

STAIR CAPABLE ROBOTIC VACUUM



WPI

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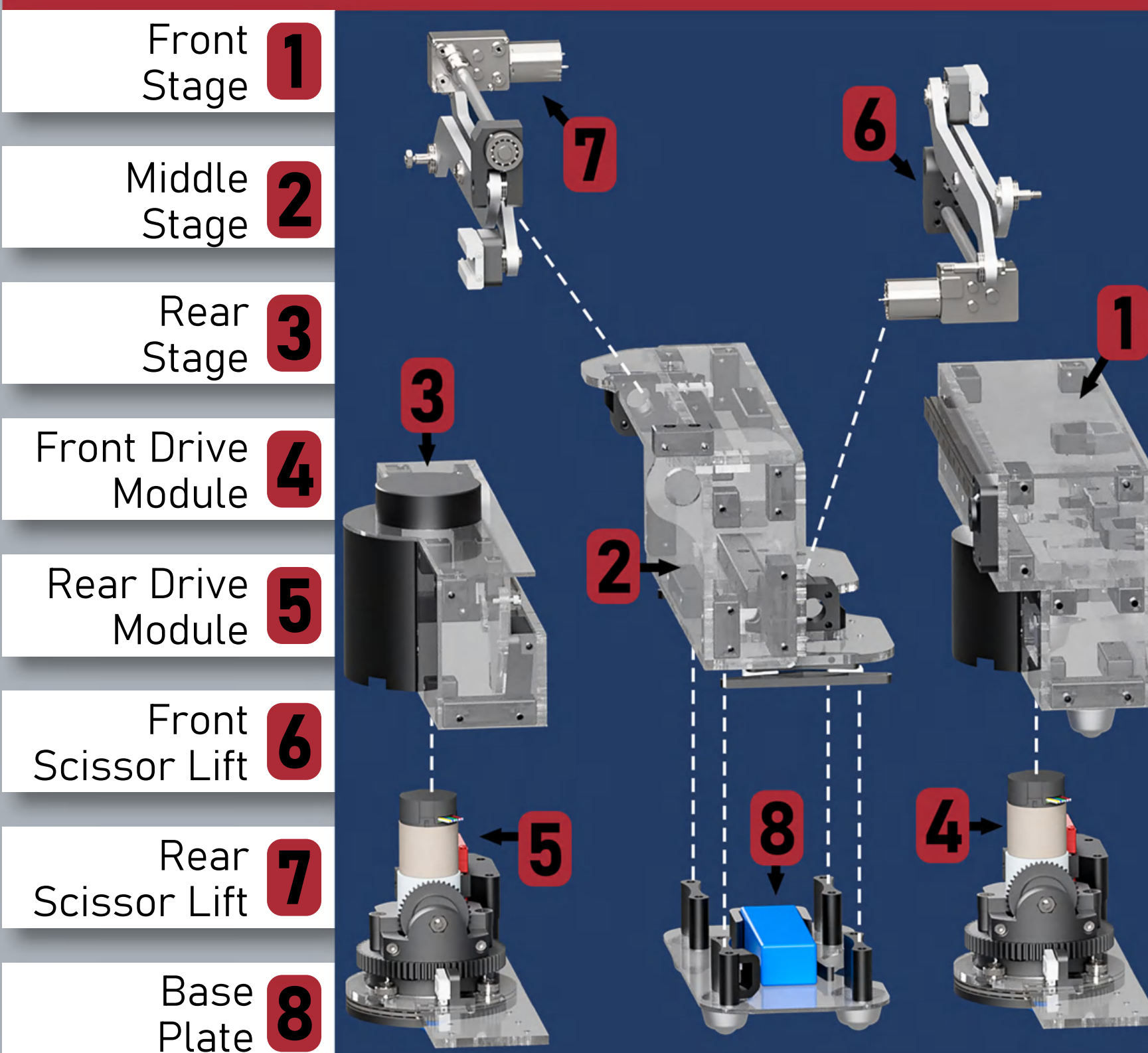
ABSTRACT

The commercial robotic vacuum is unable to bridge the coverage gaps associated with having multiple levels in a home. Staircases are insurmountable and uncleanable environments to these devices and divide a household into isolated regions. This project proposes a robotic vacuum platform that can unite these regions by traversing and cleaning stairs while maintaining a form factor practical for cleaning the rest of the home. The novel design features a three-stage platform interconnected with scissor lifts, which allows the robot to control its center of gravity and vertically extend to the heights required for stair climbing while retaining a retracted height less than that of a single stair. In tandem with the omnidirectional drive system, sensing capabilities, and wall-following control algorithm, this platform can traverse an entire multilevel home.

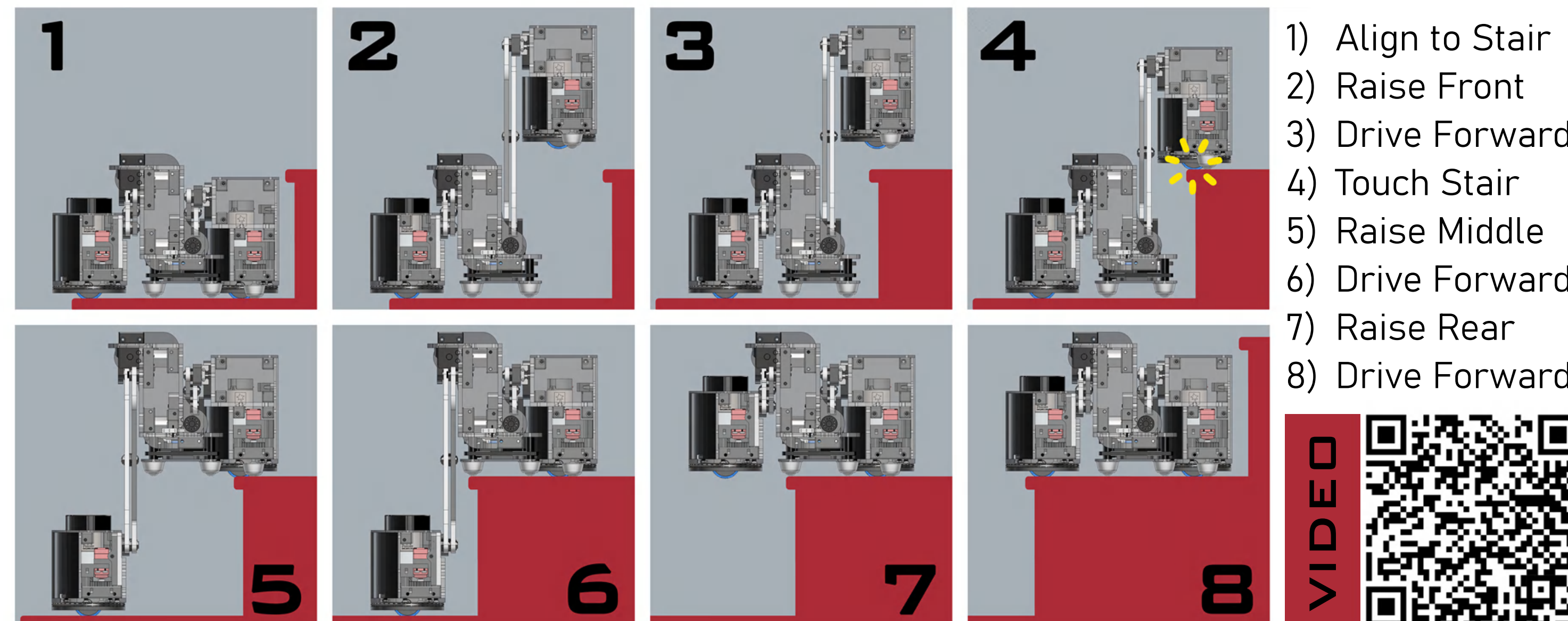
OBJECTIVES

- Being able to traverse a standard household staircase.
- Being able to move across the width of each stair with the intention of cleaning it.
- Creating a platform that is capable of vacuuming an entire multilevel home rather than one that exclusively clean stairs.
- Proposing a technology that can cooperate with and be applied to the current industry standard form factor for robot vacuums.

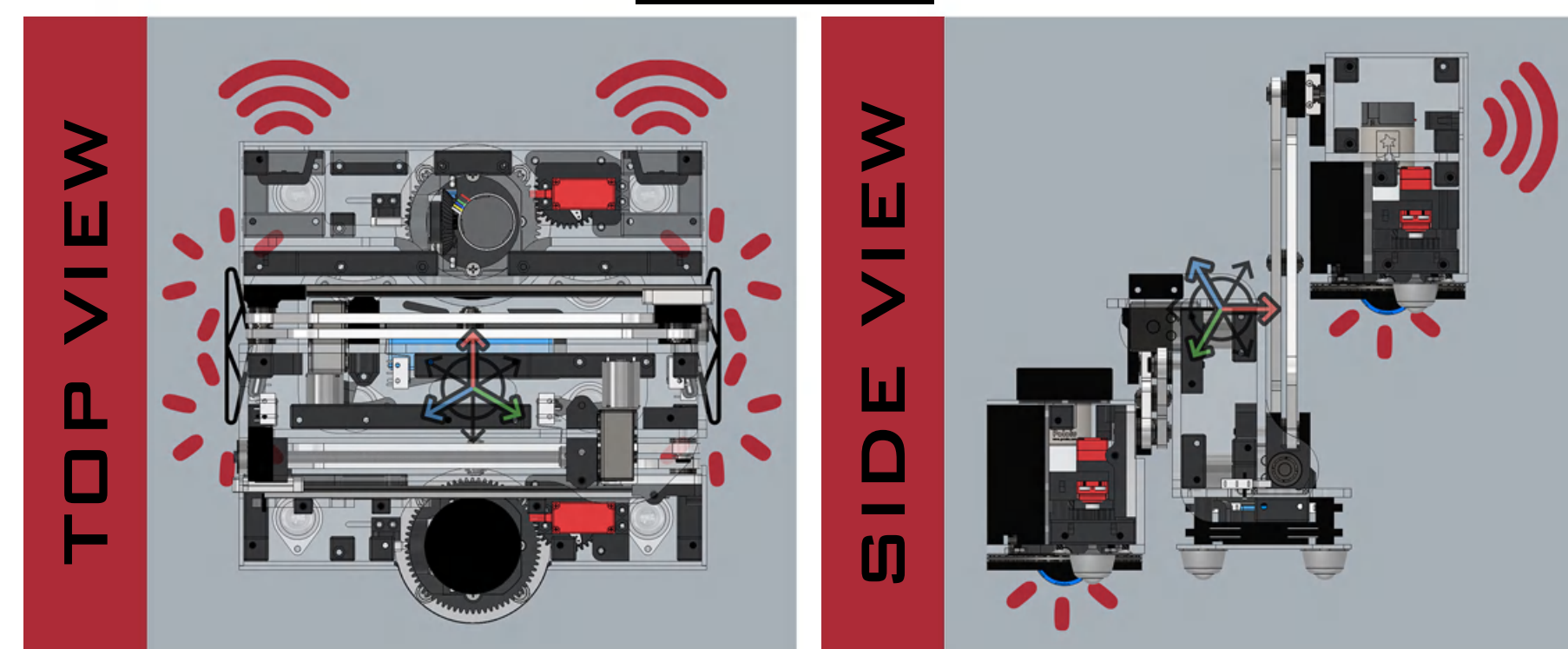
DESIGN



AUTONOMOUS STAIR CLIMBING

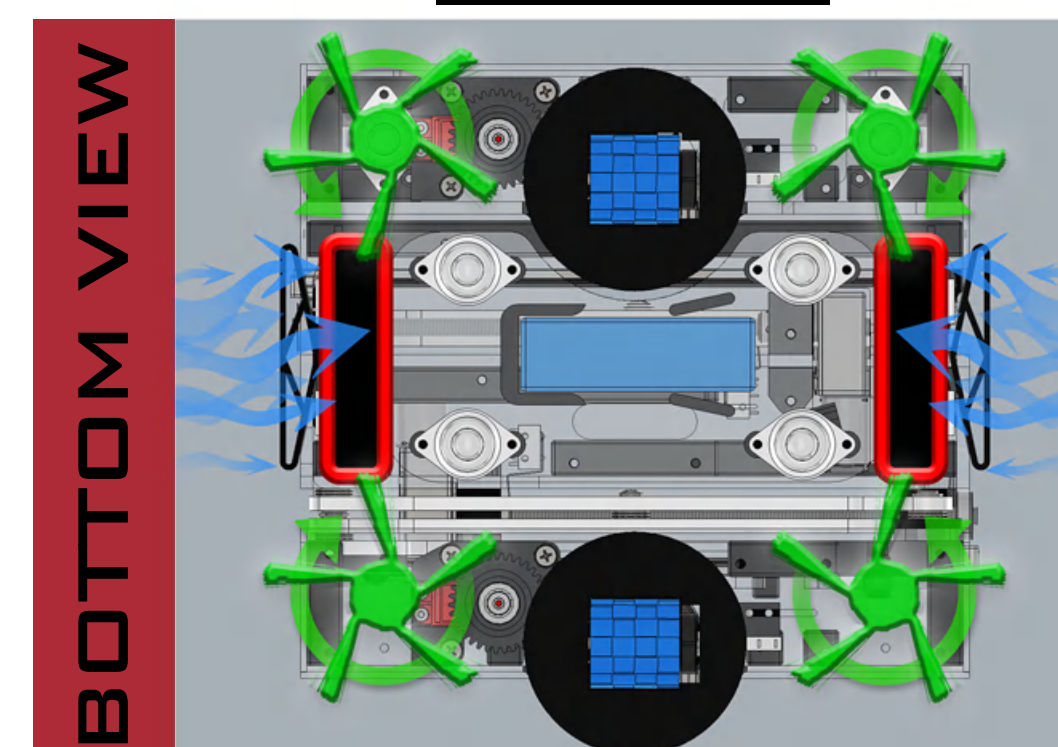


SENSING



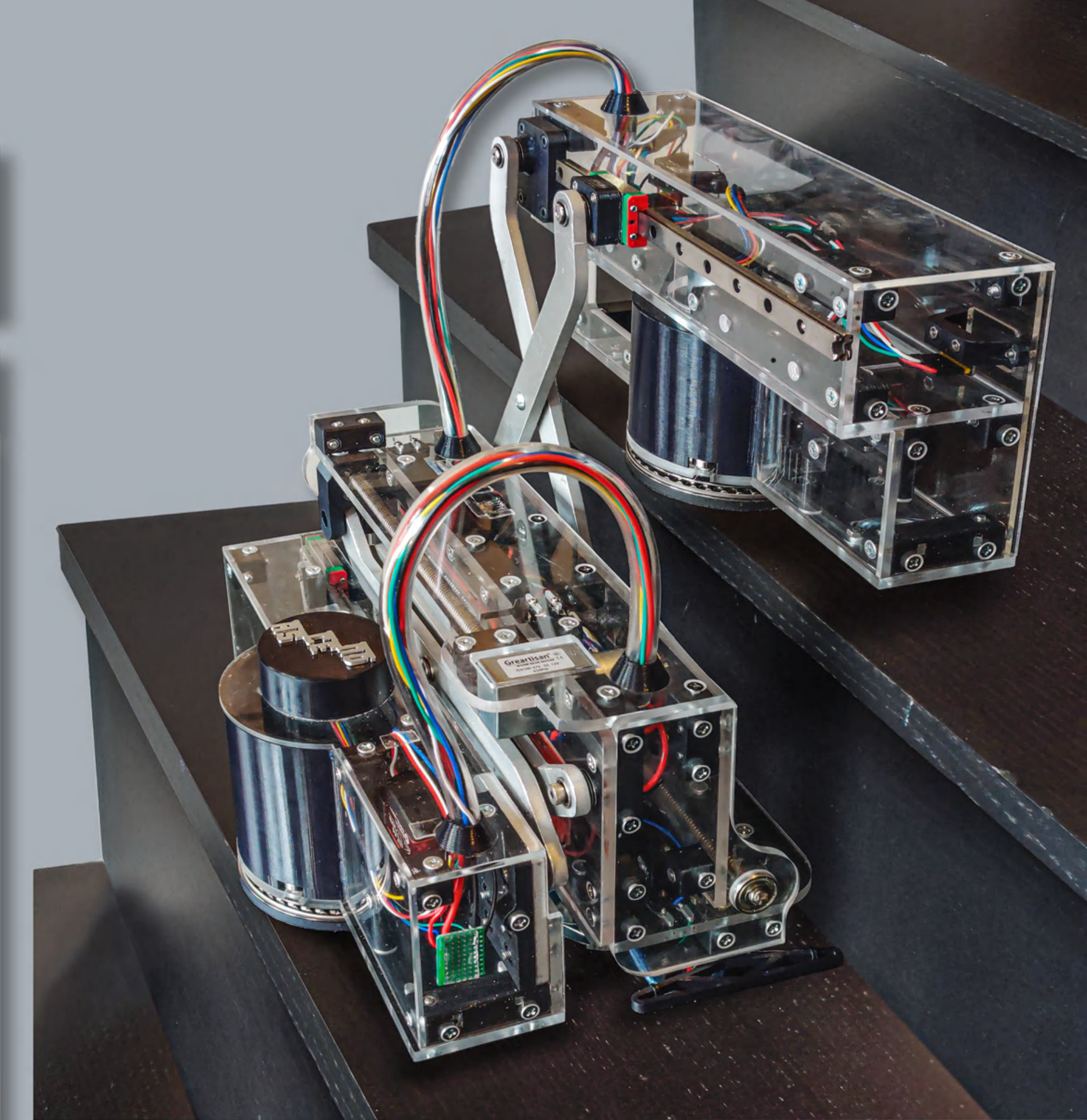
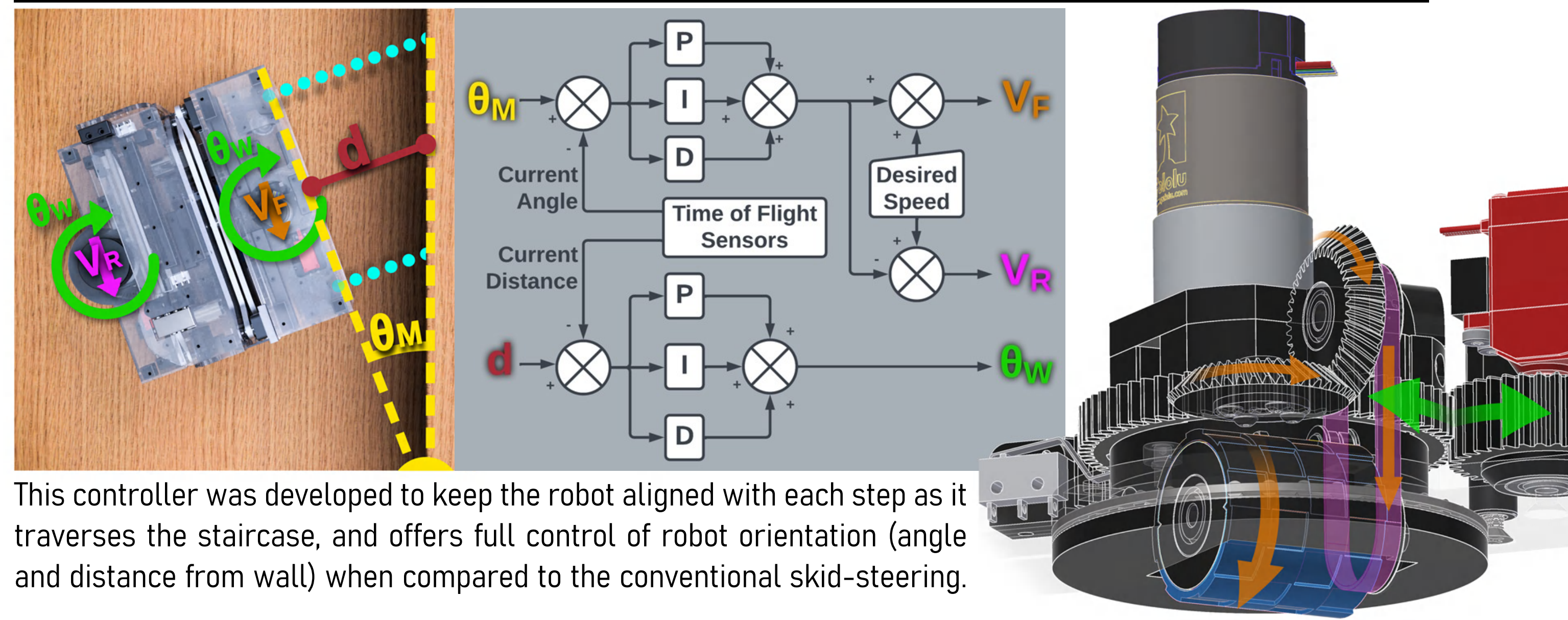
- Two Time Of Flight (ToF) Distance Sensors on the Front Stage
- Two Bump Sensors on the left and right sides of the Middle Stage
- Two Wheel Touch Sensors on the Front and Rear Drive Modules
- Accelerometer and Gyroscope Module on the Middle Stage

CLEANING



It was critical during the design process to preallocate space in all 3 stages for a practical layout of potential vacuuming components.

OMNIDIRECTIONAL WALL FOLLOWING CONTROLLER and DRIVE MODULE



RESULTS

The result from this project was a fully functioning stair climbing robot that presented challenges in every step of the engineering design process. A detailed CAD model ensured tight tolerances and easy assembly. The use of bearings ensured predictable DoF in our joints, while the choices of material and fasteners warranted a rigid structure. The electrical and firmware systems were developed in good practice and resulted in a stable system.

Features:

- Stair Climbing
- Omnidirectional Drive
- Advanced Wall Following
- IR Remote
- Time of Flight Distance Sensing
- Ground Contact Sensing
- Transparent Body
- Split-Apart Design for Easy Access into the Middle Stage



CONCLUSION

The prototype robot vacuum demonstrated during this project defines a platform that, if further developed, can act as a solution to the commercial robot vacuum's inability to clean a multilevel home. Further development would entail scaling down the platform, optimizing weight and increasing speed, improving the tolerances of scissor lifts, establishing a better alignment protocol for going down stairs, vacuum component implementation, and working on robot localization and mapping to recognize stairwells and navigate homes. We believe this proposed technology could enhance the standard form factor of the commercial robot vacuum.