Robotics Outreach Project

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Goal

- To design, fabricate, and assembly an economical, multi-purpose kit for middle schoolers--specifically historically, underrepresented students in STEM.
- To provide an introductory, evidence-based curriculum that both instructor and students can learn and sagely assemble with assistance
- To research materials and service methods to minimize cost without compromising the safety of potential users, and maximize production

Background

- 1 in 3 U.S. adults would like to see a greater emphasis on K-12 STEM education (Pew Research Center)
- The education system neglect students' needs due to poor administration of resources (Darling-Hammond, L.)
- Current educational coding and robotics kits range from: $150-$600+.
- Research shows that students develop stereotype threat as early as the 2nd grade, which creates under-performance in certain contexts, and grows into adolescence.

Design Requirements

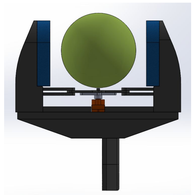
Design Requirements:

- The top chassis should be able to withstand the weight of the arm structure, claw, and tennis ball.
- The robot should be completely controlled by a human operator via Bluetooth
- The robot end-effector should operate in two modes: claw mode or image stitching mode
  - The robotic claw must be able to securely grab and carry a standard tennis ball (6.54–6.86 cm. diameter, 60 g) as well as other objects of similar weight and size.
- The motors should have enough torque to hold the load of the arm and claw structure, and to lift a 60 gram tennis ball
- Train the computer to identify and differentiate a square and a triangle within 10 seconds
- Images taken through robot's camera should be stitched by Matlab code in order to create a panorama

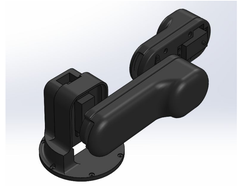
Research/Design Deliverables:

- A Raspberry Pi 4 is used to control the arm and chassis system, while providing Bluetooth functionality
- The robot's end-effector can be changed between a claw or a camera
- Image recognition code that can be further developed to detect motion
- Image stitching code that can be further developed to stitch images into a grid panel
- Printed circuit board shield that reduces space constraints on the chassis

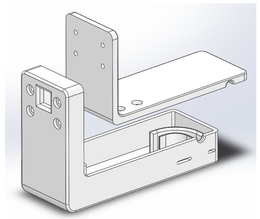
Arm System and End Effectors



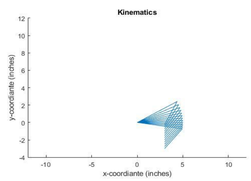
Claw



Arm



Camera Holder



MATLAB Simulations

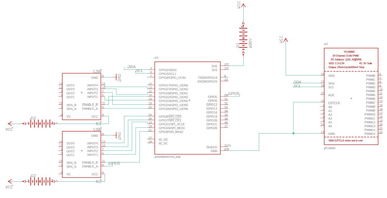
System Details/Purpose

- The articulated arm is designed to be versatile and allow for use of the two end effectors: a claw and camera.
- The parallel claw gripper is designed to pick up tennis balls and other similar-sized objects of varying geometry.

PCB, Code, Image Stitching

Example of the image stitching feature utilizing Matlab that will be used on the robot for the camera attachment

PCB Schematic



- PCB designed in EAGLE that connects raspberry pi to servo and motor drivers that will replace breadboard
- PCB will be programmed to move the claw in accordance to visual cues received by the laptop
- Image stitching allows for the creation of one coherent panorama utilizing large amounts of images captured on a camera

Timeline

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Fall 2020

Milestone 1:
11/2020
3D Print Parts

Claw, arm, camera-holder and updated chassis have been designed.

Milestone 2:
11/2020
Develop Controls and Code For Claw

Have functional code regarding arm/claw movement and claw/image-processing recognition. A prototype of the PCB has been developed

Milestone 3:
12/2020
Bluetooth and Image Processing control of the Robot

Movement of the wheels, arm, and claw can be controlled by the laptop via Bluetooth, camera provides feedback to laptop. An updated PCB schematic has been completed

Winter 2021

Milestone 1:
2/2021
Reevaluate and Finalize Claw Design

Cut the costs of the prototype through resign or using cheaper parts

Milestone 2:
3/2021
Complete and Test All Electrical Parts With Physical Parts

Debug any errors or simplify the code of the robot, have a working PCB prototype, complete 3D-image processing the camera feed, and have a finalized product of moth modes of operation of the robot.

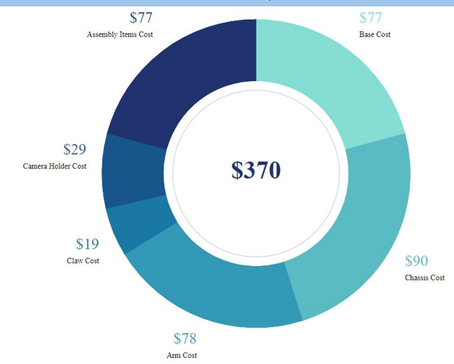
Future Works

Milestone 1:
5/2021
Coordinate with vendors and manufactures to decrease costs

Milestone 2:
6/2021
Contact outreach programs to test learning strategies and kit and redesign

Milestone 3:
6/2021
Present the kit to university staff and public school principals

Cost Analysis



- Does not include shipping, taxes, production costs, or PCB
- Assembly Items are from screws, wires, washers, etc
- Current PCB prototype is $25.00

Current Status & Next Steps

Current Status:

- Fabrication of the prototype has been completed.
- The anthropomorphic arm design with swappable claw and camera mounts on the end effector have been completed.
- Current robot controls are fully determined by the user.

Next Steps:

- Test and iterate the arm, camera mount, and claw designs.
- Modify the controls to be partially or fully autonomous; ie the robot will use infrared sensors to identify objects.
- Finalize the image stitching and recognition code

Team Structure

Project Lead:
Edgar De Jesus Ramos Munoz

Faculty Advisor:
Dr. Faryar Jabbari

Team Members:

Francisco Mayorga
Derrick Mak
Breanna Najera
Carrie Lamb
Sierra Stevens
Robert Bloom
Hadeel Al Baghdadi
Eli Tsao
Alyssa Noma

References

Darling-Hammond, L.
Pew Research Center
Teaching and Learning STEM
The National Research Council - How People Learn II

Website Link

Acknowledgments

This work was made possible under the guidance of Edgar De Jesus Ramos Munoz, teachings of Dr. Natascha Buswell. P.I., and funding and approval of Dr. Faryar Jabbari.
Their aid allowed us to further develop our program so that we can practice technical skills for the workplace and provide learning opportunities in the classroom.

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