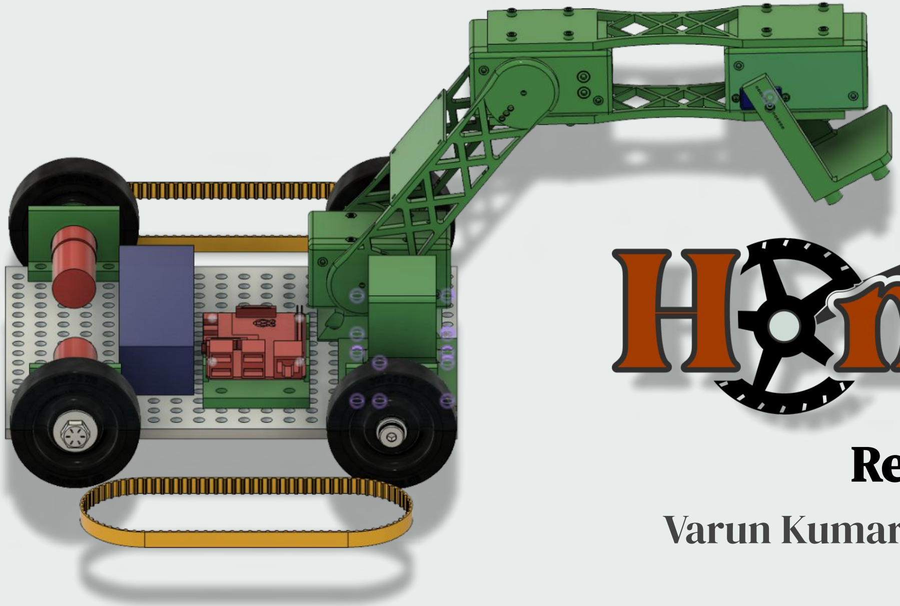


HomeRover

Reach beyond your limits.

Varun Kumar, Hayden Simon, **Nathan Zhu** - Team B1

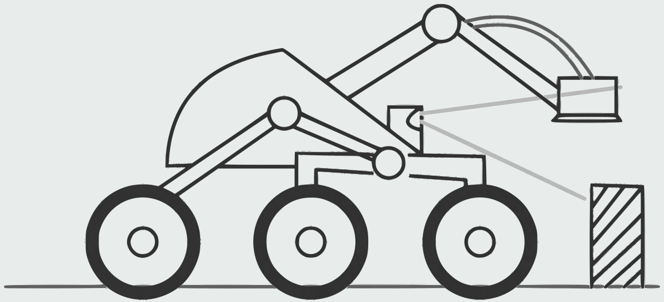
Use Case

Individuals with mobility challenges face:

- Difficulty getting into/out of chairs
- Unsteadiness while walking
- Increased susceptibility to falls

Limitations of current solutions:

- Have a limited range
- Expensive
- Only exist in research labs



Our mission:

Provide a cost-effective, intuitive method of object retrieval for individuals with mobility challenges

Design Requirements

User Control

- Roundtrip transmission **< 100 ms**
- User-side latency **< 20 ms**
- RPi screen displays camera footage
- Directional control keypad
- Min. battery life **1 hour**

Autonomous Item Detection/Pickup

- **80%** pick up accuracy
- Detection range **30 cm,** pickup in **10 sec**
- Suction capable of lifting > **700 grams**

Rover Hardware

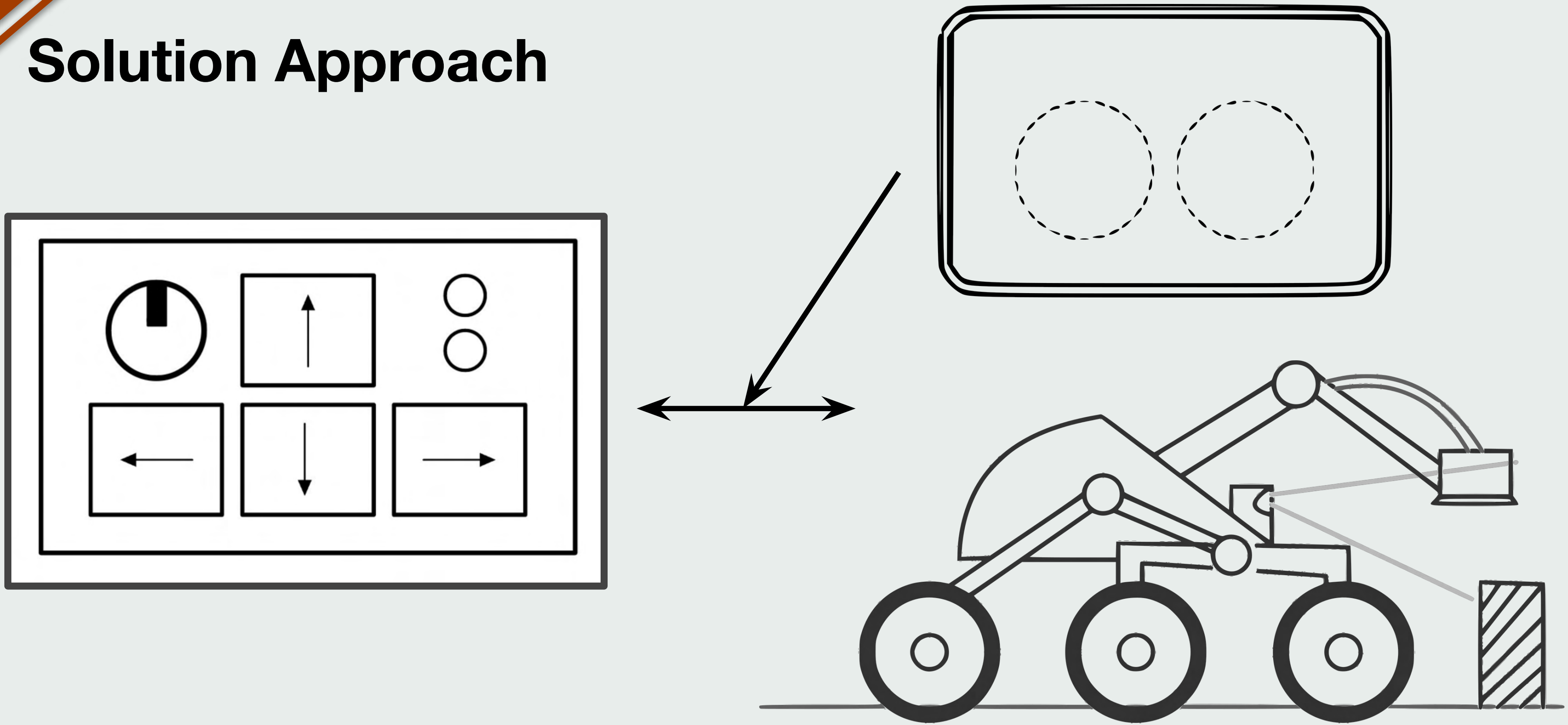
- Motor latency < **20 ms**
- Suction claw latency < **20 ms**
- Carpet, hardwood and tile capability
- Cost < **$450**
- Min. battery life **1 hour**

Safety Considerations

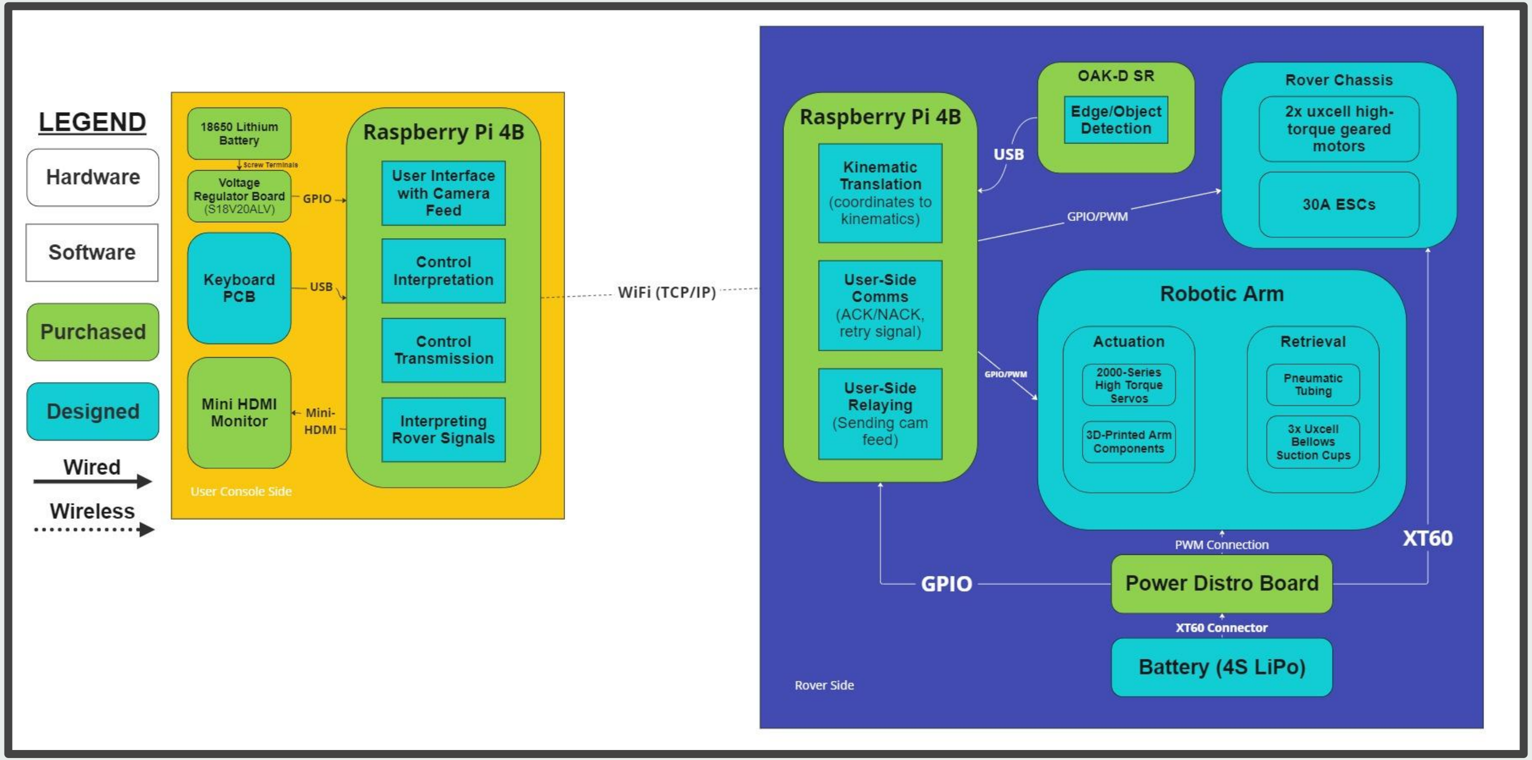
- Durable and safe Materials
- System can withstand spills
- Robot must move at safe household speeds < **0.50 m/s**

HomeRover

Solution Approach

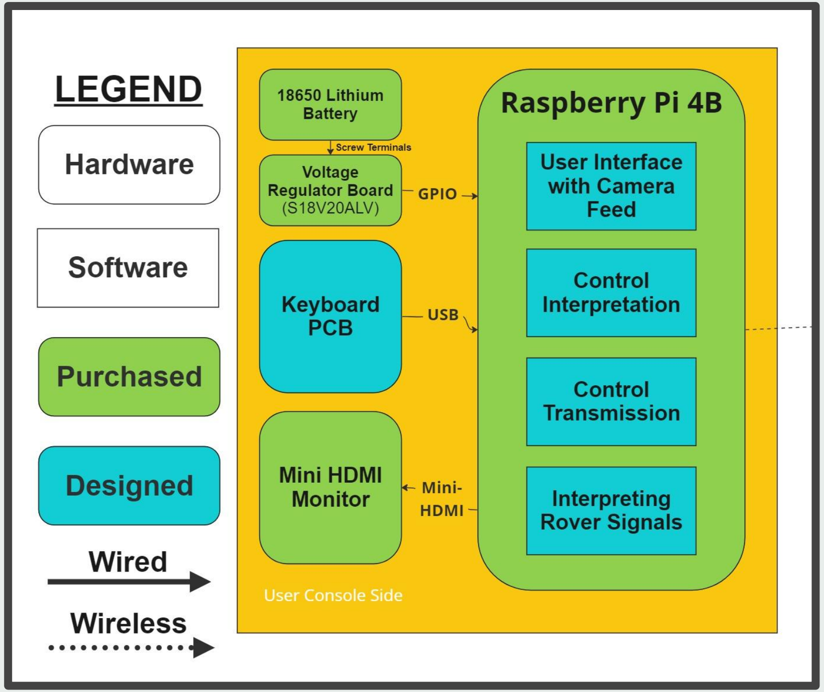


System Specification / Block Diagram



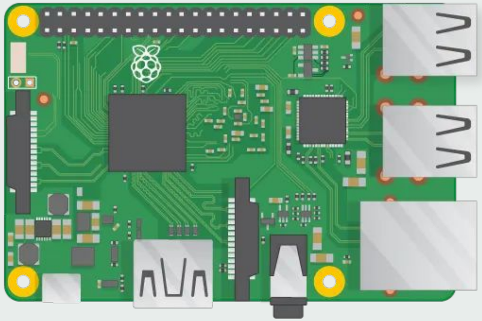
Implementation Plan: User Side

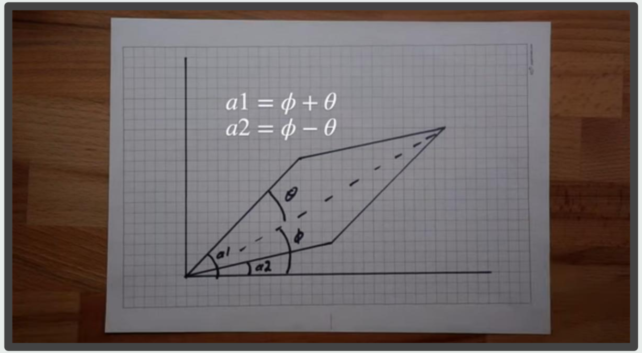
- Copying and modifying PCB for control
  - Link
- Copying and modifying arduino code to translate to USB protocol
- Raspberry Pi Wifi capabilities to communicate
- Purchasing monitor
- 3D printing surrounding assembly for controller



Implementation Plan: Software

- Writing control interpretation software
- Developing user interface for camera feed
- Adapting Depth Camera Software
- Writing Kinematic control software:
  - Drive Train
  - Robotic Arm Motion





Implementation Plan: Rover Side

Drive Train:

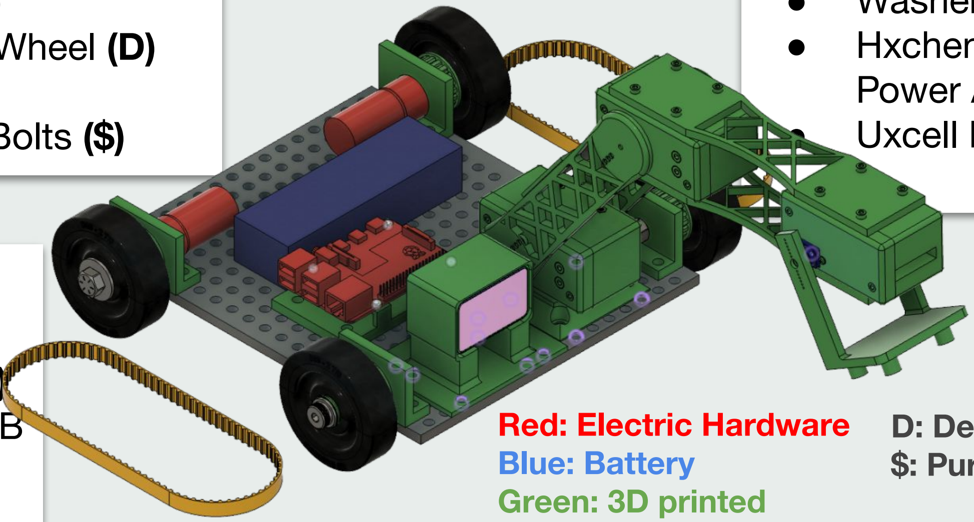
- Uxcell Gear Motor DC 12V 201 RPM Gear Ratio 21.3:1 **($)**
- Mounting Bracket **(D)**
- Timing Hub Pulley & Wheel **(D)**
- Timing Belt **($)**
- Washers, Bushings, Bolts **($)**

Suction Claw:

- 2000 Series Servo **($)**
- Robot arm chassis **(D)**
- Washers, Bolts **($)**
- Hxchen 3-6V DC 370 High Power Air Pump **($)**
- Uxcell Bellows Suction Cups **($)**

Control:

- Raspberry Pi 4 **($)**
- Oak-D SR Camera **($)**
- Electronic control PCB **(D)**
- Object Recognition & Control Software **(D)**
- ESCs **($)**



Red: Electric Hardware
Blue: Battery
Green: 3D printed Components
Orange: Rubber
Grey: Mechanical Hardware

D: Designed
$: Purchased

HomeRover

Testing, Verification and Metrics

Requirement	Method	Target
Transmission Latency	Record time of data transmission between the two RPI using simulation time	**<100ms**
Control Center Latency	Record time between pressing button and response in terminal, using slow motion iPhone camera (240 fps)	**<20ms**
Pick up weight	Have the suction arm pick up an iPad	**≤700g**
Pick up accuracy	Multiple trials with each of the items listed	**≥80%**
Item Detection range	Multiple trials with items at different ranges	**0.30m - 1m**

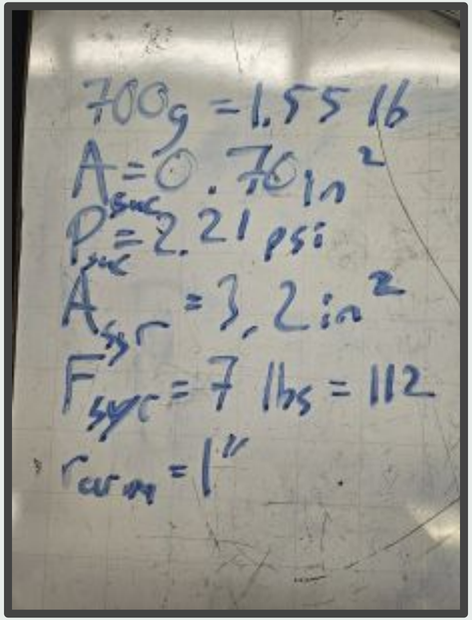
Testing, Verification and Metrics cont.

Requirement	**Method**	**Target**
Driving on different flooring	Drive the rover over carpet, tile and hardwood	**>0.5m/s** and **≥80% success**
Cost	Sum all the components	**≤$450**
Receiver to Motor Latency	Send signals through the RPi and time how long it takes for motor to respond, using slow motion iPhone camera (240 fps)	**<20ms**
Receiver to suction claw Latency	Send signals through the RPi and time how long it takes for stepper to respond, using slow motion iPhone camera (240 fps)	**<20ms**
Battery life	Record time between each recharge	**>1 hour**

Risk Mitigation

Risks	Mitigation Strategies
• Invasive footprint with current suction mechanism	• Switch to DC air pump from syringe
• Suction mechanism reaching the desired target	• Simpler, DOF-limited robot arm • Ample integration time
• Vision and detection of the objects	• Utilize examples as guidance • New camera with onboard features

Pressure Calculations



Project Management

Hayden's Tasks

Design rover (4 wheels, camera mounts, nav capa	Hayden Si...	Feb 3 – 7	Finished
Design and finalize control booth	Hayden Si...	Feb 7 – 10	Finished
Kinematics Scheme	Hayden Si...	Feb 10 – 12	In Progr...
Raspberry Pi WiFi communication scheme (Contr	Hayden Si...	Feb 12 – 15	Not Sta...
Fabricate Rover Chassis 3	Hayden Si...	Feb 16 – Mar 8	Not Sta...
Integration 4	Hayden Si...	Mar 8 – Apr 8	Not Sta...
Improving user experience/slack	Hayden Si...	Apr 8 – 21	Not Sta...

Varun's Tasks

Finalize picking-up mechanism	Varun Kumar	Feb 3 – 7	Finished
Design robot arm	Varun Kumar	Feb 5 – 10	Finished
Kinematics Scheme	Varun Kumar	Feb 10 – 12	In Progr...
Finalize comm protocol Intra-Rover	Varun Kumar	Feb 12 – 15	In Progr...
Fabricate Rover Chassis 3	Varun Kumar	Feb 16 – Mar 8	Not Sta...
Integration 4	Varun Kumar	Mar 8 – Apr 8	Not Sta...
Improving user experience/slack	Varun Kumar	Apr 8 – 21	Not Sta...

Nathan's Tasks

Set up programming and connect with RPi	Nathan Zhu	Feb 16 – 23	Not Sta...
Experiment with depth camera	Nathan Zhu	Feb 21 – 28	In Progr...
Depth camera able to detect objects	Nathan Zhu	Feb 28 – Mar 8	In Progr...
Mockup User Interface Design for control suite	Nathan Zhu	Feb 7 – 12	Finished
Finalize comm protocol intra-Rover (kinematic tra	Nathan Zhu	Feb 12 – 19	In Progr...
Identify how far objects are on Raspberry Pi, in ac	Nathan Zhu	Mar 9 – 22	Not Sta...