CAPSTONE/SENIOR DESIGN EXPERIENCE 2018

ASABE ROBOTICS

PURDUE UNIVERSITY

Agricultural & Biological ENGINEERING

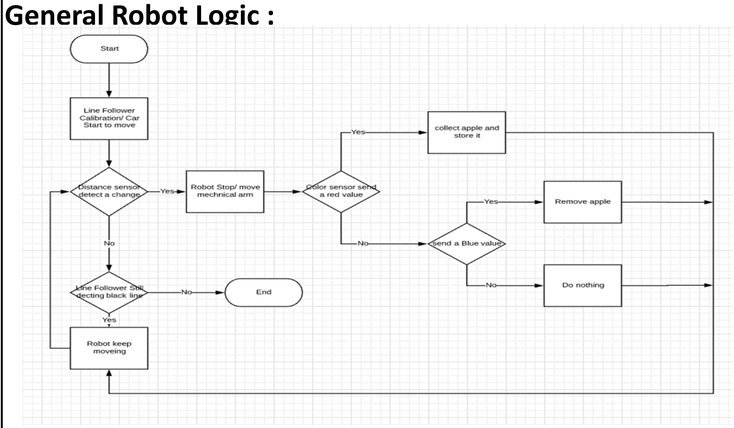
Linghan Shen (AE)

Objective:

ASABE Robotics Student Design Competition is a student design event that was conceived in 2006. This event aims for undergraduate and graduate students to develop skills in robotic systems, electronics and sensing technologies. For this year's competition, teams will be required to design and conduct a robot that will automatically harvest "apples."

This event will help the evolution of the agriculture technology. Some design ideas can be integrated into current designs to improve the designs in actual agriculture fields. Meanwhile, the event is a good practice for students to enhance their engineering skills as well as their knowledge in electronics.

General Robot Logic :



Costs:

Material	Quantity Need	Price ($)	Cost ($)
Raspberry Pi 3 Kit	1	64.99	64.99
Bread Board	1	9.77	9.77
Easy Driver	4	5.98	23.92
Arduino Cable Kit	3	6.98	20.94
Electrical Tape	1	3.98	3.98
Markers Pack	1	3.66	3.66
Clamp Claw Robot Kit	1	56.99	56.99
Ultrasonic Distance Sensor Pack	2	8.99	17.98
RGB Color Sensor	2	12.95	25.90
Wheels	4	5.99	23.96
Shipping Fee	1	30.00	30.00
Manufacture Fee	1	50.00	50.00
Total cost			332.06

Problem Statement & Background

- July 29– August 1 , 2018 COBO CENTER | DETROIT , MICHIGAN
- This year's competition is to design a fully automatic robot to simulating an "apple harvesting" process
- Three types of Ping-Pong ball represent apples in different states:
  - Red : mature apples and ready for harvesting
  - Blue: rotten/diseased apples which should be removed
  - Green: immature apples which should be skipped
- Apples are randomly distributed on a fixed height on the board
- Competition board:

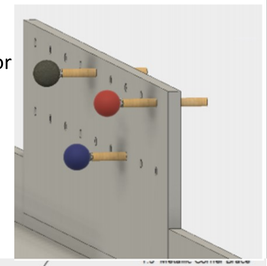
8 x 8 foot piece of plywood

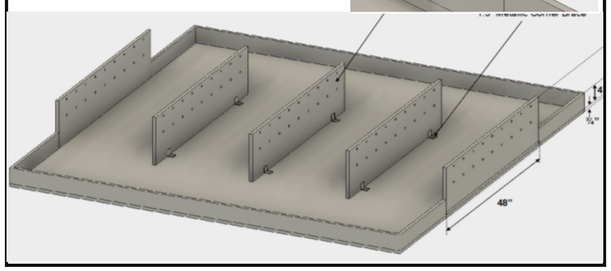
4" wall surrounds the entire board

Five 12" vertical wall with apples attached on a fixed height(7")

A total of 24 balls on the wall, 8 for each color

A black line will be incorporated into the field to aid with navigation





Final Design:

Mechanical Claw :

. Collecting & transporting apples
. Attached with a rotational base which allows it to rotate 180 degree
. Color sensor mounted on the front to identify types of apple

QTR Sensor:

. Line following
. Integrated with PID function to mix the robot on the line

Distance sensor:

. Detecting apples
. Route fixing

Color Sensor:

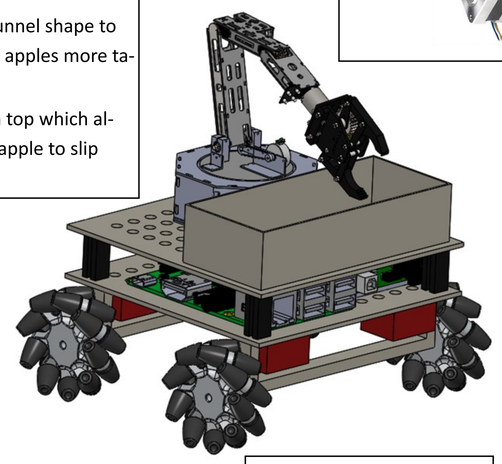
. Return RGB data
. Determine apple types

Microcontroller:

. Arduino + Raspberry Pi
. Selected for plenty analog and digital ports
. Have a relatively high respond speed

Storage box:

. Inverse funnel shape to make the apples more table
. A hole on top which allows the apple to slip through



Power supply:

. Main power is from a 12V Battery for four stepper motor
. Using a voltage converter to change it to 7.2V for Raspberry Pi and Arduino

Bipolar Stepper Motor :

. Controls for wheels
. High precision compared with DC motor
. - 40 mm motor
  - 200 steps per revolution

Mecanum Wheel

. 4 x60 mm diameter
. Enables motions in all directions

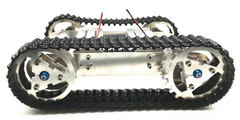
Alternative Solutions:

Magnetic Arm:

. Easier to grab balls using Magnetic force
. Unrealistic compared with Using a mechanical arm
. Much more expensive

Crawler Belt:

. Better flotation
. More stable on rough surfaces
. More expensive



Both theses options have at least one major downfall. Some pf them are too expensive for a robot. Other options were too large to fit within the robot. The mechanical arm is simple and closer to the real-time applications.

Impact & Sustainability :

. The competition is based on the real harvesting process of apples
. The execution logic on the robot is similar to the real field. The logic used here could be applied to real –time application
. It is possible that one of the innovative solutions from the competition can be used in the industrial field

Sponsor:
Roger Tormoehlen

Technical Advisor:
Robert Stwalley

Instructors:
Robert Stwalley

PURDUE AGRICULTURE
PURDUE UNIVERSITY

PURDUE ENGINEERING
Think impact.