Use Case: Why sorting robots?

The Problem:

- ❏ Society processes lots of objects
- ❏ Sorting is time consuming and mundane

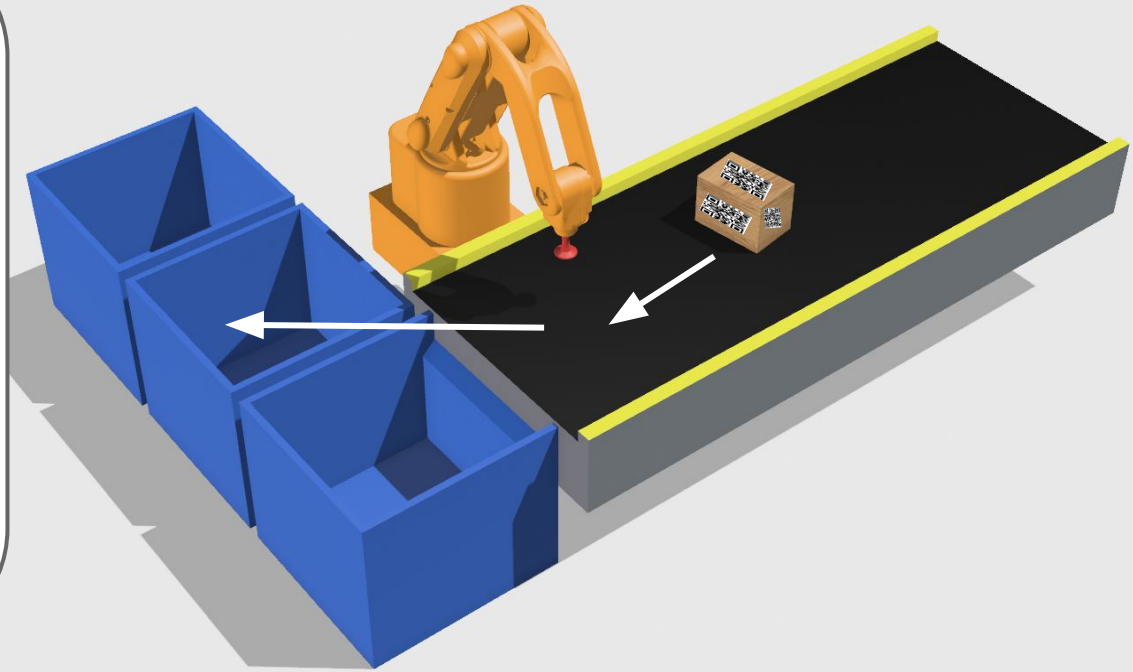
Use case requirement:

- ❏ Continuous and synchronous package sorting

Solution Approach

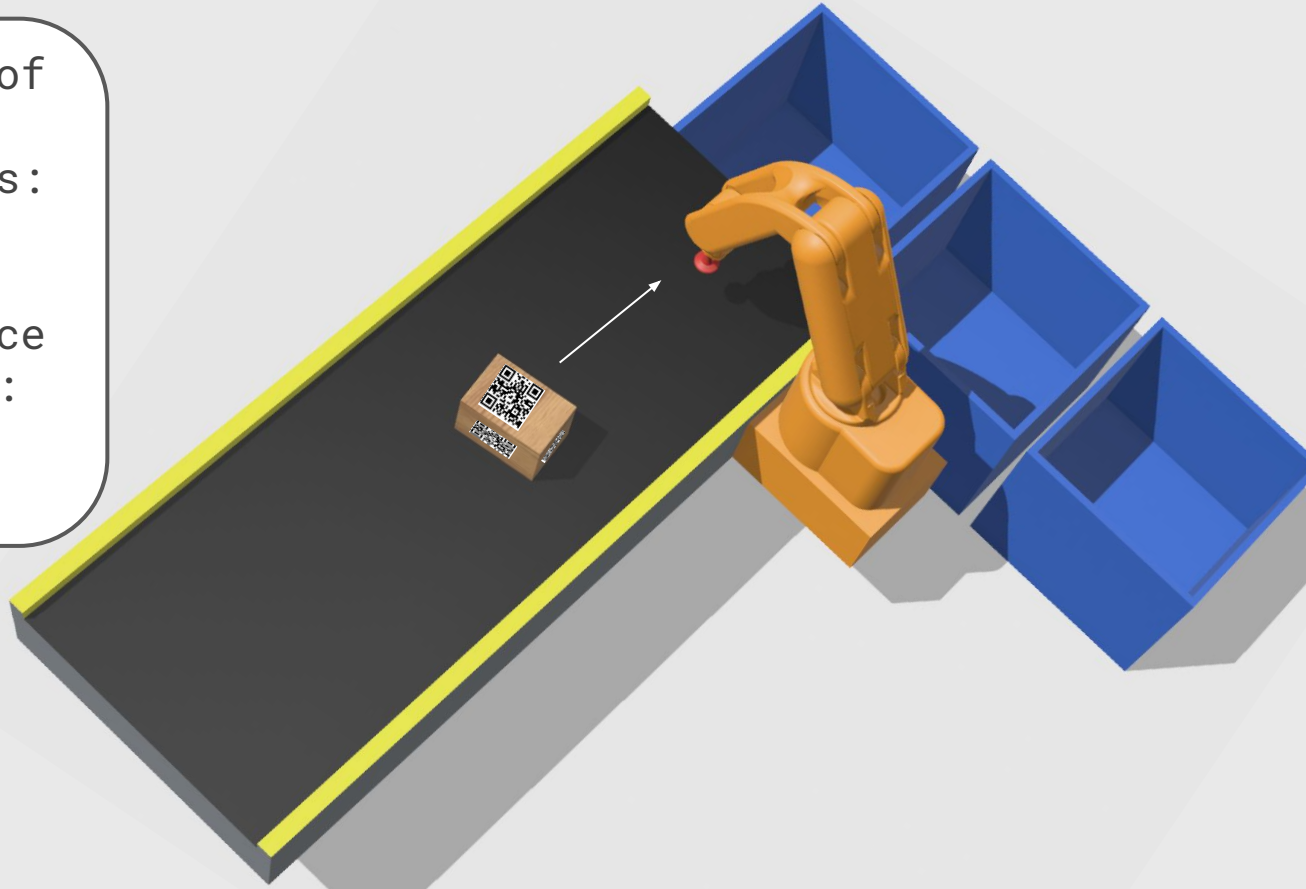
Robot arm with conveyor belt vision:

- ❏ Modular
- ❏ Scalable
- ❏ Synchronous actions lead to high efficiency
- ❏ Robot arms will accomplish more sophisticated tasks in the future



System Design Requirements

- Synchronous grab of box on the move
- Complete action 4s:
  - 15 items/ min
- 95% qr detection
- 90% grab confidence with box variance:
  - Size/ orientation



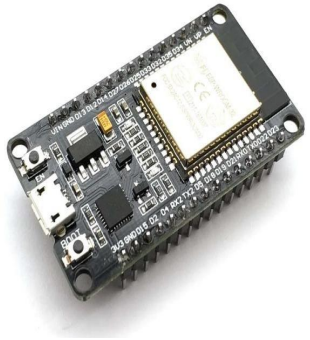
System specification

Camera

Takes photo every .1s

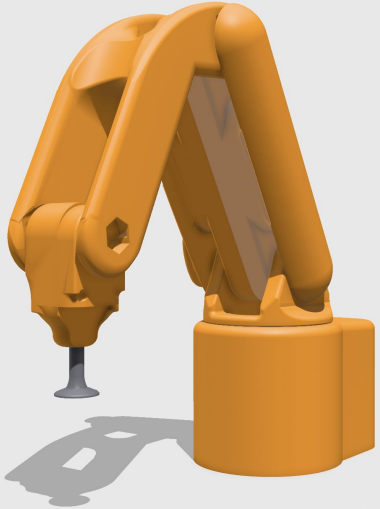
PC

Calculates and sends moves



Esp32

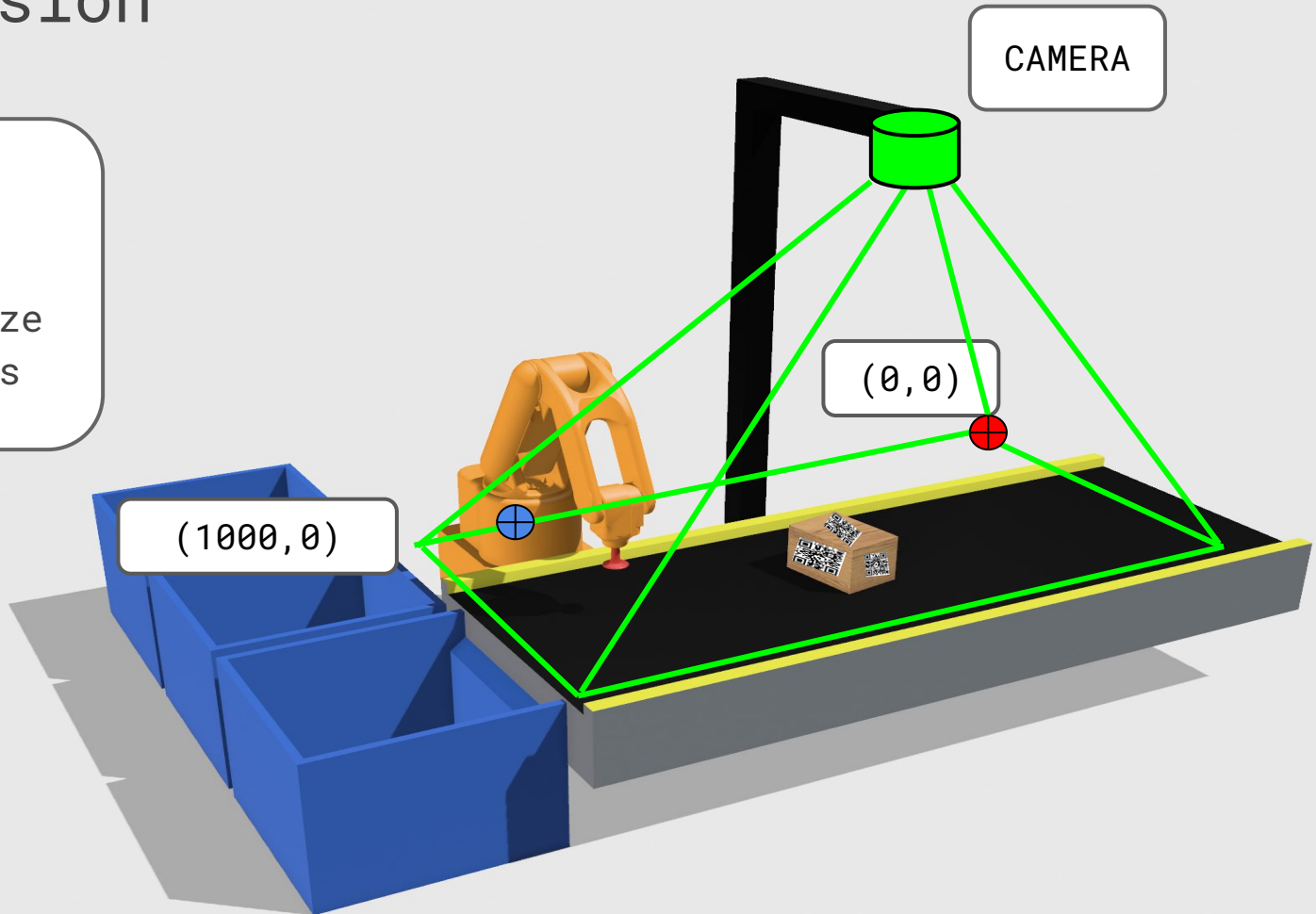
Controls robot moves w/ feedback



Robot

Computer Vision

- Camera will be directly above conveyor
- Take and analyze photo every .1s

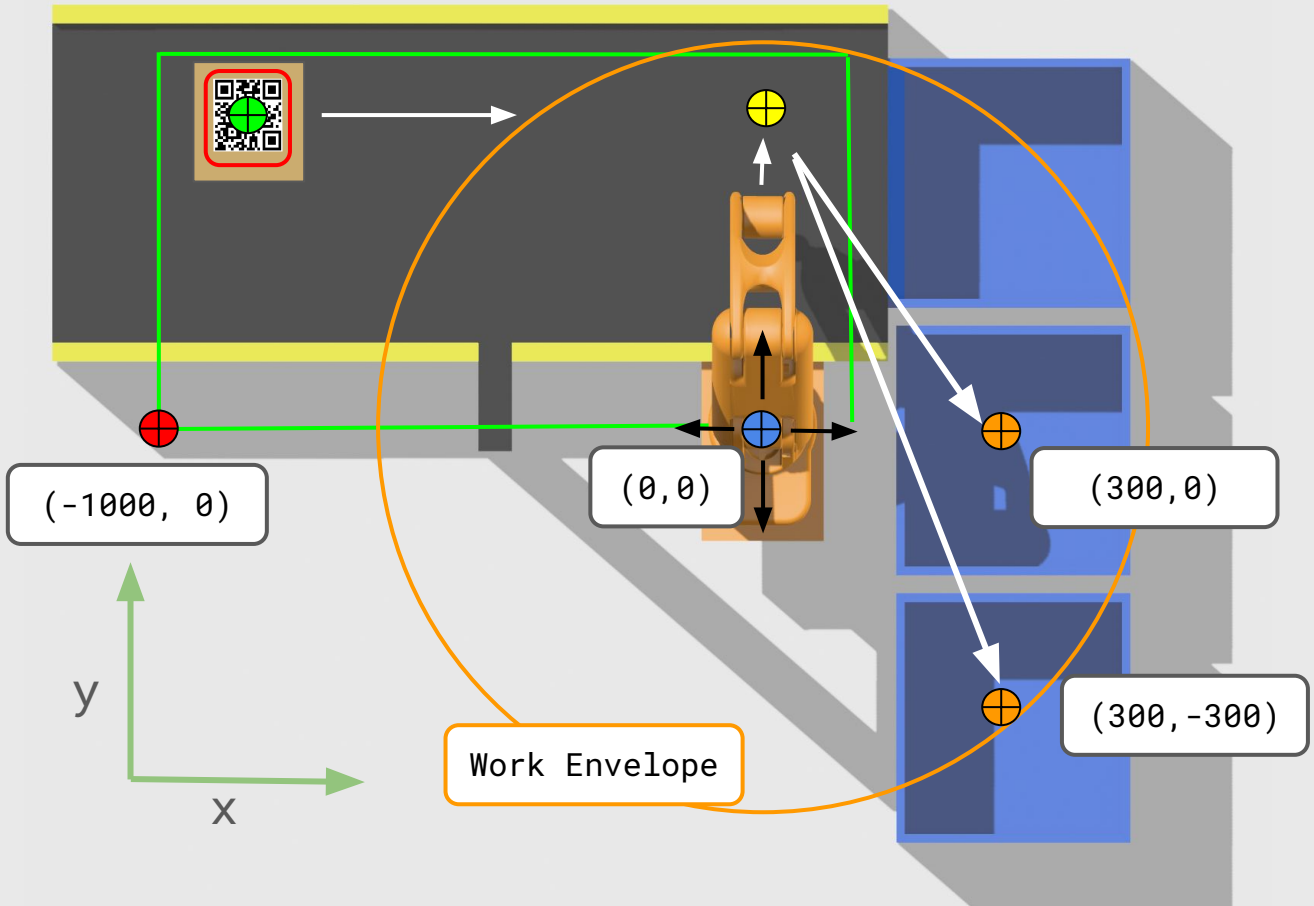


Units are mm

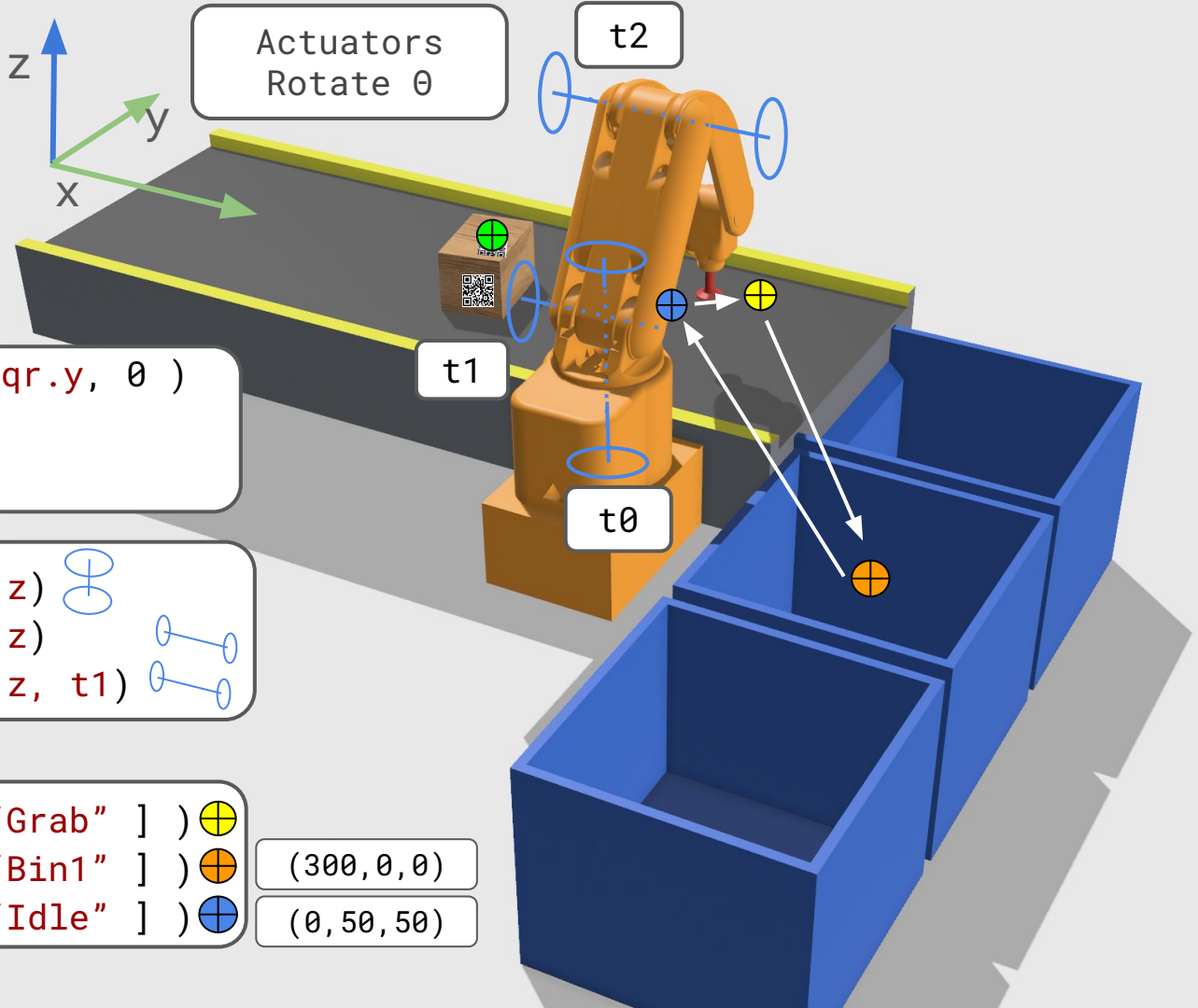
Geometry Layout

- Robot t0 pivot is at (0,0)
- Computer sends sequential moves
- Computer converts between cam and robot worldview

Units are mm



Code




```
qr = getQR()
```

```
(x,y,z) = toWorld( qr.x, qr.y, 0 )
x += beltSpeed * moveTime
z += maxBoxHeight
```

```
t0 = solveAngle_0( x, y, z)
t1 = solveAngle_1( x, y, z)
t2 = solveAngle_2( x, y, z, t1)
```

```
sendMove( [ t0, t1, t2, “Grab” ] )
sendMove( [ 0,  0,  0,  “Bin1” ] )
sendMove( [ 0,  0,  0,  “Idle” ] )
```

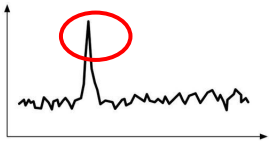
(300,0,0)

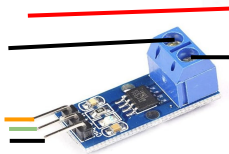
(0,50,50)

Suction Gripper

Requirements

- ❏ Lift 3 lbs
- ❏ “Grabbed” = current spike



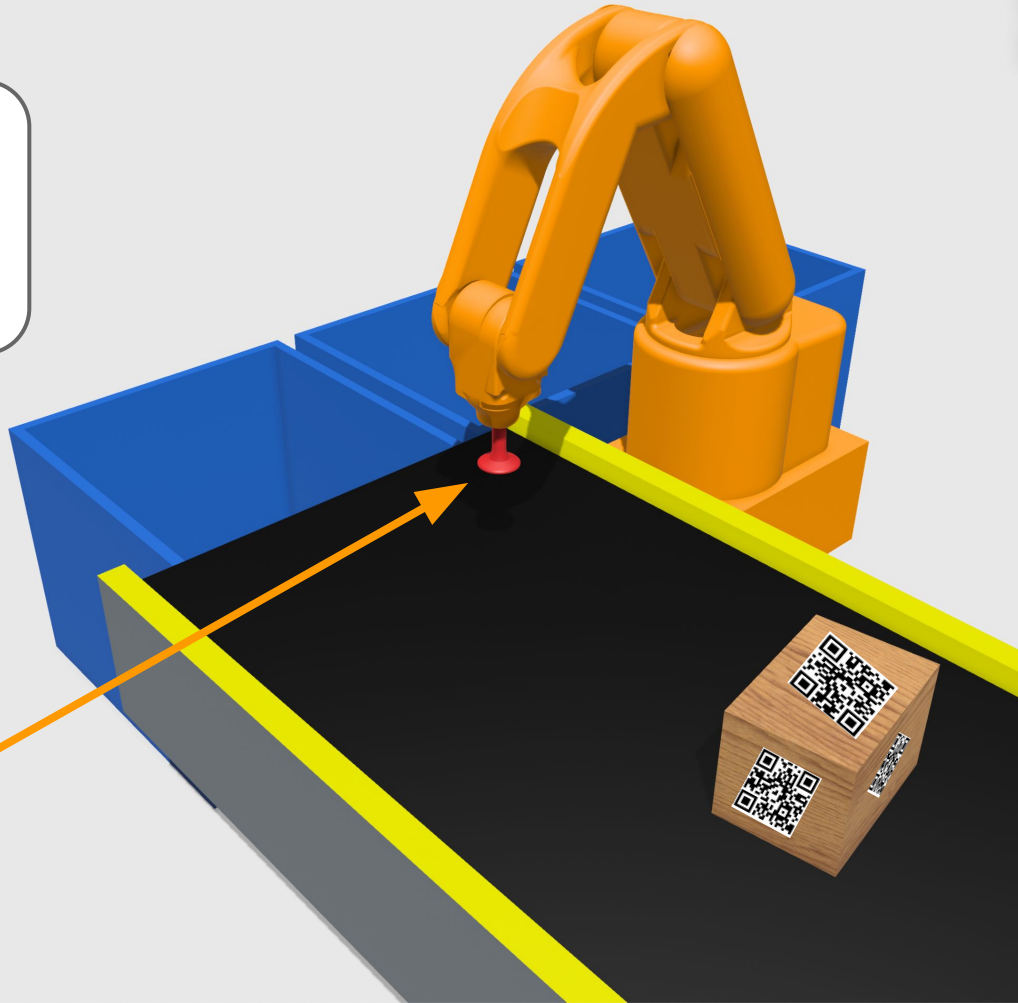


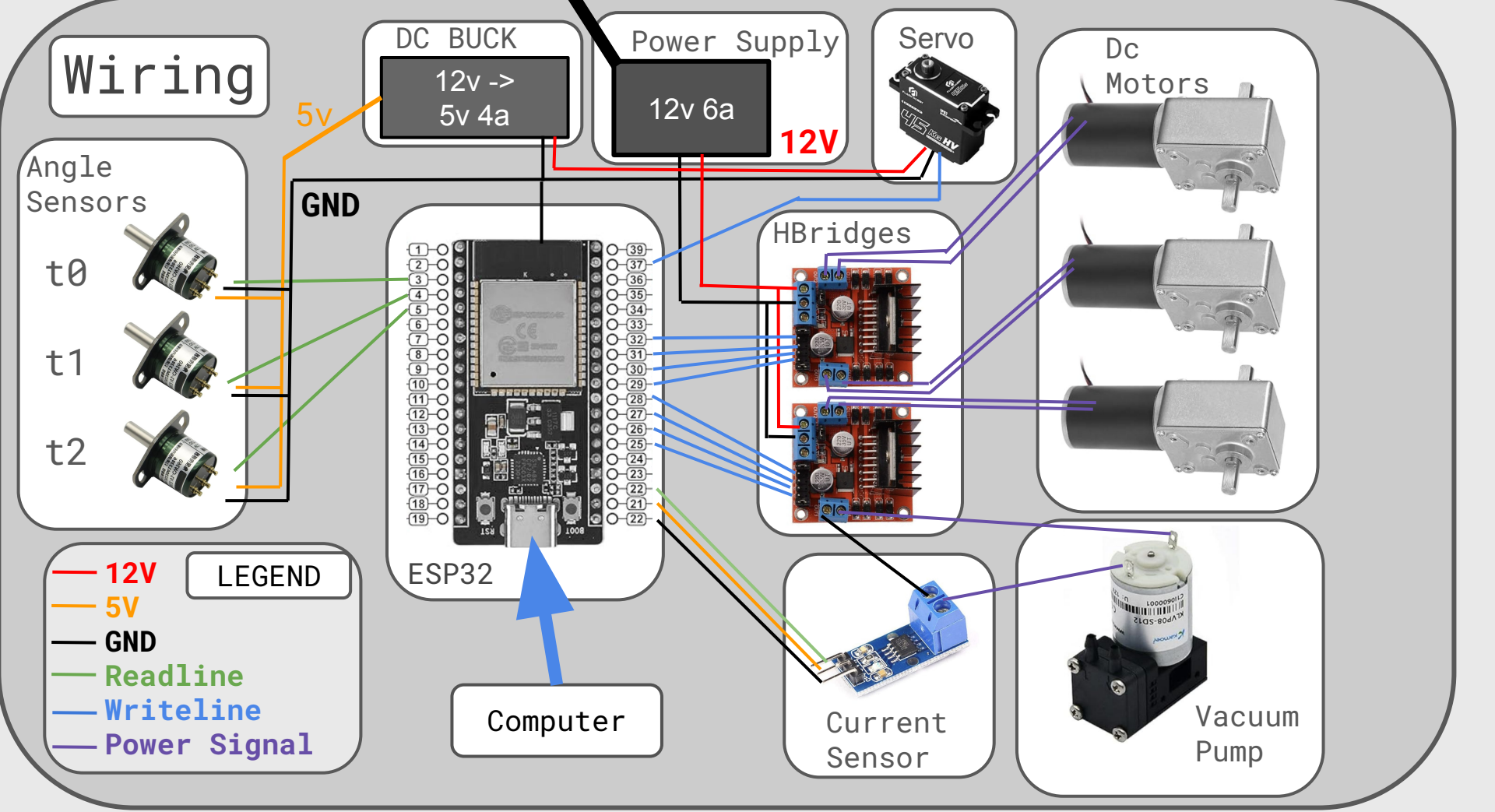
Tube

Current sensor triggered on Pickup

Pump

Gripper

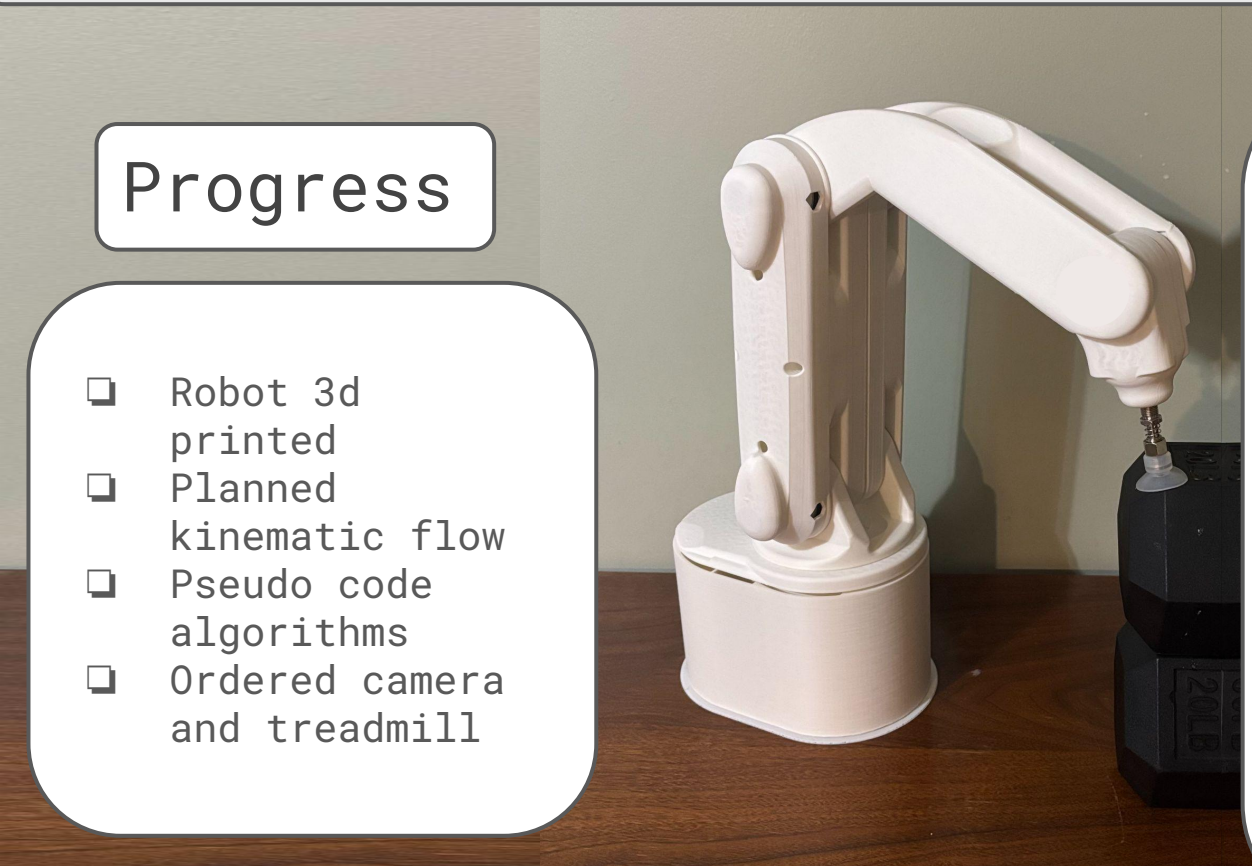



Wiring
DC BUCK
12v ->
5v 4a
Power Supply
12v 6a
12V
Servo
Dc
Motors
5v
GND
Angle
Sensors
t0
t1
t2
HBridges
ESP32
LEGEND
12V
5V
GND
Readline
Writeline
Power Signal
Computer
Current
Sensor
Vacuum
Pump

Project Management

Progress

- ❏ Robot 3d printed
- ❏ Planned kinematic flow
- ❏ Pseudo code algorithms
- ❏ Ordered camera and treadmill



Next Steps

2 weeks

- ❏ Wiring electronics MT
- ❏ Qr localizing MR
- ❏ Kinematics Algo RS

4 weeks

- ❏ Movement test MT
- ❏ Low latency data MR
- ❏ Sorting moves RS

6 weeks

- ❏ Testing components -> increased throughput MT, RS, MR

Testing and validation

Metrics

- ❏ Low miss rate %
- ❏ Action synchronous at +1 mph
- ❏ No damage to packages

If synchronous sorting not possible

- ❏ Introduce conveyor belt stop and start functionality
- ❏ Laser detection

If we have trouble picking up boxes

- ❏ Introduce sideways boxheight camera