PingPongBot

An Autonomous Robot
Set Your Hands Free
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Team

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Project Idea

- An assembled functioning system that locates ping-pong balls, figures its path of collecting them, brings them back to a initialized spot for people to receive.

Background

Background-Fields

Problem Statement

- For table tennis lovers or athletes, they always practice their skills with hundreds of balls on daily bases. It's always a heavy task to pick up the balls all over the place manually and place them in baskets manually. Many coaches and athletes developed their own little tools like, but the pick-up process still requires lots of time and involves running around handling tools with long poles. So, we decided to design a little robot with the ability to perform this process without human monitoring.

Preliminary System Specifications

- System shall start and finish at its "base"
- System shall be triggered remotely, for example by a click of the "On" button from a remote control, or through a phone app
- System shall detect, locate, collect a ball and move to the next target autonomously
- System shall have the ability to count the number of balls that have been picked up until it reaches the maximum capacity of the container
- System shall automatically stop the picking process and drive back to the base, when the built-in container is full or the whole field is checked
- System shall have a removable bucket which can hold up to dozens of balls
- System shall be able to run the whole place(6m*6m) and pick up dozens of balls(reach its capacity) within 10-15 minutes
- Ideally the battery should last for around 3~5 hours

Testing Plan

- System shall start and finish at its "base"
- Demonstrate that the robot will be placed at its base at the beginning, and test if it will autonomously run back to its base at the end.

- System shall be triggered remotely, for example by a click of the "On" button from a remote control, or through a phone app

- Demonstrate that the system can be turned on remotely.

- System shall detect, locate, collect a ball and move to the next target autonomously

- Test if the system can perform its picking progress without human inspection once turned on.

- System shall have the ability to count the number of balls that have been picked up until it reaches the maximum capacity of the container

- System shall have indicators which tell people if the capacity is filled or not

- Demonstrate the change of the indicators before and after the system has reached its capacity

- System shall automatically stop the picking process and drive back to the base, when the built-in container is full or the whole field is checked

- Test if the robot will turn to its base aftering finishing the pick-up process.

- System shall have a removable bucket which can hold up to dozens of balls

- Demonstrate the use of the removable bucket filled with balls.

- System shall be able to run the whole place(8m*5m) and pick up dozens of balls(reach its capacity) within 10-15 minutes

- Test if the system can run the whole place and pick up all the balls within 10-15 minutes.

- Ideally the battery should last for around 3~5 hours

- Test how long the battery will last if we keep it on and running trails.

Competing Solutions: Pong-Pal Ball Tube

- Aim at the ping-pong balls manually
- The special-angled end can retrieve balls at hard-to-reach places
- Hold up to 20 ping-pong balls
- $24

https://www.newgy.com/collections/paddles/products/pong-pal?newgy.com&gclid=Cj0KCQjwtMCKBhDAARIsAG-2Eu8gOrrAkudC2O6HXPnC3adIQv5To7dRFfM3lZManlfcusI0QmceUkIaArKcEALw_wcB

Competing Solution: Ping-pong Pick-up Net

- Find ping-pong balls manually.
- The net capacity is 100 balls.
- Need a pivot to scoop the balls.
- $23

https://www.amazon.com/JOOLA-Telescoping-Pickup-Black-22721/dp/B08BL12K1N

Competing Solutions: Ping-pong Catch Net

- Attach to the end of the table
- Stop and gather the coming balls
- balls may bounce to the outside of the net
- requires installing constantly, could be troublesome and time-consuming
- $39

Relevant Solutions: Tomohopper Ball Mower

- Find tennis balls manually
- The 42 inches gathering arms allows picking up balls against fences and walls easily
- Pick up balls in less than 2 minutes
- No electrical part
- Pick the balls by pushing the draw-bar
- $350

https://oncourtoffcourt.com/tomohopper-for-tennis-pickleball/?sku=CETHG&gclid=Cj0KCQjw[%E2%80%A6]Ga9iS6hsIJREGEAWZacJzsxIk6GXLa_NFT95Tufp R7bmRoaAkKYEALw_wcB

Relevant Solutions: Tennibot

- Detects tennis balls using machine learning
- Place Tennis Station on the net post for precise location
- Can be controlled and customized by smartphone
- Autonomously picking up tennis balls
- $ 950($850 on sale)

https://www.kickstarter.com/projects/770435035/tennibot-the-worlds-first-robotic-tennis-ball-coll?lang=zh

Comparison

Yellow block for tennis balls

	Manually	Ball Tube	pick-up net	catch net	Tomohopper ball mower	Tennibot	Our solution
User Friendliness	🟩	🟩	🟩	🟩	🟧	🟧	🟩
Portable	🟩	🟩	🟩	🟥	🟥	🟧	🟩
Convenience	🟥	🟩	🟥	🟩	🟧	🟧	🟩
Time consuming	🟥	🟥	🟥	🟥	🟧	🟧	🟩
Ball Capacity	🟥	🟥	🟩	🟩	🟧	🟧	🟩
Autonomous	🟥	🟥	🟥	🟥	🟥	🟧	🟩

Our Solution

- Make practice session easier, remotely start our PingPongBot
- There is no need of human inspection
- Take a break, get rehydration, get more advice from your coach
- It has a self-check mechanism
- There is no need for the assist arm
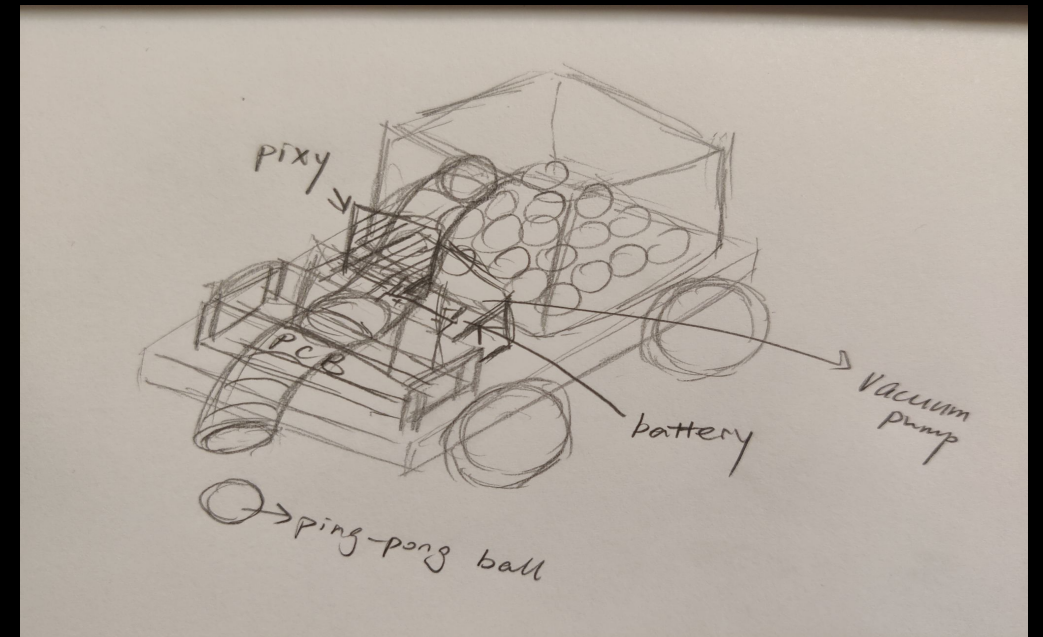
# Pixy2: Vision Sensor & Machine Learning

- Pixy2 detects lines, intersections and small barcodes, intended for line-following robots
- Improved framerate – 60 frames-per-second
- Tracking algorithms have been added to color-based object detection
- Improved and simplified libraries for Arduino, LEGO Mindstorms EV3, Raspberry Pi and other controllers
- Pixy2 processes images from the image sensor and only sends the useful information to your microcontroller
- The most common type of machine learning is to learn the mapping Y=f(X) to make predictions of Y for new X.


Pixy2 Camera

Hardwares:
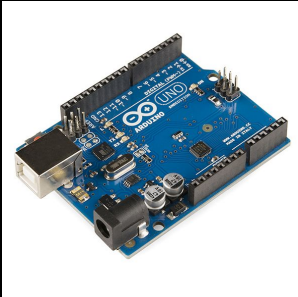
Arduino Board	Bottom Wheels With Frame	Vacuum Pump	Vision Sensor	Plastic Tube

Distance Sensor	Motors	24V DC Battery	LEDs	OLED display. 3 lines of text
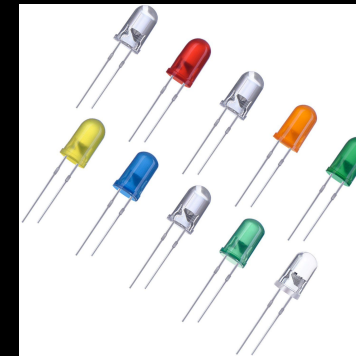
Design Diagram
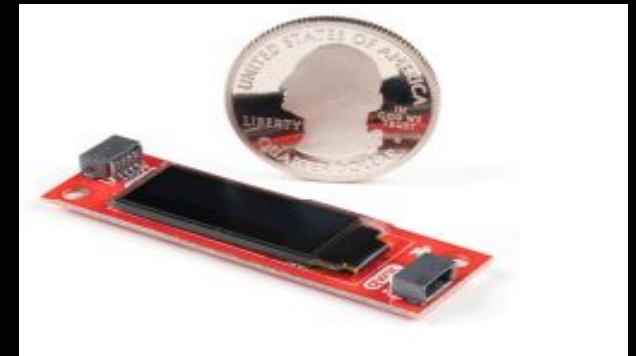
Software Diagram
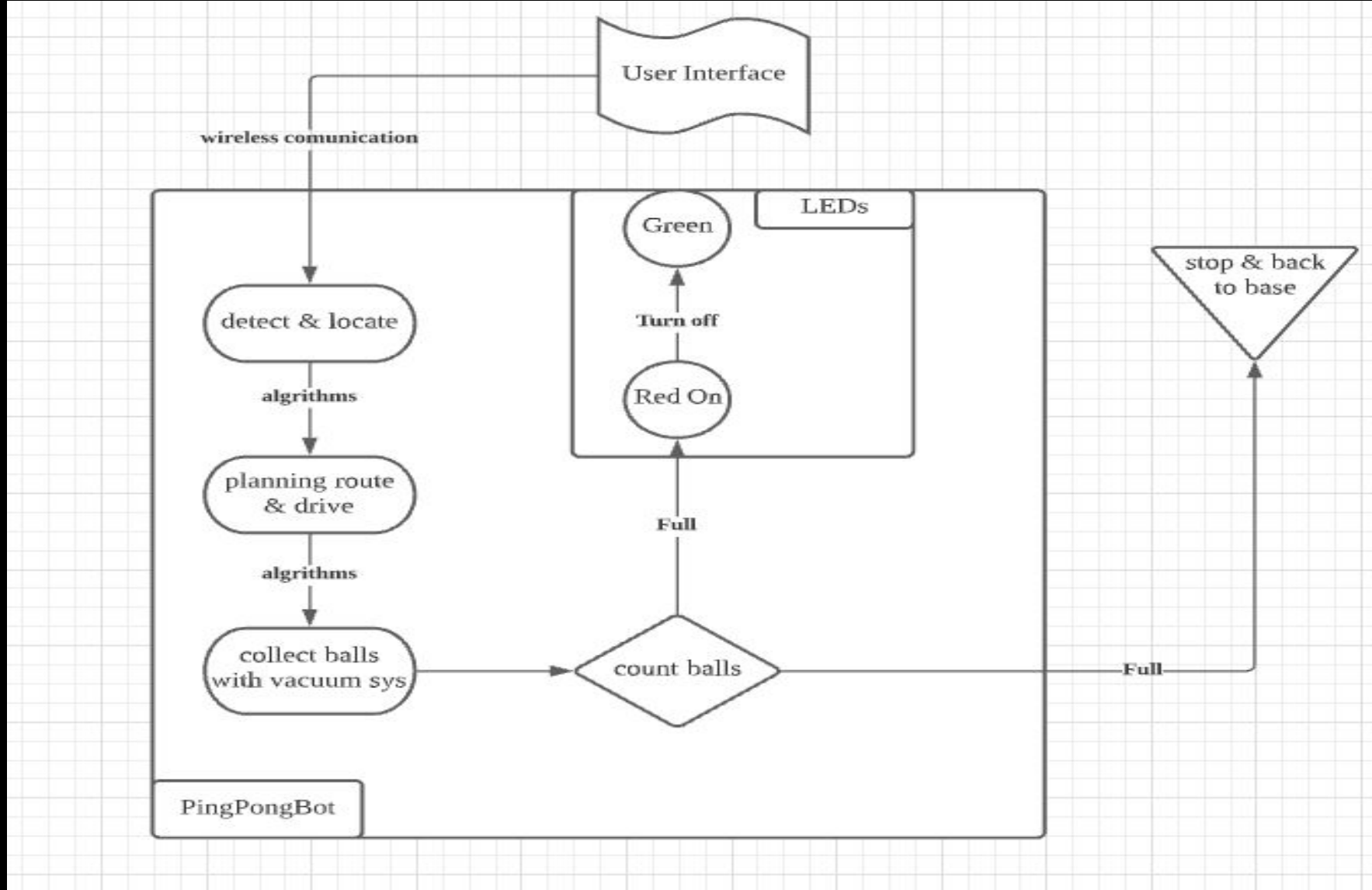
Cost Estimate

Item	Predicted Cost
Ping-pong Balls	$15
Vacuum Pump	$50
Pixy2	$60
Early PCB Revisions	$110
Final PCB Revisions	$90
24V Battery	$60
Distance Sensor	$50
Motor	$10~15
Robot Components (Wheels, Removable Basket, Plastic Tube)	$50
Total	$500

MDR Deliverables

- System shall collect dozens of ping-pong balls randomly placed within a 6m*6m field.

- Simulate circumstances: high density of balls or only a few placed far away.
- System shall be initialized at the "base"
  - Turned on by a remote controller or
  - Autonomously turn on vacuum system before reaching the ball and stays on until the end of the collecting process.
- System shall drive itself back to base if the built-in container is full or the whole field is checked.
- Finish one round of collection and return to base within 10-15 minutes.
- Demonstrate how to simply pick-up the removable bucket and use the balls.

Team Responsibilities

Xumeng
Set and Test Distance sensor
Main Board Prototype
Main Board Verification
Organize and Enclosure
Test Collecting & Basket Capacity
Position Check Algorithms
Digital Counter Set-up
System Communication
PCB Lead

Huiyu
Set and Test Vacuum System
Set and Test Distance sensor
Set and Test Vision Sensor
Main Board Verification
Wireless Turn-on
Machine Learning Training
Position Check Algorithms
Search Algorithms
Digital Counter Set-up
System Communication
Budget Lead

Mingrun
Set and Test Vacuum System
Set and Test Vision Sensor
Main Board Prototype
Organize and Enclosure
Test Collecting & Basket Capacity
Wireless Turn-on
Machine Learning Training
Search Algorithms
Digital Counter Set-up
System Communication
Team Coordinator

Gantt Chart

Task Name	Start Date	End Date	Team Member(s)
Hardware			
Set and Test Vacuum System	10/11	10/15	Tao & Zhang
Set and Test Distance sensor	10/18	10/29	Tao & Pan
Set and Test Vision Sensor	10/25	11/5	Tao & Zhang
Main Board Prototype	10/4	10/29	Pan & Zhang
Main Board Verification	11/1	11/12	Tao & Pan
Organize and Enclosure	10/4	10/15	Pan & Zhang
Test Collecting & Basket Capacity	11/15	11/26	Pan & Zhang
Software			
Wireless Turn-on	10/18	10/22	Tao & Zhang
Machine Learning Training	10/25	11/12	Tao & Zhang
Position Check Algorithms	10/25	11/12	Tao & Pan
Search Algorithms	10/25	11/12	Tao & Zhang
Digital Counter Set-up	11/8	11/19	Pan & Zhang
System Communication	11/8	11/26	Pan & Zhang

Week 6 (Post PDR) | Week 7 | Week 8 | Week 9 (Check-in 3) | Week 10 | Week 11 | Week 12 | Week 13 (MDR)

10/4/2021-10/8/2021 | 10/11/2021-10/15/2021 | 10/18/2021-10/22/2021 | 10/25/2021-10/29/2021 | 11/1/2021-11/5/2021 | 11/8/2021-11/12/2021 | 11/15/2021-11/19/2021 | 11/22/2021-11/26/2021

Q&A

Thank You!