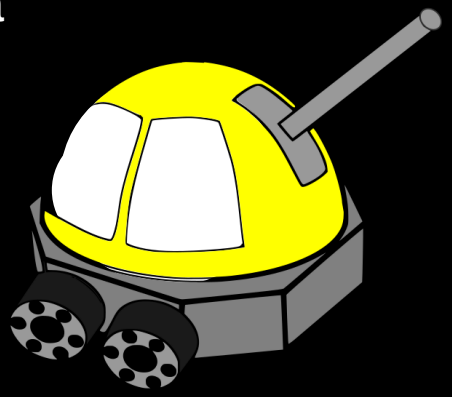
PURDUE UNIVERSITY

IE 590 FINAL PRESENTATION

Tele-Operation of a 6 DOF Robotic Arm Using ESP32 Over WiFi

Team Rocket: Terrell Glenn & Ana Villanueva

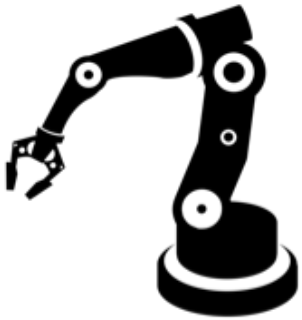
Mechanical Engineering | C Design Lab



PURDUE UNIVERSITY

ABSTRACT

Enabling IoT Accessibility and Interaction



Robot Arm

unity

Unity Application

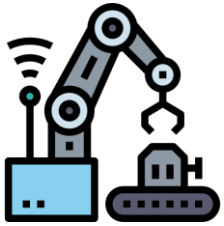
Cython

OpenCV

Livestream Object Detection

Multiple IoT Applications

MOTIVATION

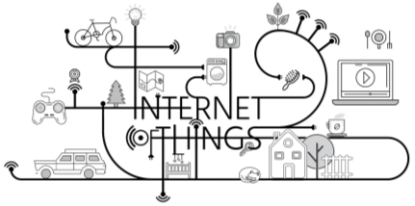


Robotics

Devices that can enhance the experience of an end-user in complete some task.

Computer Vision

Giving sight to a device so that the device, or a remote user, can see and maneuver the terrain.

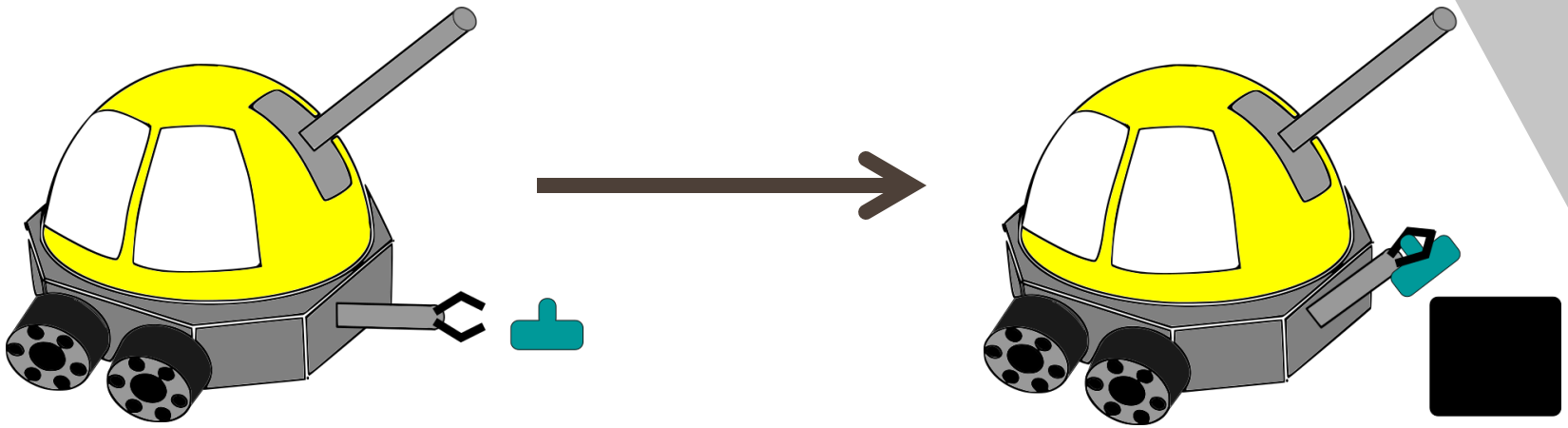


Internet of Things

Devices that are connected via WiFi for flexibility and scalability

PURDUE UNIVERSITY

WHAT DOES OUR ROBOT DO?



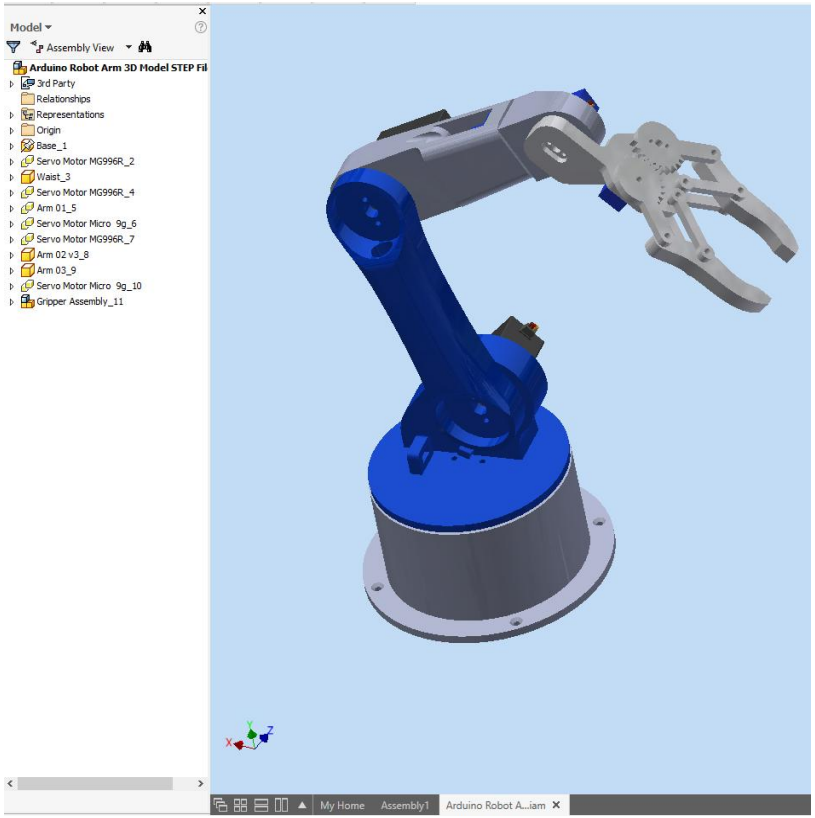
(a): The robot detects the color of an object and creates a bounding box around it.

(b): The user can drive the robot towards the object.

(c): Robot picks up object from location.

(d): User drives the robot with the object towards a target or basket.

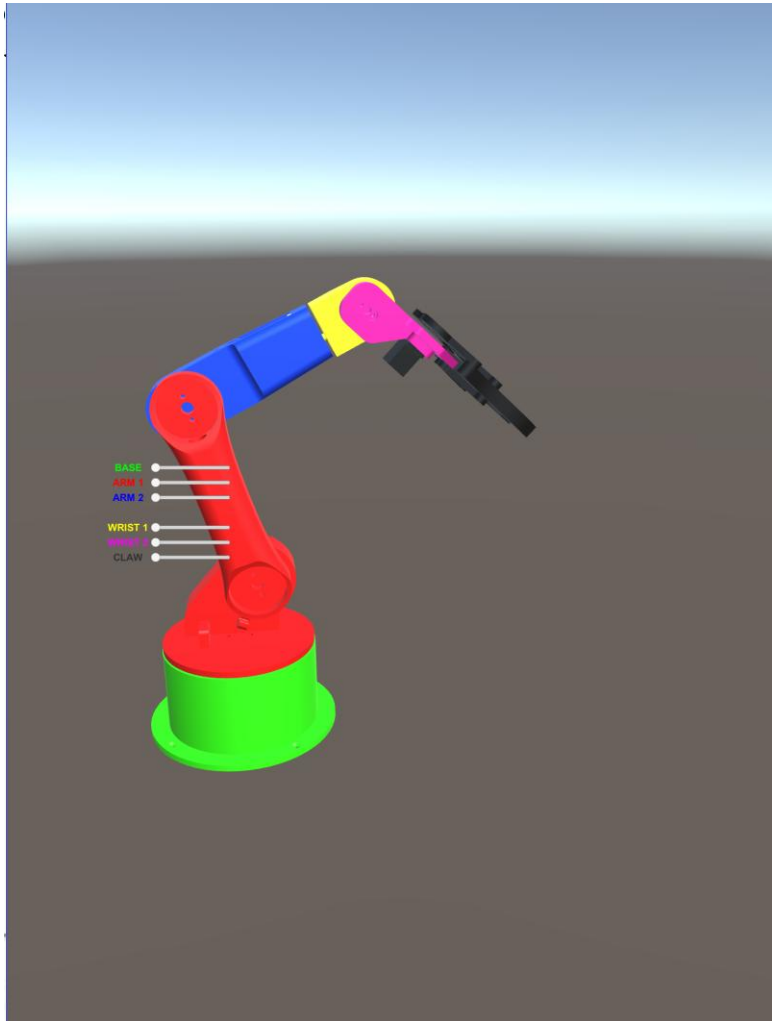
THE ARM



To begin with, we designed the Robot Arm using Autodesk Inventor 3D modeling software. The arm has 6 degrees of freedom.

For the first 3 axis, the waist, the shoulder and the elbow, we used the MG996R servos, and for the other 3 axis, the wrist roll and wrist pitch, as well as the gripper we used the smaller SG90 micro servos.

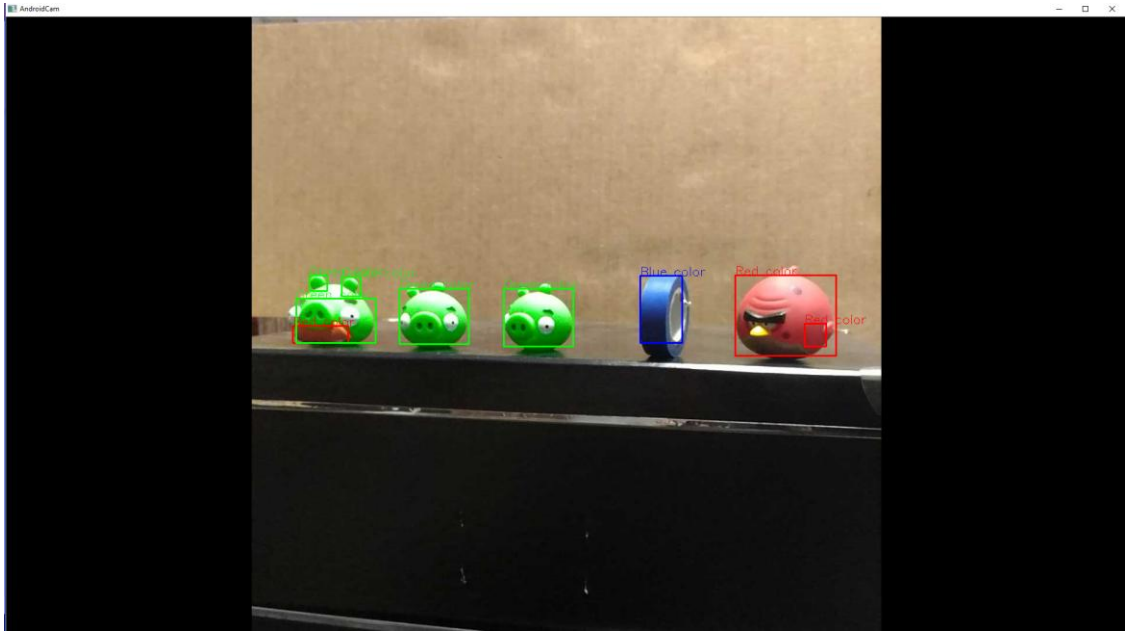
UNITY SETUP



We utilized Unity to tele-operate the robot. We imported the virtual representation of our robot into Unity software. The attached scripts enable control of each of the servo motors via sliders which represent their input angles.

PURDUE UNIVERSITY

PYTHON



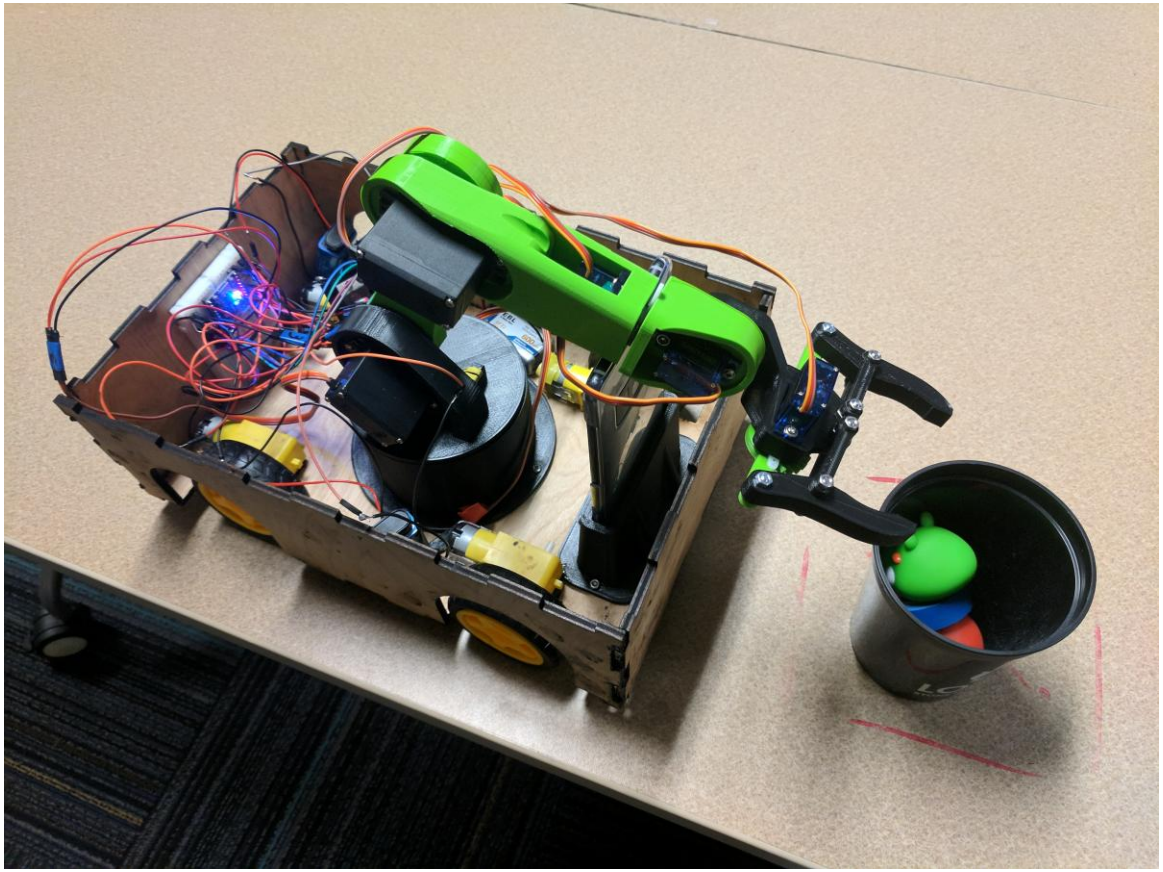
We utilized openCV to livestream from the phone camera. From the livestream, our code used masking and morphological operations to create bounding boxes around objects' colors. Our code can detect: red, green, blue, purple.

PURDUE UNIVERSITY

OUR PHYSICAL SETUP

We placed our targets in view of the camera of our robot. The livestream video enables our code to detect each our “Angry Birds”, then we could tele-operate our robot to grab each target and leave it inside the cup placed to its left.

FINAL RESULTS



Angry Birds are in the cup!

PURDUE UNIVERSITY

Bill of Materials

Product Name	Description	Link	Quantity	Unit price	Sub-Total
HiLetgo ESP-WROOM-32 ESP32 ESP-32S Development Board	Arduino development board that we will use to program the robot	ESP32	1	$10.99	$10.99
AL422 640x480 CMOS With 3M-Bits OV7670 FIFO Camera STM32 Chip Driver Module	Camera module compatible with ESP32 dev board	Arduino Camera	1	$10.58	$10.58
LCD Module Display PCB Adapter 1.8 Inch Serial SPI TFT Power IC SD Socket 128X160 C1 1.8'' 128x160 for arduino DIY KIT	Camera screen for Arduino compatible with ESP32 dev board. We will use this for debugging purposes.	Small Camera Screen	1	$3.73	$3.73
HC-SR04 Ultrasonic Sonar Distance Sensor	Ultrasonic sensor that we will use to detect obstacles around the robot	Ultrasonic Sensor	3	$3.95	$11.85
DC Electric Motor 3-6V Dual Shaft Geared TT Magnetic Gearbox Engine with 4Pcs Plastic Toy Car Tire Wheel	The motors and wheels that will drive our robot	DC Motors	4	$3.42	$13.68
L298N Motor Drive Controller Board Module Dual H Bridge DC Stepper For Arduino	These motor drivers will be used to control the 4 DC motors that drive the robot	Motor Driver	1	$6.89	$6.89
TowerPro SG90 Micro Servo	Micro servos that we will use to position and aim our NERF blasters	Servos	2	$3.65	$7.30
MG996R Metal Gear Torque Digital Servo with Arm Horn	This servo will be used to activate the NERF blaster. It has enough torque to push the trigger.	Continuous Servo	4	$12.95	$12.95
Nerf N-Strike Elite Jolt Blaster	Small NERF Single Shot Blaster that we will use to shoot targets	NERF Blaster	1	$5.69	$5.69
Robot arm/claw	The arm will be designed for 3D printing and will include 2 continuous rotation servos and 1 micro servo.		1	$0	$0
ASUS ZenFone AR Smartphone	Used to send camera livestream to python/OpenCV		1	$0	$0
Grand Total:					**$76.77**

PURDUE UNIVERSITY

CONCLUSION & FUTURE WORK

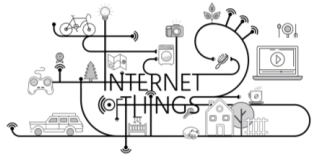
- Utilize OV7670 Arduino Camera Module
  - Raspberry Pi camera also an option!
- Autonomous
- Inverse Kinematics
- Dart Blaster

FUTURE WORK

STORYTELLING & STEM EDUCATION

Computer Programming
(Logic)

Physical Prototyping
(Tangible)



Internet of Things
(Virtual + Physical)

PURDUE UNIVERSITY

THANK YOU!

Questions?

Terrell Glenn (glenn3@purdue.edu)

Ana Villanueva (villana@purdue.edu)