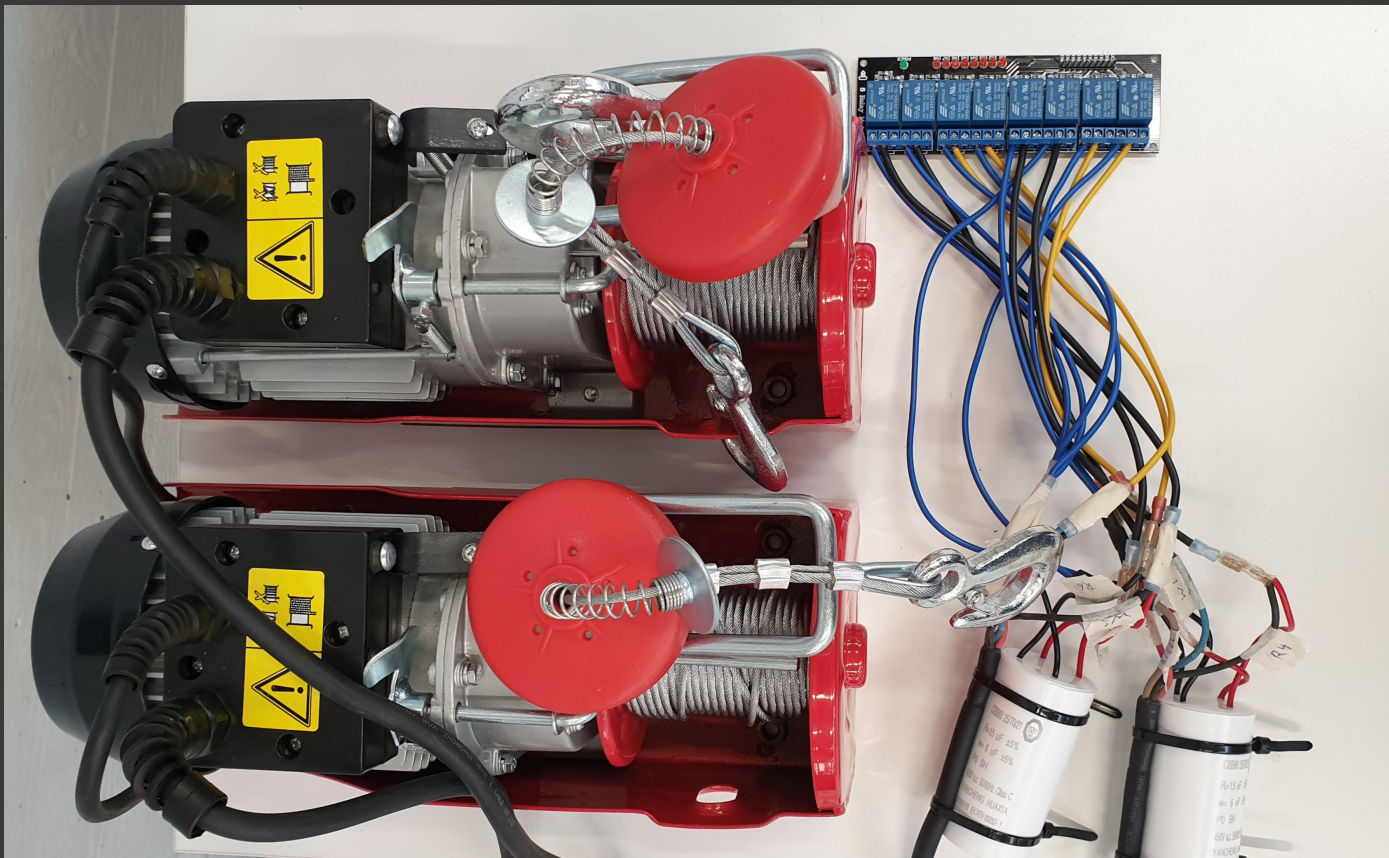




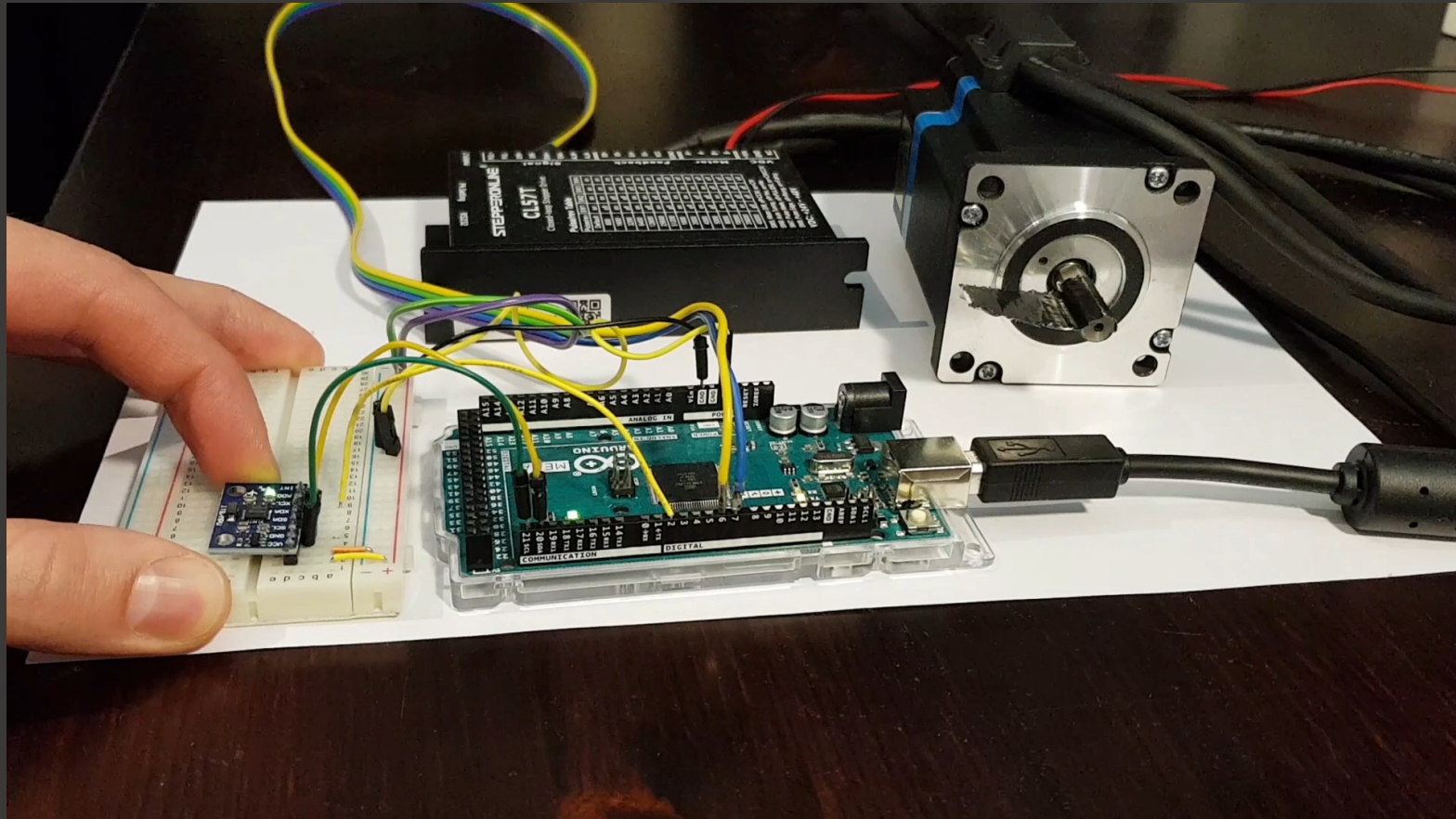
# Bluetooth Controller Proof of concept



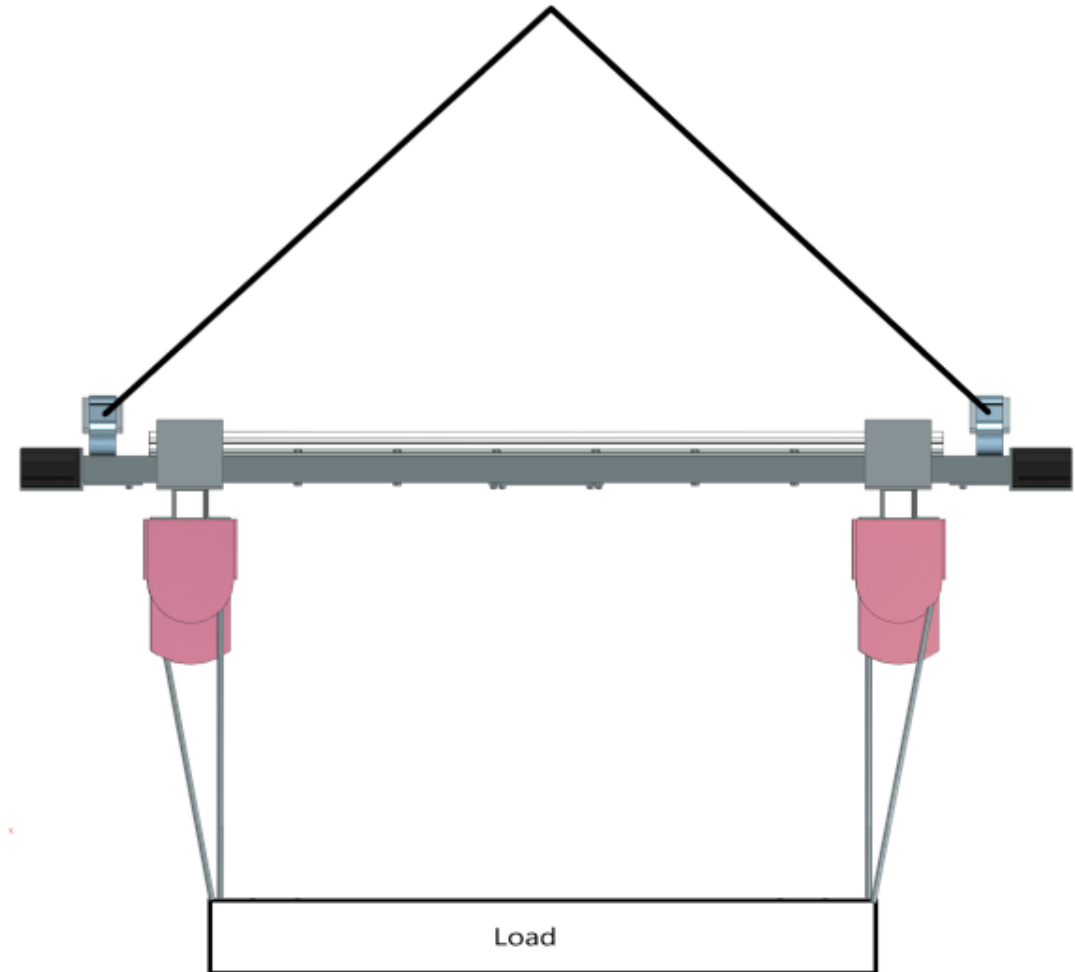
# Relay modules



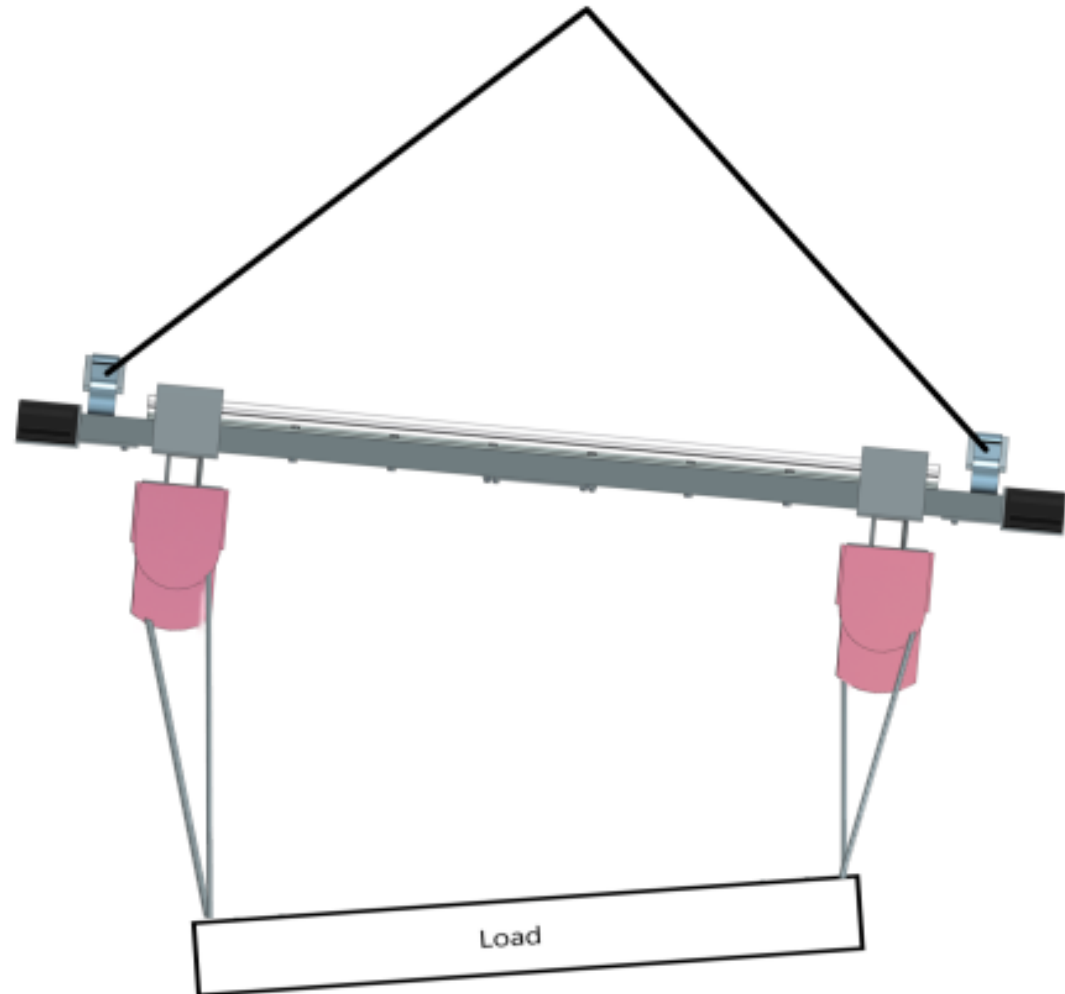
# Stepper control



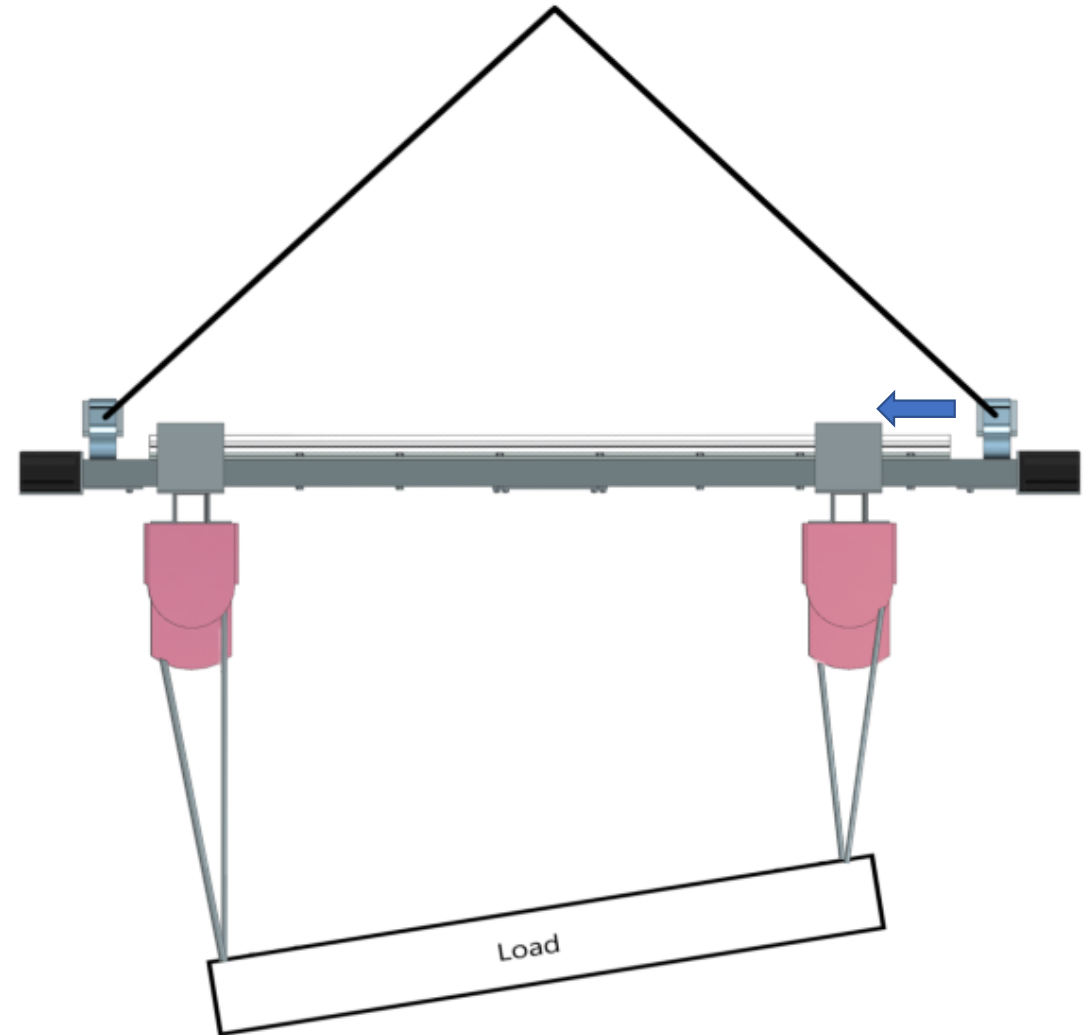
# Load under frame



Load rotated



Frame balanced



# Discussion

- Microcontroller capability

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- Potentiality to execute the task

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- Potentiality to execute the task
- Diversify the range of crane use

# Future steps

- Perpendicular linear movement
- Closed-loop control
- Logic to take main crane into account
- Power with batteries
- Implement sensor data filtering
- Optimize component selection

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Questions?