



# Autonomous Debris Collector Design Presentation

By Hojun, Omar, Andy

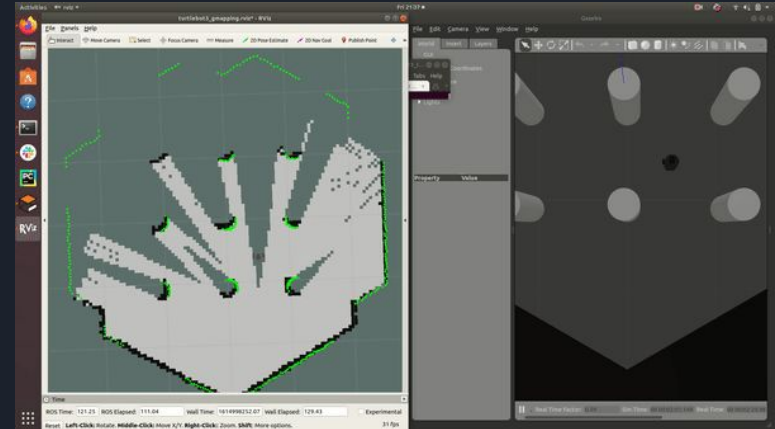
# Use Case

- Workshops frequently have tools and items falling onto the floor
  - Scattered tools and debris are safety hazard
  - Manual collection long and tedious
  - Tools hard to see and identify
- No specialized solutions



# Solution Approach - Software

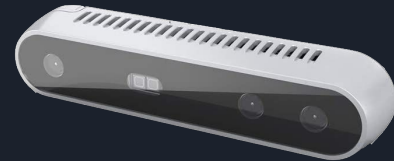
- Use color thresholding to detect tools
  - Ambient light calibration
- Steer robot to have object be center of the image
  - Drive until the object is close enough to grab
- Perform set arm movement



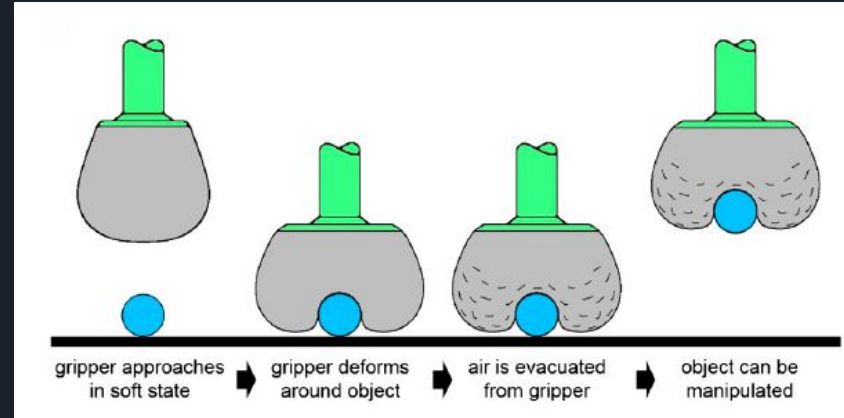
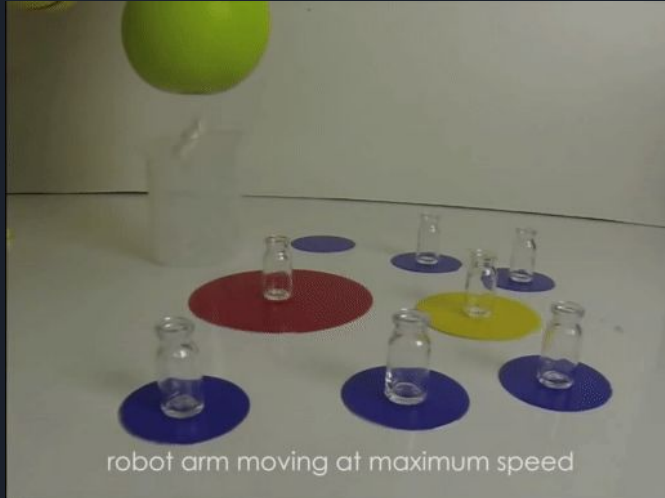
Simulation to test motion planning

# Solution Approach - Hardware

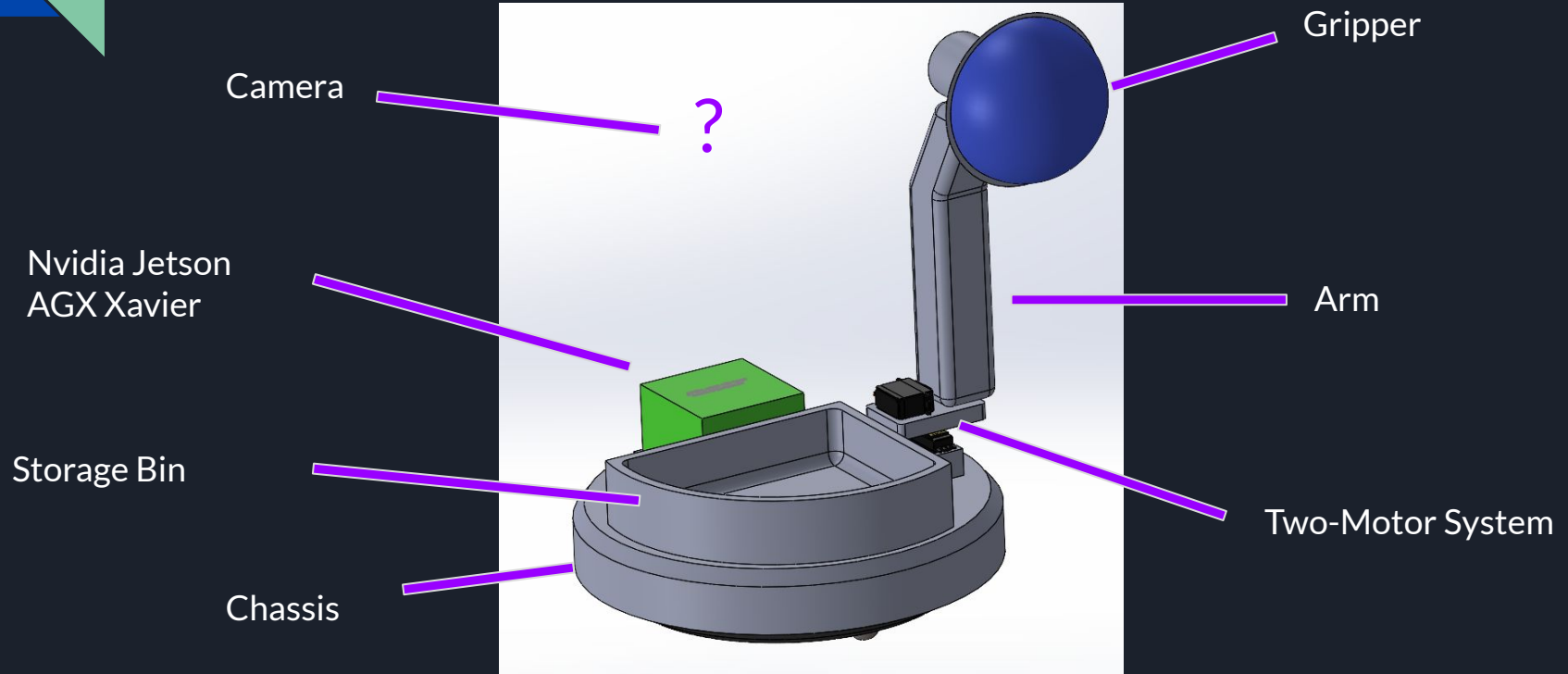
- Computer
  - Jetson AGX Xavier
  - Arduino Uno
- Robotic base
  - iRobot Create 4400
  - 2 servos
  - Electric air pump
- Depth camera
- Battery
- Aluminium
  - Arm



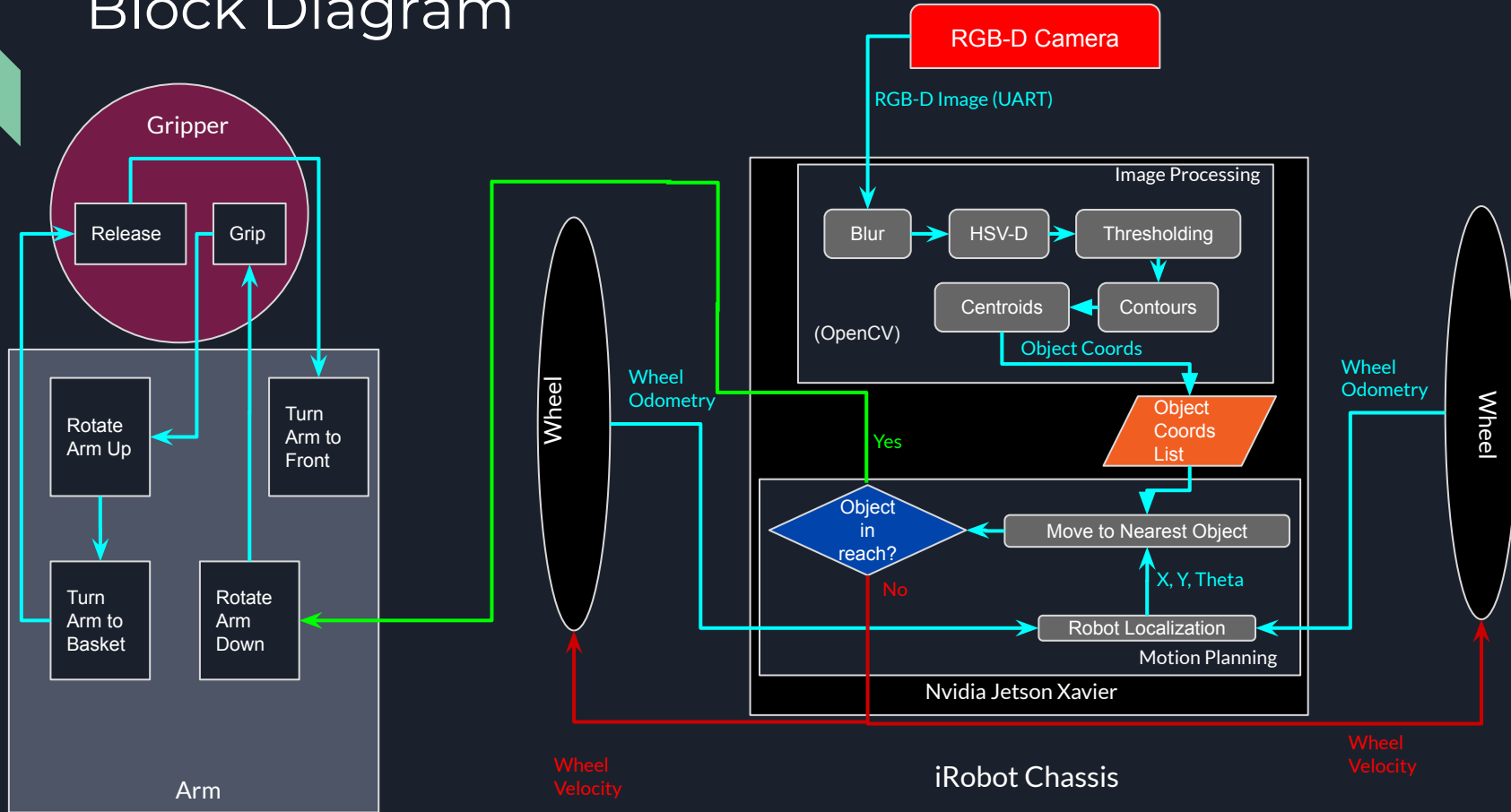
# Gripping Mechanism



# CAD Model



# Block Diagram





# Implementation Plan

- Tool Tracking
  - Use Xavier and depth camera
  - OpenCV functions
  - Wheel odometry to orient and drive robot to tool
    - Differential drive motion model
- Robot
  - Model arm parts in CAD
  - 3D print the chassis and funnel design for gripper
  - Buy servos, aluminum, thick balloons, electric pump, depth camera
  - Obtain Xavier, Arduino, iRobot from course parts list
  - Assemble gripping mechanism and robot separately for testing





# Risk Factors / Unknowns

<b>Risks</b>	<b>Solutions</b>
Variance in lighting could affect the visual recognition and CV algorithm performance	Use auto calibration to adjust color threshold every use
Tool weight/shape affects gripping ability	Select best material based on gripper tests
Universal gripper doesn't work out	Use a solenoid to pick up only magnetic objects
Robot stability when center of mass shifts due to arm movement	Use less mass for arm or add a counterbalance

# Testing, Verification, and Metrics

Requirements	Testing	Metrics
Fast and Reliable Image Processing	Item recognition code testing	Runtime = 10ms 0% false positive rate < 7% false negative rate
Reliable item pickup	Robot picks up item on attempt	> 90% success rate picking up items that are < 0.7kg and 10cm in length
Item collection	Robot can carry multiple items	15 Items picked up
Fast path planning algorithm	Measure run time	50 ms to make path decision
Robot speed .4m/s	2m dash	Completes the dash within 5 seconds
Accurate arm control	Arm hover over items in a circle	5cm arc length accuracy



# Division of Labor

- Hojun
  - Build Arm + Gripper
  - Programming iRobot
  - Integrate Jetson AGX Xavier and iRobot
- Andy
  - Tool Detection (color-marked tools)
  - Tool Distance Algorithm
  - Computer Vision
- Omar
  - Path Planning
  - Localization
  - Final Testing and Performance Tuning

