Electrical & Computer Engineering
Carnegie Mellon

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Electrical and Computer Engineering Department

Carnegie Mellon University

Product Pitch

Across the United States, approximately **39 million Americans** face motor impairments. According to Pew Research and ACS estimates, around **7% of Americans have difficulty walking or climbing stairs**, characterized as serious ambulatory difficulties. A crucial consequence of these ambulatory difficulties is an increased susceptibility to falls as well as difficulty getting in and out of chairs, with emergency departments seeing 3 million older patients each year due to fall injuries. Thus, these affected individuals face challenges to their autonomy, with their condition potentially getting exacerbated by the need to constantly bend down and pick things up.

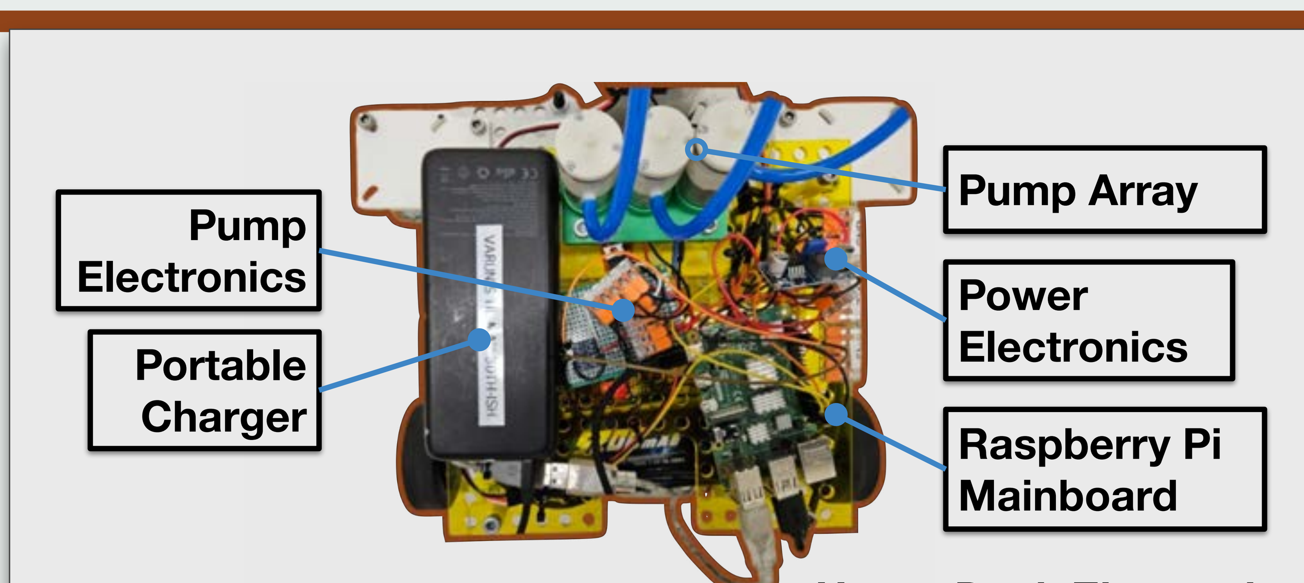
HomeRover is a **cost-effective, intuitive method of object retrieval** for individuals with mobility challenges. Taking the form of a user-assisted autonomous robot, it features an **interface for user navigation of the rover** to an object's general vicinity, **autonomy in operating within the vicinity to pick up the object**, and the ability to **return the object back to the user.** By removing their need to pick things up, we hope to ease their ambulatory difficulties and **improve their health and quality of life.**

System Description

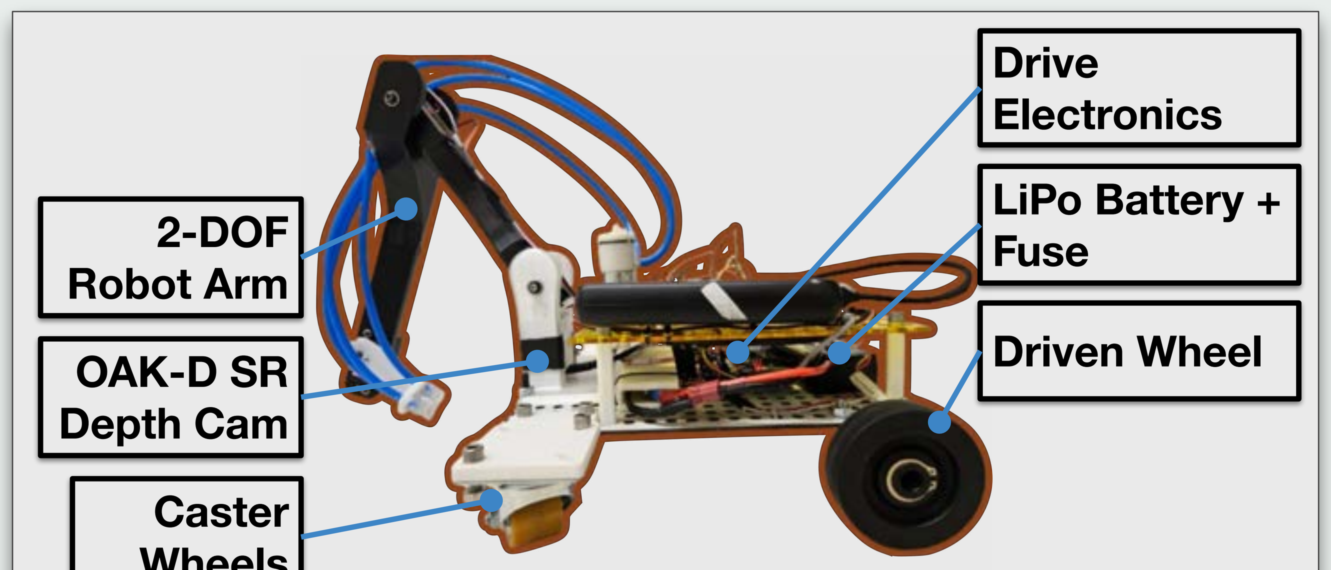
Reaching

Retrieving

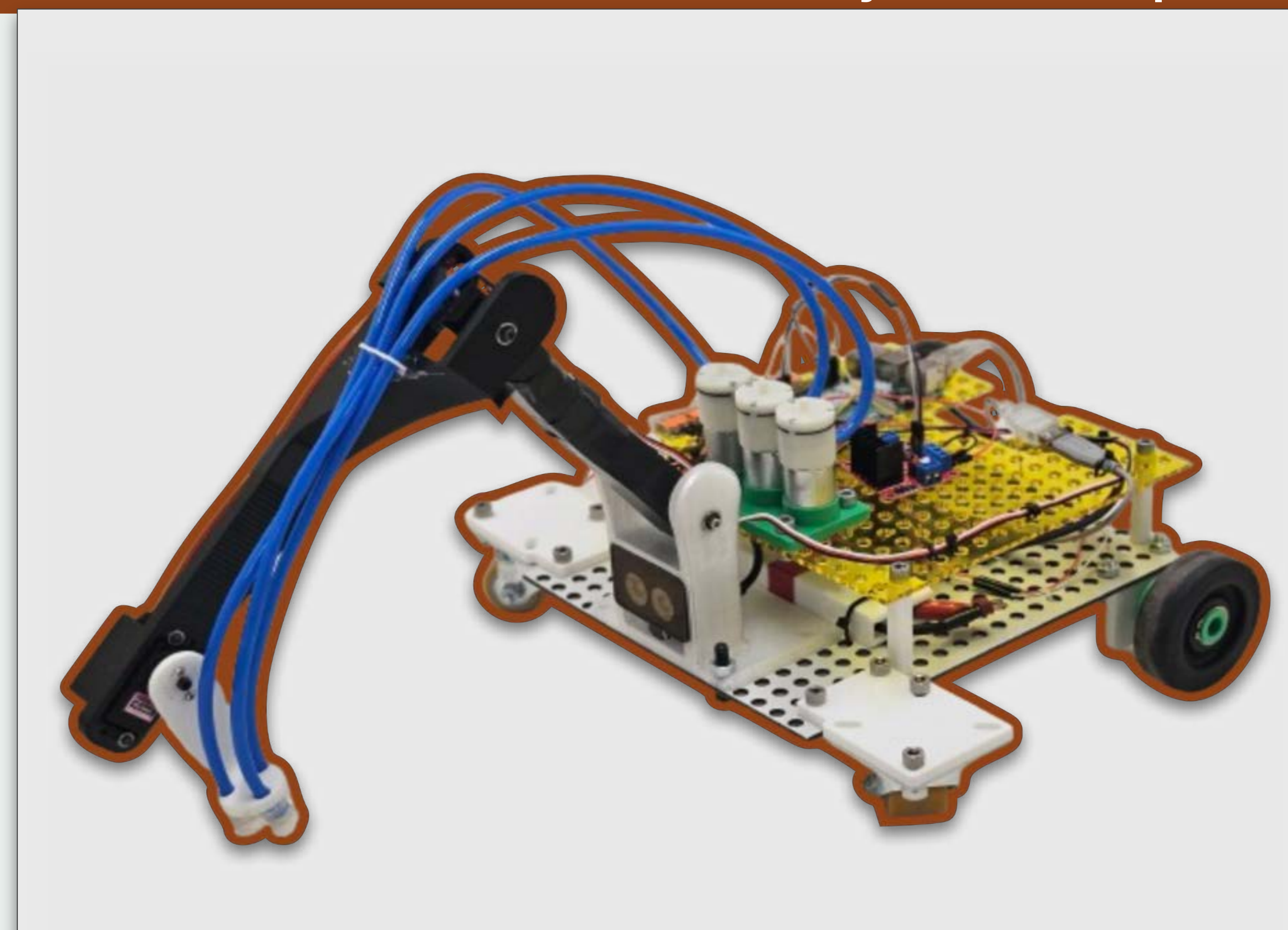
Relinquishing



Upper Deck Electronics

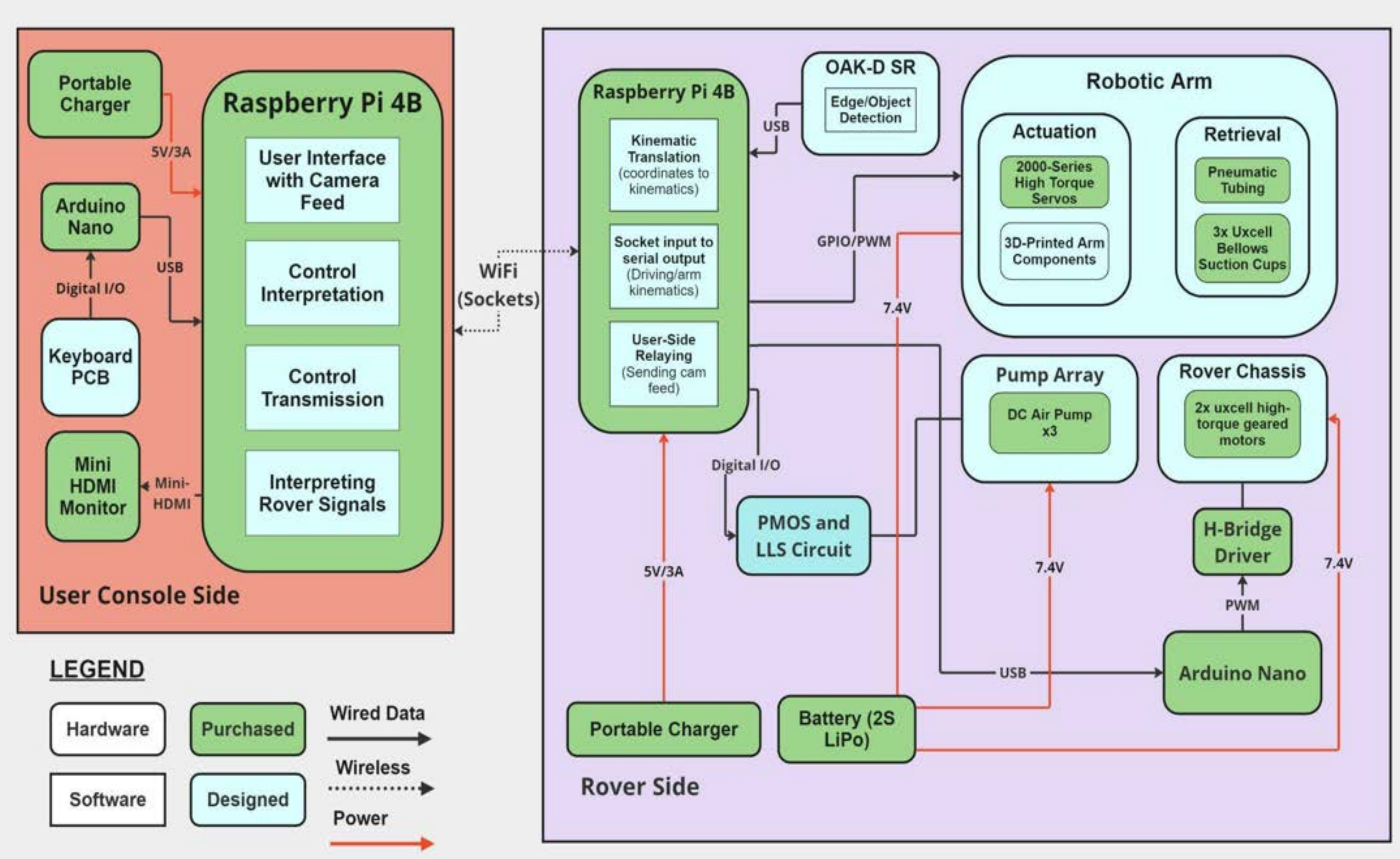


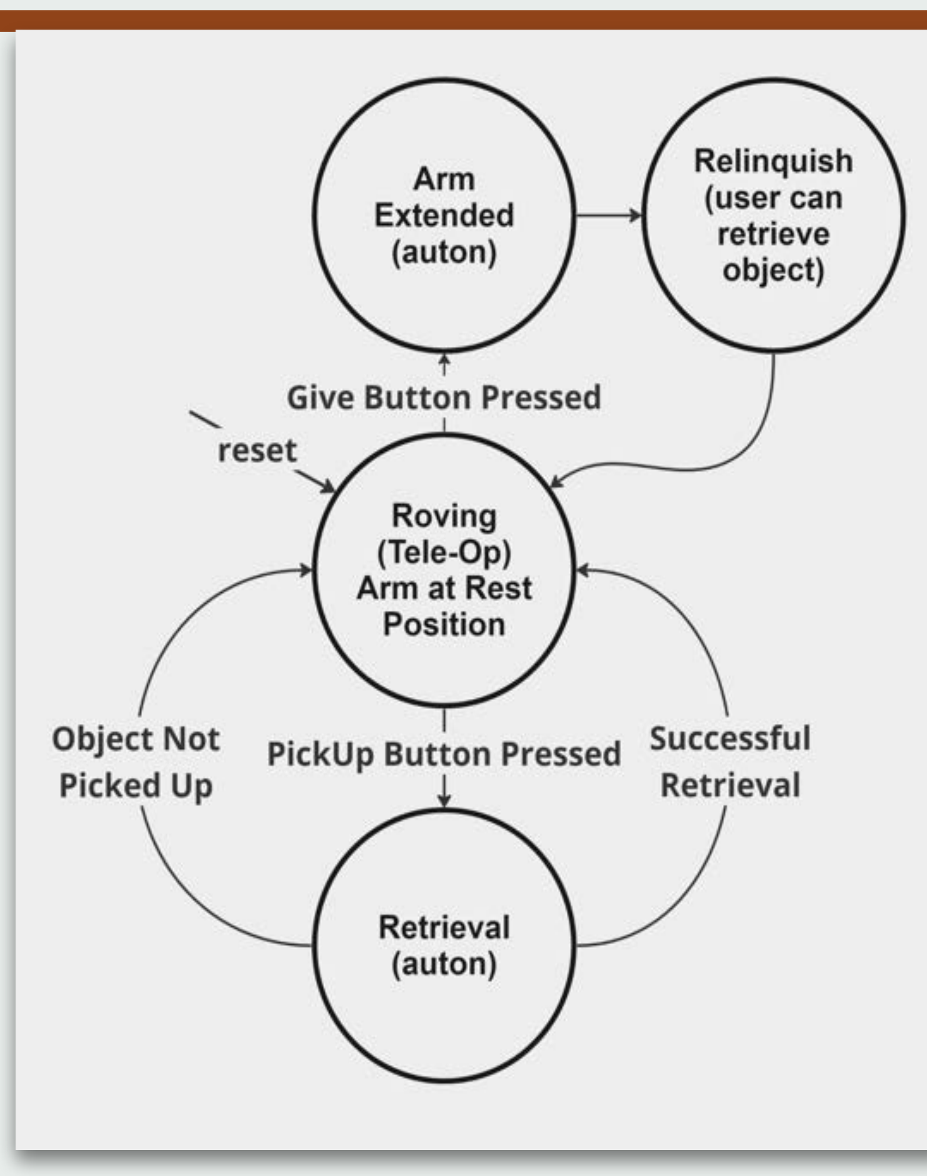
Arm + Lower Deck Electronics



HomeRover

System Architecture





The HomeRover architecture is split into two different subsystems: the user control side and the physical rover side.

On the user side there is a **Raspberry Pi 4** with a monitor and a **controller Printed Circuit Board** that allows the user to control the rover's actions.

On the rover side there is another **Raspberry Pi 4** that acts as the central control for the rover. The rover has an **OAK-D SR camera** which detects object depth and produces a camera feed that is relayed to the user; this camera connects directly to the Raspberry Pi and the data is processed for the arm movement. The two subsystems communicate via **Wi-Fi sockets allowing the two-way transmission of data between the computers.**

Conclusions and Additional Information

Interested in learning more about HomeRover's development? Scan this QR Code!

https://course.ece.cmu.edu/~ece500/projects/s24-teamb1/

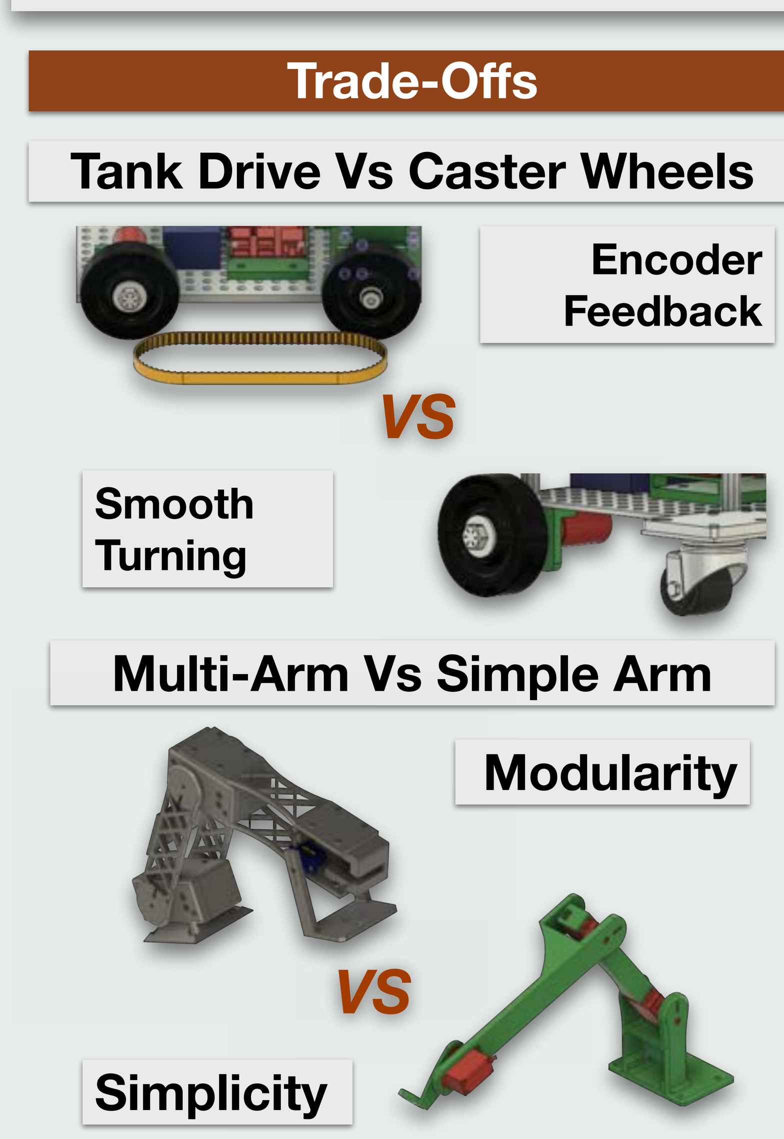
Conclusions- HomeRover represented an **ambitious challenge** to our team - it was an opportunity to foray into the expansive world of robotics with an emphasis on **learning mechatronics,** to a level that we never had reached before**.** We achieved a system that could perform for our use case requirement, detect an object and return to the user. Object detection could be improved to **detect irregularly shaped objects** and the rover could be improved to allow for a **greater capacity and drive capabilities.** We learned a lot about power electronics, as well as strengthened our mechanical design skills while confronting the challenges of our project.

Future Areas of Improvement- ML Model refinement, Sensor Fusion with TOF Depth Perception

System Evaluation

We focused on rigorous verification of our subsystems prior to performing full system validation these subsystems consisted of **transmission**, **driving** and **arm capabilities.** The table shows the results of our **subsystem verification**, and the pictures show the **trade-offs** we've made along the way.

Trade-Offs



Test	Required	Achieved
Transmission Latency	< 100 ms	15 ms
Control Center and Rover Latency	< 20 ms	10 ms
Battery Life	> 1 hour	1.25 hours driving
Pick Up Weight	700 grams	850 grams
Pick Up Accuracy	> 80%	80%
Item Detection and Pick Up Range	30 cm	33 cm
Driving Speed	< 0.5 m/s	0.238 m/s