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# VESSEL INSPECTION AND REPAIR ROBOT

MECHANICAL ENGINEERING

## OBJECTIVE

TO DESIGN A MODULAR ROBOTIC SYSTEM CAPABLE OF CARRYING OUT INSPECTION AND REPAIRS INSIDE INDUSTRY VESSELS.

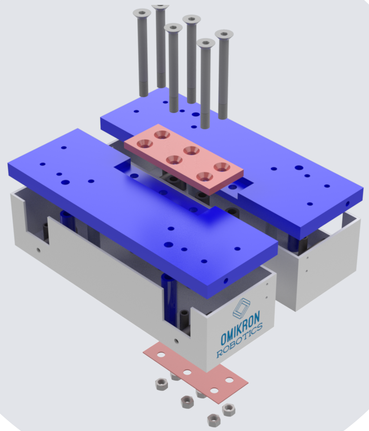

## BACKGROUND

VESSEL INSPECTIONS AND REPAIRS IN THE PROCESS INDUSTRY ARE DIFFICULT, TIME-CONSUMING, AND POSE SIGNIFICANT SAFETY RISKS TO PERSONNEL ENTERING CONFINED SPACES. TO REDUCE THE NEED FOR HUMAN PRESENCE IN THESE HAZARDOUS ENVIRONMENTS, SEVERAL INDUSTRIES ARE CONSIDERING REMOTE ROBOTIC SYSTEMS AS A SOLUTION.

## DESIGN REQUIREMENTS

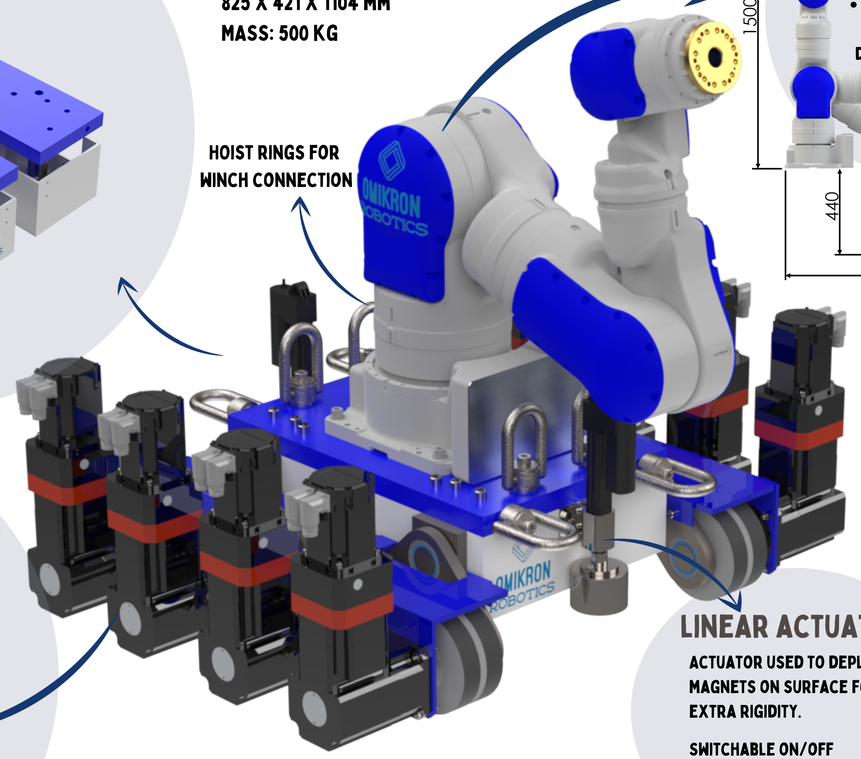
- TRAVERSE BOTH VERTICAL AND HORIZONTAL SURFACES WHILE MAINTAINING STABILITY
- OVERCOME 3IN X 3IN VESSEL RIBS THAT SPAN THE CIRCUMFERENCE OF THE VESSEL
- SUPPORT A MANIPULATOR ARM WITH AN END EFFECTOR PAYLOAD OF 20 KG
- MODULES MUST FIT THROUGH A 45 CM VESSEL OPENING
- ROBOT SYSTEM MUST BECOME RIGID DURING INSPECTION/REPAIR TASKS

## MODULARITY




ASSEMBLY DIMENSIONS (NO MANIPULATOR):
825 X 421 X 1104 MM
MASS: 500 KG

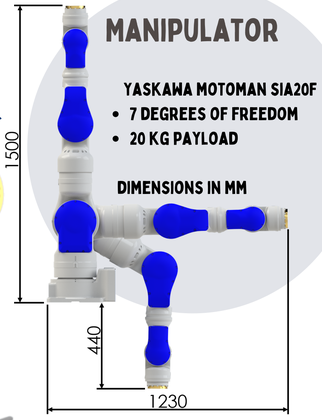
HOIST RINGS FOR WINCH CONNECTION



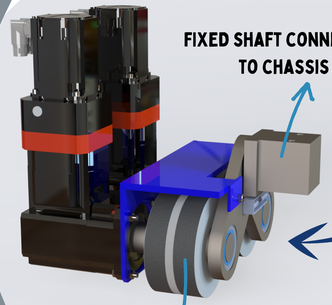

## MANIPULATOR

YASKAWA MOTOMAN SIA20F
- 7 DEGREES OF FREEDOM
- 20 KG PAYLOAD

DIMENSIONS IN MM

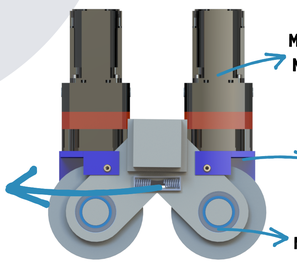



## DRIVE SYSTEM



FIXED SHAFT CONNECTED TO CHASSIS

POLYURETHANE LAYER TO INCREASE FRICTION



MOTOR AKM2G-41D WITH MAXIMUM CONTINUOUS TORQUE OF 2.85 NM

GEARHEAD DTR115-100 WITH 100:1 RATIO

MAGNETIC WHEELS

LINEAR SPRINGS FOR EQUILIBRIUM

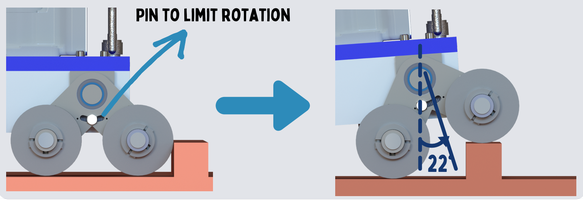
## LINEAR ACTUATOR

ACTUATOR USED TO DEPLOY MAGNETS ON SURFACE FOR EXTRA RIGIDITY.

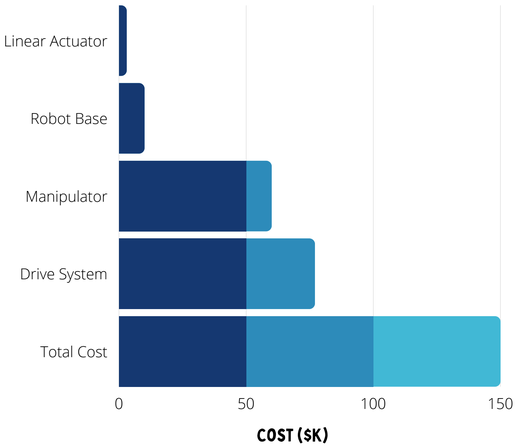
SWITCHABLE ON/OFF ELECTRONICALLY CONTROLLED PERMANENT MAGNETS.

## MOTION OVER OBSTACLES

PIN TO LIMIT ROTATION




## COST & MANUFACTURING




## STABILITY AND STRENGTH ANALYSIS

| Stability of overall system | *Driving vertically on a wall - Tipping* | *Driving horizontally on a wall - Tipping* | *Driving vertically over an obstacle on a wall - Slipping* | *Driving horizontally over an obstacle on a wall - Slipping* |
|---|---|---|---|---|
| *Minimum reaction force on wheels (N)* | 612 | 1116 | N/A | N/A |
| *Maximum Traction (N)* | N/A | N/A | 5597 | 5400 |
| *Traction Factor of Safety* | N/A | N/A | 1.14 | 1.10 |
| *Magnetic force provided by wheels normal to surface (N)* | 1800 | 1800 | N/A | N/A |
| *Comments* | No tipping | No Tipping | No sliding | No sliding |
| **Strength of critical components** | *Top plate platform* | *Drive shaft* | *Fixed shaft* | *Pivot link* |
| *Maximum stress (MPa)* | 6.89 | 276 | 80 | 95 |
| *Min. factor of safety* | 66 | 1.9 | 3.5 | 4.9 |

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OMIKRON ROBOTICS