Mechatronics: Group Project Report

ECOR1044 C: Mechatronics

Group 1044-PC2-12

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Group Member 3: 101242223 Shenhao Gong

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INITIAL RASPBERRY PI PROJECT IDEAS

NO.	Group Member Name	Raspberry Pi Project Ideas	Brief Description of Project Ideas
1.	Shenhao Gong	1. Automatic window shades–motor，H-bridge	After receiving the command, operate the motor to open or close the curtain.
		2.Shared Fish Tank-camera, motor	Automatic feeding of fish to the fish tank, by putting food in one motor, everytime the motor spins, drop a little food into the tank.
		3.Remote control toy car-signal receiver,motor	2 motors as 2 tires of the toy-car. By controlling the steering of the car wheels, to control Forward, backward, and turn.
2.	Uchenna Obikwelu	1.Person-Detecting Doorbell	Using a Raspberry Pi, power cable, WIFI etc., it rings the bell any time a person is in front of your door. It also detects and displays activities going on in its surroundings and displays the information on an indoor monitor.
		2.Smart Mirror	Using an old TV or monitor, a mirror, framing materials and a Raspberry Pi a smart mirror could be made. The mirror tells the weather, reads the news, and displays a calendar, at the same time, a functional mirror.
		3.Garbage Thrasher	Using a Raspberry Pi, an Arduino nano, camera, servo and gear motor, the robot roams around indoors when turned on, then it detects little garbage such as cans and trashes it into its bin. It changes direction when it runs into large obstacles such as walls, tables etc.

3	Nikolas Sante	1.Baker/chef	Movable arms with grippers, LCD, LED, Temperature probe, Heating mechanism, Level sensor, DC Motor, Buzzer Takes a recipe as input, provided that all the ingredients are either laid out or measured beforehand, and executes the recipe by moving arms in correct motions. Depending on either baking or cooking, will measure either consistency, level of rise or internal temperature then removes food from the element when done.
		2. Water quality testing and self-filter	LED, LCD, Water quality tester, Filter, Valve, Level sensor Takes a large sample of water, tests the quality, and indicates level of pollution and safeness to drink. Depending on results it'll either pour out water as is, or it'll filter it out. Can fill up water bottles using the level sensor.
		3. Automatic cooler/heater / AC unit / thermostat	Temperature probe, LED, LCD, Movement/heat sensor Monitors whether someone is in the room and adjusts the temperature to whatever the desired temp is, maintains temperature until manual override or no movement/heat signal detected. Alternate use is maintaining temperature when no movement/heat is detected.

Decision of Best Project Ideas

The main decision factors were the potential cost, complexity of designing and implementing the device, and usefulness. Without having done any prior research into our ideas, we estimated which project would have the lowest cost, which would likely make it easier to design and implement. Also, having an idea of what each idea is supposed to do we could guess which ideas would be complicated and which ones would be simple. Our main criteria however is how useful it was. Each of us had a mix of useful and/or practical ideas and fun and/or less practical ideas. Although we might've enjoyed coming up with the more "fun" ideas, we opted to go with practicality. With all this in mind, we all decided and chose the idea that would be the most practical while also not being overly complicated or more advanced than we were capable of, which in turn likely meant the cost would be lower.

The shared fish-tank project, while not being necessarily practical, was certainly simple to implement as well as cost being low. It could connect to an online server and allow people from around the world to feed fish in the shared fish tank. In this case the interest in the idea outweighed the other ideas and other criteria, but still kept largely to the criteria. The person-detecting doorbell was a very useful idea compared to the other ideas. It could monitor the front-door and automatically ring the doorbell for them. As far as components and cost, it's very simple and cost-efficient and only

requires a few components to function. The automatic thermostat was the least complex of the three ideas but was the most complex of all the other project ideas as it required more components. Costwise, it's relatively inexpensive compared to market models but still costly. It's very useful for controlling the temperature of a room automatically.

DESCRIPTION OF SELECTED PROJECT IDEAS

1. **Uchenna** : **Person-Detecting Doorbell**

Out of the three initial ideas this was chosen to be the most useful and practical.

Advantages	**Disadvantages**
Easy installation	Potential theft of device
Promotes home security	Software vulnerable to hacking
Could be used anywhere around the home e.g the garage, backyard etc.	Could give false signals or no signals at all.
It is multi-purpose.(e.g could be use else were apart from the home)	Requires the use of resources like the internet.

Materials and Cost

1.Raspberry Pi 4 Model B/4GB : **$72.95** [8]

2.Mega Phones / speakers with a 3.5mm input and a 3.55 cable: **$32.99** [9]

3.Monitor with HDMI and power cables: (Raspberry Pi 7" Touchscreen HDMI Monitor): **$144.64** [10]

4.MicroSD cards, one for the Raspberry Pi, another for the camera: Silicon Power 32GB 3D NAND High Speed MicroSD Card with Adapter (SP032GBSTHBU1V1GJA): $8.99 each, **$ 17.98 total** [11]

5.WYZE Cam Pan v2 1080p Pan/Tilt/Zoom Indoor Baby Monitoring Camera with Colour Night Vision, Motion and Sound Detection, Home Security Camera Works with Alexa & Google Assistant : **$79.98** [13]

TOTAL ESTIMATED COST: $ 348.54

DESIGN PROCESS

The first thing that would be done is to set up the Raspberry Pi. This includes connecting the raspberry pi to a monitor and keyboard basically. This would take about **2 hours.**

Then the Python libraries and other dependencies for the project to run will be obtained. In this case the machine learning library to detect people is needed. This would be simply done by installing git and downloading the code from GitHub. The repository would then be copied from GitHub.com to the computer. By doing this we have all the codes and audio files needed for this project to run. [12]

The “make install” command would then be used to install all the project dependencies. This script will take care of installing lower level dependencies, as well as the Python libraries you need for the project to run[12].

This code would then be refactored to our own liking. Another option would be to write the code by ourselves which would be more tasking and time consuming, so preferably the code would be sourced from git . This would take about **10 hours of work.**

Next the 3.5mm audio output would be set to be the default audio output in the Raspberry Pi configuration. The speakers would then be plugged into the Raspberry Pi using a 3.5mm cable and tested by playing the selected doorbell audio file [12]. The monitor to be used to display what the camera captures would also be connected to the Raspberry Pi and tested. The monitor and speaker would be mounted on the desired location. This would take about **4 hours of work.**

Next, to connect to the camera and set it up the custom RTSP firmware would be flashed to the Wyze camera then the camera would be set up above the front door or the desired location. This would take about **6 hours of work.**

Now, the program could be run on the pi to start the doorbell system. When a person is detected in the frame, the doorbell will ring continuously with a set delay in between rings until the person leaves the frame. Extra **3 hours** for testing and clean-up.

Approximate assembling time: 26 hours of work.

2.Nikolas - Automatic AC

Out of the initial ideas, this idea was deemed the most practical while being simple enough to create.

Advantages	**Disadvantages**
Compared to market thermostats, is much cheaper	Could be more complicated than installing a smart-thermostat
Not overly expensive, not many components	Potentially dangerous to test
Simple to install	Short circuit can cause fire
Short Construction time with modern thermostats/AC systems.	May not be possible/very complicated with some furnaces
Code has been used before, simple sourcing of code	Can be slow to activate/turn on
Large temperature range	Could be annoying having to change desired temperature
Very practical, mainly hands-free	Larger space requires more components

Materials & Cost

All prices were sourced from RobotShop or Home Depot (wires) and components used were based on open source. [6]

Raspberry Pi and basic components/kit –70.00$

Temperature sensor – 15.00$

Breadboard – 15.00$

Thermostat wire – 30.00$

GPIO pins – 11.00$

LCD touchscreen – 50.00$

Solder and iron – 22.00$

Power supply and wires–50.00$

LED – 20.00$

Motion sensor (if using) – 35.00$

Estimated cost: 400$

Design Process

Approximate schedule for the whole project could be up to 2 days of work. If code is sourced, the process will be quicker. Configuring the Raspberry Pi to the thermostat and/or furnace could be very complicated if it isn't up to date. Modern thermostats can easily be configured as it is mainly electronic already. Raspberry Pi connects to the furnace and/or thermostat using thermostat wire. Can control the temperature of various rooms from one location if enough temperature sensors are implemented (only one room is being controlled in this project.) First day would entail building the Raspberry Pi and thermostat control, followed by coding. Firstly, the Pi and pins would need to be soldered to a breadboard along with any wires connected to it. Then the sensors would have to be positioned and connected to the Pi via thermostat wire. Finally the original system would have to be rewired to connect to the Pi. The next day would entail coding and testing. The coding will likely take the bulk of the schedule due to various factors and bugs that could arise. A third day would be needed in order to fix all the issues and perfect the system in case there are large bugs and errors.

3.Shenhao- Shared fish tank

Advantages	**Disadvantages**
Design for recreation	Small audience
Very low cost	One tank has a limited number of feedings per day
Have a suitable target group, especially during the pandemic	Can't warn, no more fish food
Once put fish food can be used for a long time	

COST

Components and their prices:

Raspberry pi – 200$ (more expensive now because of the lack of the chips, usually 70$).[14]

Raspberry pi motor–30$ [15]

Raspberry pi camera– 30$ [16]

GPIO pins–20$ [17]

Total estimated price: 270$

DESIGN PROCESS

It takes about 4 days to make and test this device.

Connect all hardware together: 1 hour

Set up the environment for raspberry pi: 4 hours

Design the program of camera and motor: 8 hours

Test the function:2hours

Test the final product and make it keep running for: 2 days.

For the final product, First, we need to connect the wide-angle camera to the motherboard and stick it to the surface of the fish tank to be able to shoot into the tank. The camera will automatically turn on when someone connects to the raspberry pi through the network. The fish food will be placed in a box that is connected to the motor. When the motor is turned, some of the fish food will fall into a small slot in the motor, and when the motor is turned again, the fish food will fall into the tank, and the fish food in the box will fall into the slot on the other side of the motor, and so on and so forth.

To design this product, We need to connect the camera to the gpio port in order to automatically power up the camera pin when there is a network connection, the motor also needs to be connected to the gpio and preset to be able to rotate half a turn. When the user gives a command, the motor can rotate and cast food. And the preset motor should be used a certain number of times within a certain period of time, for the health of the fish.

WEIGHTED TRADE STUDY

Criteria for Weighted Trade Study:

- Societal impact/practicality (20%)
    - Not the largest criteria but is a main focus since we wanted projects that will be useful and therefore have a greater societal impact. Ideas that are more ‘fun’ than practical will score less than those that are more practical than fun.
- Cost (30%)
    - The biggest factor when trying to come up with ideas. The cheaper the idea is the higher its score will be. Cost isn’t necessarily connected to simplicity but normally is.
- Feasibility / ability to create (30%)
    - Along with cost is the biggest criteria. Goes along somewhat with simplicity in that a simple idea is likely more feasible. Higher the feasibility the higher the score.
- Simplicity (10%)
    - Not the most important criteria when deciding since the main focus is on practicality and cost. A simple project will likely have a lower cost and higher feasibility. A simple project will score higher than a complex project.
- Safety (10%)

- Isn’t the main focus of our ideas since we assumed that we should use safe projects. Isn’t related to other criteria, but is important to consider. A safer project will have a higher score than one that is less so.

	Doorbell	**AC**	**Fish Tank**
Societal impact /practicality(20%)	10/10 9/10	10/10 10/10	3/10 6/10
Cost (30%)	7/10 6/10	8/10 7/10	7/10 8/10
Feasibility / ability to create (30%)	8/10 7/10	8/10 8/10	8/10 8/10
Simplicity (10%)	10/10 8/10	7/10 7/10	10/10 10/10
Safety (10%)	10/10 10/10	9/10 10/10	9/10 10/10
Scores	**8/10**	**8.3/10**	**7.5/10**

SUMMARY

When designing a product,we should first consider its market, Is there an audience for the product ? Likewise, at this stage, we have to consider its feasibility, the production should not be too complicated and the cost should not be too high. Further,we need to consider many details. Product security, product human-computer interaction experience, safety, etc, need to be taken into account. We first brainstormed potential project ideas on our own, giving a general idea as to what they would do and how they would work. We then compared our ideas and each chose our best idea to do further research on. The next step took considerable time as we were required to come up with a cost analysis and a rough project schedule, and an overall design process. Having had little experience with Raspberry Pi, we couldn’t go into extraordinary detail and so had to give our best judgement as to necessary components. The costs of some components were also surprising as some elements were expensive while others were relatively cheap. Finally we conducted a weighted trade study where we judged each other's ideas based on five criteria, including cost and societal impact. This led to us choosing the automatic AC as our main project idea.

Overall, this project gave us an insight on the countless applications of the Raspberry Pi. Through our research we got to understand the integration of software and hardware. We also learnt the importance of task and time allocation in Project designing . This allows us to stay on track and complete the project easily.

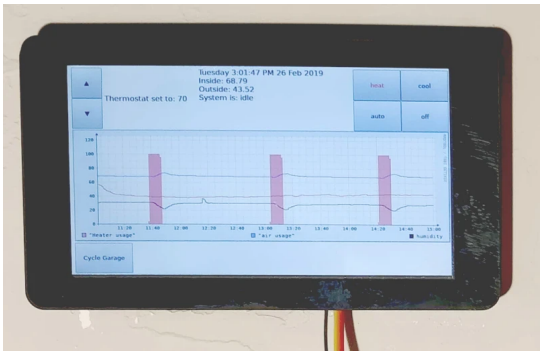
APPENDIX A - REFERENCE IMAGES

Baker/chef

[4]

Water quality testing and self-filter

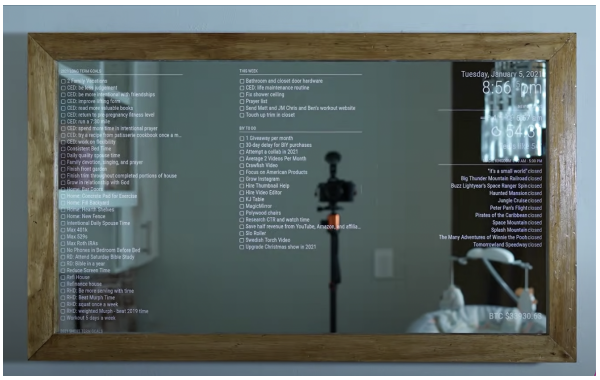
Automatic cooler/heater / AC unit / thermostat



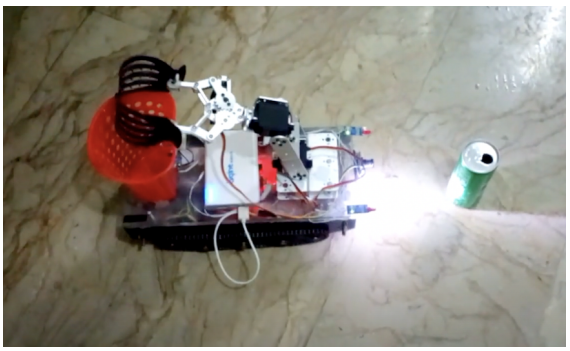
[5]

Person-Detecting Doorbell

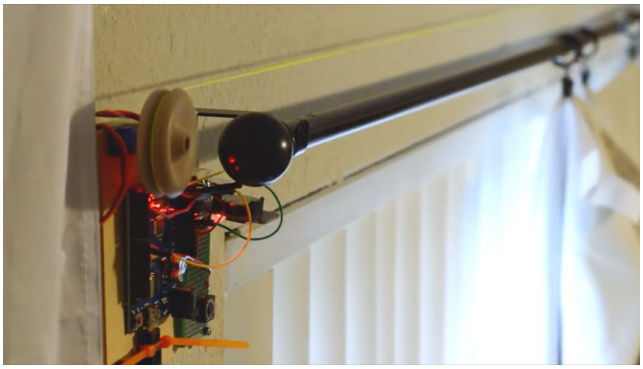
Smart Mirror



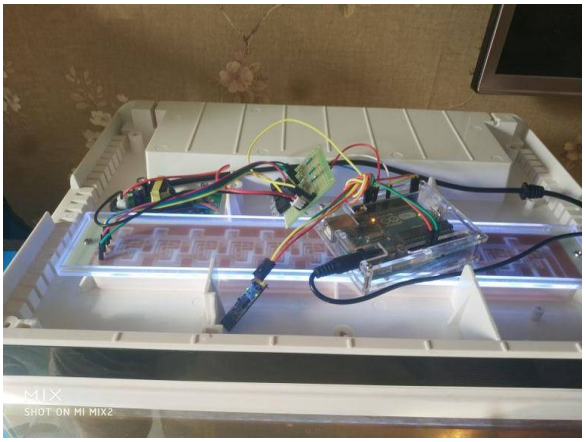
Garbage Thrasher



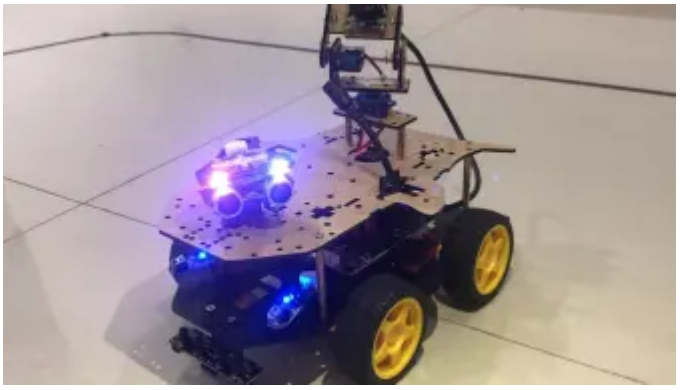
Automatic window shades



Shared Fish Tank



Remote control toy car-signal receiver



APPENDIX B- SIGNED GROUP CONTRACT

TEAM PROCEDURES

1. Days, times, and method (e.g. Zoom, etc.) for regular **team meetings:**
   a. Wednesdays- 11.30am to 2.25am (Discord)
   b. Sunday- 1.00pm to 3.00pm (Discord)

2. Preferred method of **communication** in order to discuss the project and to inform each other of team meetings, announcement, updates, reminders, problems:

   a. Discord
   b. E-mail

PERSONAL ACCOUNTABILITY

1. Expected individual attendance, punctuality, and participation at all team meetings:
   - If the group has decided to meet on a particular day and time, all members should show up and if they are late or won't be able to attend , they should inform the other members as soon as possible.

2. Expected level of responsibility for fulfilling team assignments, timelines, and deadlines:
   - If a team member is not able to achieve their task in the allotted time, then they should ask for help immediately from the team.
   - It is mandatory for every team member to meet their respective deadlines and reach out to both other group members or any other aid e.g TAs if experiencing difficulties completing their task.

3. Expected level of communication with other team members:
   - Be honest and trust the team, if you have made any mistake or are facing difficulties to reach your goal.
   - Constant communication with other members helps the team to bond and understand each other well, which will be beneficial to complete and make the project better.

4. Expected level of commitment to team decisions and tasks:
   - All team members are expected to attend every meeting and contribute to all Decision making and task completion.

MEETINGS

1	FRIDAY APRIL 1

2	Wednesday April 6
3	Thursday April 7
4.	Saturday April 9

Deadlines

1.	1/04/22	SUBMISSION OF THREE PROJECT IDEAS
2.	06/04/22	RESEARCH INDIVIDUAL PROJECTS
3.	08/04/22	COMPLETE PROJECT REPORT TASKS
4.	10/04/22	COMPLETE GROUP PROJECT PRESENTATION
5.	11/04/22	SUBMISSION OF ALL THE PROJECT DELIVERABLES

Confirmation

By signing this form, you are confirming that you participated in the preparation of the team contract and that you will abide by its terms; specifically:

a) *I participated in formulating the standards, roles, and procedures as stated in this contract.*
b) *I understand that I am obligated to abide by these terms and conditions.*
c) *I understand that if I do not abide by these terms and conditions, I will suffer the consequences as stated in this contract.*

Date: 03/28/2022

Bright Space Team Identifier	Group 1044-PC2-1		
Optional Fun Team Name			
Team Members	Student Number	First Name	Last Name
1 (Dept. Leader)	101241887	Uchenna	Obikwelu
2	101244556	Nikolas	Sante
3	101242223	Shenhao	Gong

References

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