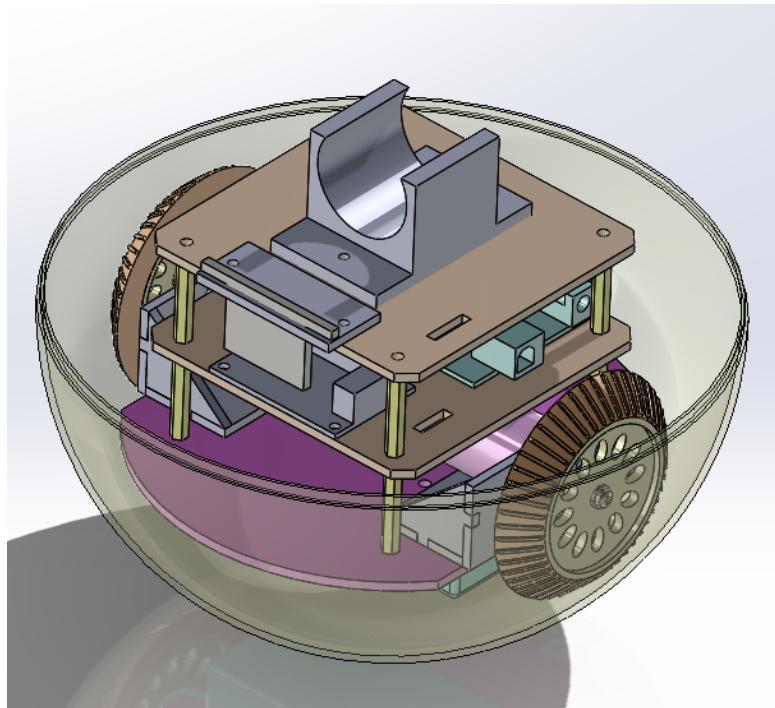


**IC3103 Integrated Project
AY 22/23 Semester 2**



PETRONUS

Your Pets' Patronus

Group 12

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1. Executive Summary

Petronus is a spherical robot designed as a pet sitter that takes advantage of the latest trends in artificial intelligence and the Internet of Things. The robot provides pet owners with the ability to monitor and play with their pets while improving the quality of their pets' lives.

With the growing demand of innovative solutions for pet care, our company was founded in 2022 with a goal to provide practical solutions for pet owners to provide better care for their pets, consequently improving their quality of life. Through intensive research, Petronus was developed with a purpose to serve as a pet sitter and playmate for pets.

Several electronic components are used in our product. A unit of Arduino Uno is used to serve as the robot's main microcontroller. It is used to connect and control all the other electronic components used in our robot. Other electronic components used include, but not limited to, an HC08 Bluetooth module, DC motors, LED lights, a camera and a speaker. LED lights have been specially designed to correspond to each mode of movement. All instructions are coded in Arduino IDE.

By considering the total production cost of our product and looking into the cost of competitors' products, Petronus is priced at HK\$1,199. With the design and unique features we have, we will still be able to remain competitive in the market. To promote Petronus, various advertising methods will be utilized, including pet events, social media marketing, influencer marketing and referral programs.

The presence of Petronus will bring several advantages to potential consumers. Possible benefits include:

- 1) Provide a solution for owners who can't physically be with their pets
- 2) Improve quality of life for pets by providing companionship and entertainment for them
- 3) Enhance the ability of pet owners to monitor their pets
- 4) Act as an alternative to traditional pet toys

This report also covers several other aspects including the detailed design and manufacturing process, marketing strategy, competitor analysis, costing analysis, plan of operation, future plans, etc.

2. Introduction

Petronus is a spherical robot with a purpose of being a pet sitter. The aim of this product is to create a robot-led solution that leverages the latest trends in artificial intelligence (AI) and the Internet of Things (IoT) to care for pets, improve their quality of life, help monitor their daily activities and create a compelling experience. With the use of this robot, pet owners will be able to monitor and play with their pets whenever they want. It will serve as a replacement for traditional pet toys.

Based on the cost-plus pricing strategy, the price of the product is HKD\$1199. To effectively market the Petronus Pet Ball Robot, the company can utilize several strategies, such as attending pet events and trade shows, using social media marketing, working with influencers in the pet industry through influencer marketing, and creating a referral program that motivates customers to recommend the product to others. These strategies can help the company reach its target audience of pet owners and promote the unique qualities and benefits of the product.

3. Mission Statement

Our mission is to provide innovative and practical solutions that improve the quality of life for pets and their owners. We are committed to leveraging the latest trends in Artificial Intelligence (AI) and the Internet of Things (IoT) to provide a range of products that enable pet owners to monitor and care better for their pets.

4. Company History

Our company was founded in 2022 by a team of entrepreneurs with a passion for technology and pets. We saw an opportunity to meet the growing demand of innovative solutions that improve the quality of life for pets and their owners. After extensive research and development, we created Petronus, a unique spherical robot designed to serve as a pet sitter and playmate for pets. Our team continue to innovate and develop new products to meet the needs of pet owners and their furry companions.

5. Business and Industry Profile

The pet industry is a growing and lucrative market. In 2020, the global pet industry is valued at \$237 billion, with Asia Pacific being one of the fastest growing markets. The pet industry is expected to continue to grow, driven by factors such as the humanization of pets, increased pet

ownership, and growing interest in pet health and wellness. the COVID-19 pandemic is also contributing to the growth of the pet industry, with more people adopting pets as a source of companionship during lockdown.

According to online sources, the pet care robot market size is valued at \$1.41 billion in 2021. Some of the major competitors that can be found in the market today are Pebby, Playroll! and Pawly. there is a wide variety of robotic pet sitters available in the market now, leading to a wide price range of \$15-\$159.

A report published by Next Move Strategic Consulting states that the global market for pet care robots generated \$1.41 billion in 2021 and is expected to garner \$3.65 billion by 2030 [1]. As of now, increasing awareness about animal welfare and well-being is driving the growth of the market. Also, robotics is penetrating to address pet health issues due to the development of artificial intelligence. Moreover, many pet owners are increasing their spending on pet care products, complementing the market growth [2]. The market share of robotic pet dogs is expected to increase to USD 914.33 million from 2021 to 2026. However, 5-6 million is a reasonable estimate of the market share given the small market and the number of pet owners in Hong Kong [3].

North America currently holds the major share of the pet care robots market and is expected to drive the market over the forecast period. This is attributed to factors such as increasing population of pet lovers and rising pet expenditure. Moreover, the market growth in the region is further driven by the availability of pet care robots through different distribution channels. However, Asia Pacific is expected to show a steady rise due to increasing adoption of robots in pet care activities such as pet feeding, pet entertainment, and pet cleaning. Moreover, increased digitization coupled with emerging IoT technologies such as automated pet control and automated defense systems are driving the market growth in the region [3].

In Hong Kong, there are approximately 250,000 households (9.4%) with an estimated total of over 405,000 cats and dogs [4]. Petronus targets 30% of pet owners in Hong Kong (75,000), as this 30% have never tried a pet robot or they are not regular customers of other pet robot companies and are therefore more likely to try. These 30% of pet owners are therefore the primary target customers for Petronus. The expected sales volume for Petronus is 75,000 units, and Petronus is targeting one pet robot for each of these 30% of people. Therefore, the expected sales revenue is estimated at \$48,750,000. Therefore, there is a huge market potential for developing pet care robots at this stage.

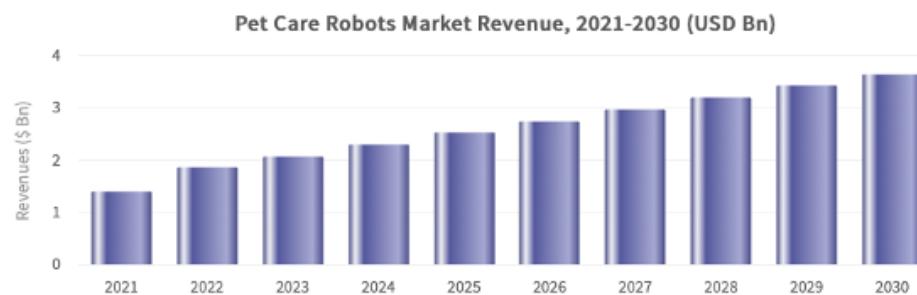


Figure 1: Pet Care Robots Revenue [1]

Our business strategy focuses on leveraging technology to create innovative solutions that improve the quality of life for pets and their owners. We aim to differentiate ourselves in the market by offering unique products that take advantage of the latest trends in Artificial Intelligence (AI) and the Internet of Things (IoT). Our product development process involves extensive research and development to ensure that our products meet the needs of pet owners and their pets.

We plan to market our products through a combination of channels, including pet events and trade shows, social media marketing, influencer marketing and referral programs. We will also focus on building strong partnerships with pet stores and other retailers to ensure that our products are easily accessible to our customers.

Our business strategy also includes continually improving and innovating to stay ahead of the competitors. We invest in research and development to ensure that our products continue to offer a unique and compelling value proposition for pet owners.

In terms of our financial strategy, we plan to focus on cost-plus pricing to ensure that we price our products competitively while also ensuring profitability. We will also explore opportunities for partnerships and collaborations to expand our reach and business scale. In addition, we plan to seek investments to drive our growth, enabling us to invest in product development, marketing and other key areas.

6. Detailed Design and Manufacturing Process

6.1 Mechanical Design

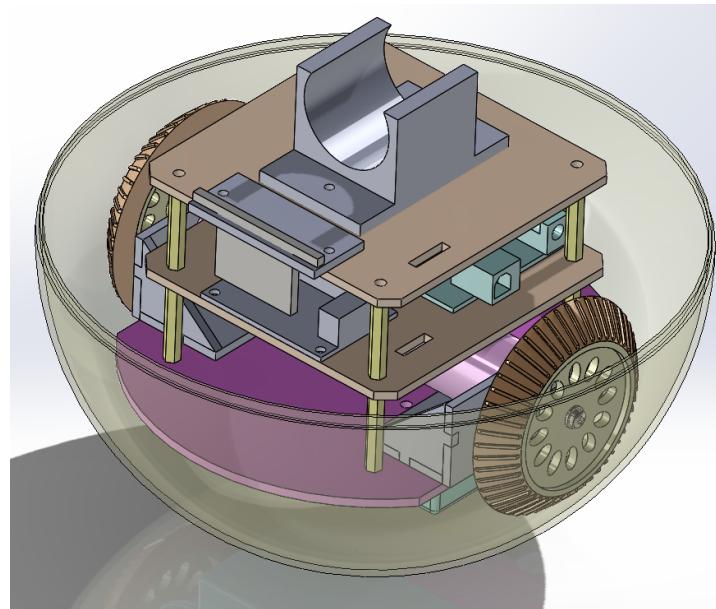


Figure 2: Overview of body design

The body of robot consists of three main sections: the outer casing, the inner body structure and the wheels.

The outer casing is made up of a transparent thermoplastic called polymethyl methacrylate (PMMA). It is also known as acrylic and is formed into a spherical shape through a process called injection molding.

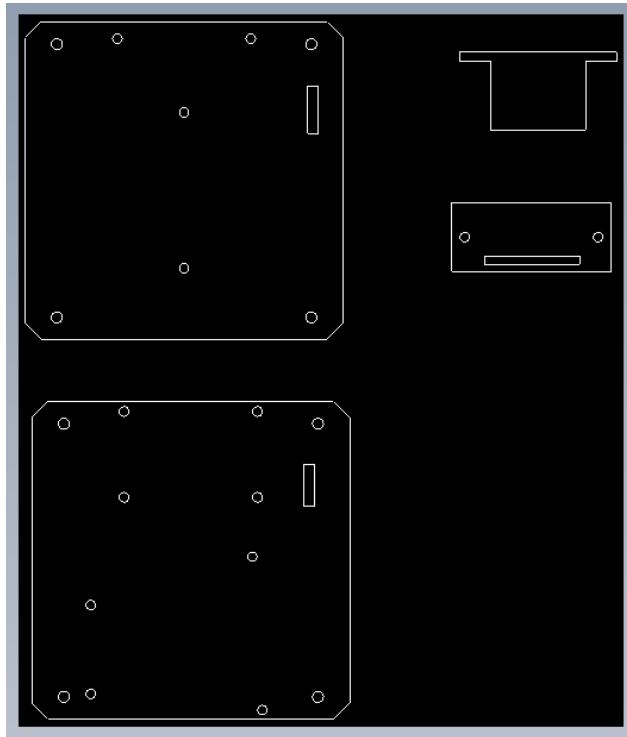


Figure 3: Layer 2 and 3

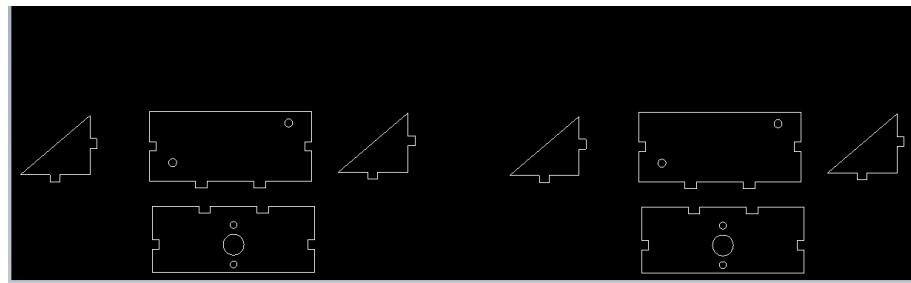


Figure 4: DC motors housing

The above drawings are used for laser cutting to produce parts of the inner structure. Our spherical robot's inner body structure has three layers in total. The first layer, the bottom most layer, is designed to house the motors, battery, and weight. The second layer is for the electronic components such as the Arduino board, HC08 Bluetooth module, etc. Finally, the last layer, which is the topmost layer, is for placing the camera and speaker.

Lastly, to produce the wheels of the robot, injection molding was also done. Two separate procedures needed to be done to result in two parts, the inner wheel and the outer part of the wheel. This is because they differ in the material used to produce each part. The inner part of the wheel is made up of PMMA, which is hard when cool, while the outer wheel itself is made up rubber.

6.2 Packaging Design

The packaging box is a 25cm x 25cm x 25cm square box with an open lid that is made by CORR. A rectangular container in which a hole is cut in the center will be put inside the square box. The pet ball robot is placed in the hole to keep it in place. Polyethylene terephthalate (PET) is used to undergo vacuum forming and our product name is printed on it in a circular formation. There are several label stickers that are adhibited on the box, it not only enhances its attractiveness, but also tell the clients the basic functions and target user of our ball robot.



Figure 5: Front side of packaging box



Figure 6: Vacuum forming

6.3 Electronic Design

6.3.1 Components

Arduino Uno

The Arduino Uno is the microcontroller implemented in our product. It is a programmable open-source microcontroller board equipped with sets of digital and analog input/output pins that is used to connect other components. It is inexpensive, flexible and simple to use. It facilitates the communication between the computer and the robot.

HC08 Bluetooth module

This module allows for the controlling of the robot through mobile devices via Bluetooth connection as it enables the establishing of connection between the mobile device and the robot. This low energy module allows for communication up to 80 meters and runs on a frequency of 2.4GHz.

Speaker

The speaker serves various purposes. First, it lets users play music for entertainment purposes. Next, it may also perform text-to-speech functions. Lastly, it may also remind users such as when the robot is almost out of battery, etc.

RGB LED ring

The WS2812 5050 RGB LED is a versatile and popular choice for creating colorful lighting effects in a variety of applications, including LED strips, matrix displays, and wearable electronics.

The LED contains a red, green, and blue (RGB) diode in a single package embedded with a WS2812 control IC. It is responsible for receiving digital signals and controlling the brightness of each of the three diodes based on the signals received. It also allows multiple LEDs to be connected in series, each of which can be individually addressed and controlled.

The RGB values of the WS2812 5050 LEDs can be controlled with a microcontroller or a dedicated LED controller. Colors are specified with RGB values ranging from 0 to 255, where 0 represents no brightness and 255 represents maximum brightness. The brightness of each LED can be controlled independently so that multiple colors can be created.

The flexibility of the LED lights have been implemented in Petronus to indicate different modes:

- Moving forward: green lights displayed
- Moving backward: orange lights displayed
- Turning left: left part displays green, right part displays red
- Turning right: left part displays red, right part displays green
- Spin: colorful lights displayed
- Stop: red lights displayed

Camera

The Car recorder configuration software controls all aspects of the camera, including the shooting and recording functions, as well as other settings such as resolution, frame rate and image quality. The software is typically used to configure the camera to meet specific needs, such as adjusting the camera's angle and field of view, setting up motion detection, or configuring the camera to automatically start recording when the car starts. The configuration software allows remote access to the camera, and we can view and manage recordings from the mobile device.

18650 rechargeable batteries

Rechargeable batteries have been utilized in this robot to increase customer convenience. Users can simply recharge the robot instead of needing to purchase new batteries whenever it runs out of power. The 18650 batteries have been selected as they are reliable, have long run-times and can be recharged hundreds of times over.

DC motors

The 2 wheels of the robot are controlled by two DC motors. Each DC motor is connected to one wheel. This allows for robot movement. Using Arduino IDE, the wheels are controlled by the code programmed for each movement setting. The speed and direction of each motor can be controlled by the Arduino code. Hence, controlling the speed and direction of the ball robot itself. Each DC motor is connected to two pins of the Arduino board. One pin is used to control the clockwise direction of the motor while the other pin controls the counterclockwise direction of the motor.

TB6612FNG

It is motor driver ICs that are typically used with Arduino microcontrollers to control the speed and direction of DC motors or stepper motors.

The TB6612FNG is a dual-channel H-bridge motor driver that can control two DC motors or one stepper motor with peak currents up to 1.2A per channel. It operates from 2.5V to 13.5V and has built-in protections such as overcurrent protection, thermal shutdown, and undervoltage lockout. It is commonly used with Arduino microcontrollers to control motors in a variety of robotics and automation projects. They can be controlled using the Arduino's digital output pins to provide direction and PWM signals to control the speed of the motor.

6.3.2 Control Diagram

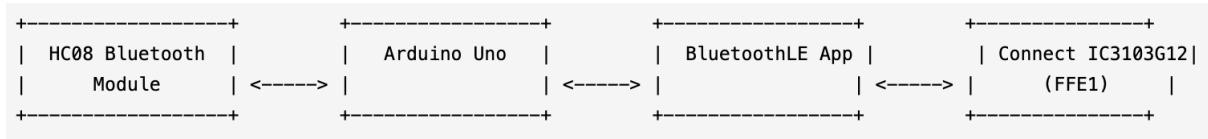


Figure 7: Bluetooth module

In this picture, the HC08 Bluetooth module is connected to the Arduino Uno via Bluetooth. The BluetoothLE application is also connected to the Arduino Uno via Bluetooth. The Arduino Uno acts as a bridge between the Bluetooth module and the Connect IC3103G12 (which has the FFE1 feature). The FFE1 feature is used to transfer data between the Bluetooth module and the Connect IC3103G12 to transfer data between the Bluetooth module and the Connect IC3103G12.

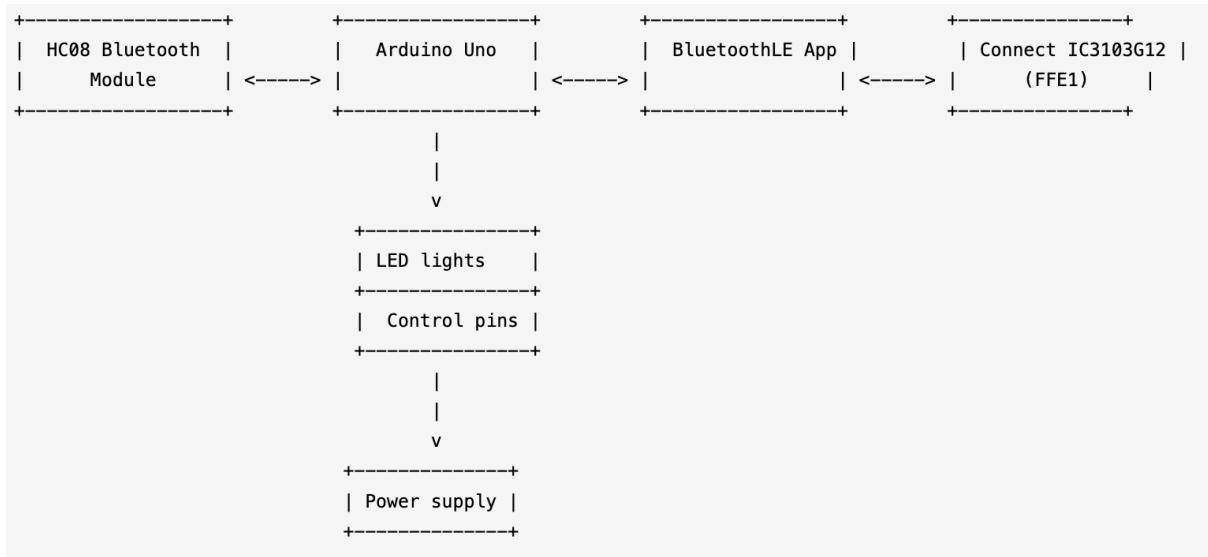


Figure 8: Bluetooth LED Lights

In this diagram, the HC08 Bluetooth module is connected to the Arduino Uno via Bluetooth. The **BluetoothLE** app is also connected to the Arduino Uno through Bluetooth. The Arduino

Uno receives input from the Bluetooth modules and uses the **FFE1** characteristic to transmit data to the Connect IC3103G12. The Connect IC3103G12 then sends signals to the LED lights to turn them on or off and to change their color based on the input received from the Bluetooth modules. The LED lights are powered by a power supply, and their control pins are connected to the Connect IC3103G12.

The input received from the Bluetooth modules controls the LED lights as follows:

- Entering "A" or "a" moves the lights forward.
- Entering "B" or "b" moves the lights backward.
- Entering "L" or "l" turns the lights left.
- Entering "R" or "r" turns the lights right.
- Entering "S" or "s" makes the lights spin.
- Entering "N" or "n" stops the lights.
- Entering "O" or "o" turns off the lights.

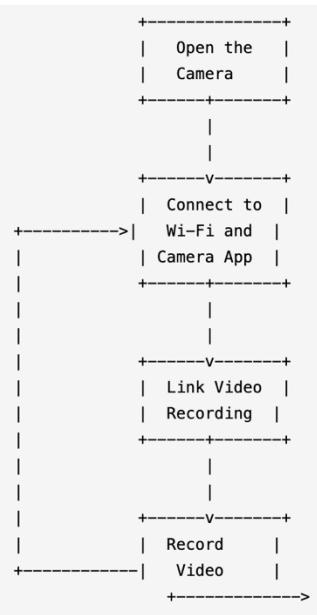


Figure 9: Camera

1. Open the camera and ensure that it is connected to the same Wi-Fi network as the device that will be used to view the footage.
2. Link the video feed from the camera to the viewing device, which can be a computer, smartphone, or tablet.
3. Establish a connection between the camera and the viewing device using the appropriate software or app.

4. Once the connection is established, you can begin recording by pressing the appropriate button or icon on the viewing device's interface.
5. The camera will capture the video footage and send it to the viewing device in real-time or store it on the device's memory card.
6. To stop recording, press the appropriate button or icon on the viewing device's interface.
7. The camera will stop capturing video footage and the file will be saved on the viewing device's memory card or cloud storage if applicable.

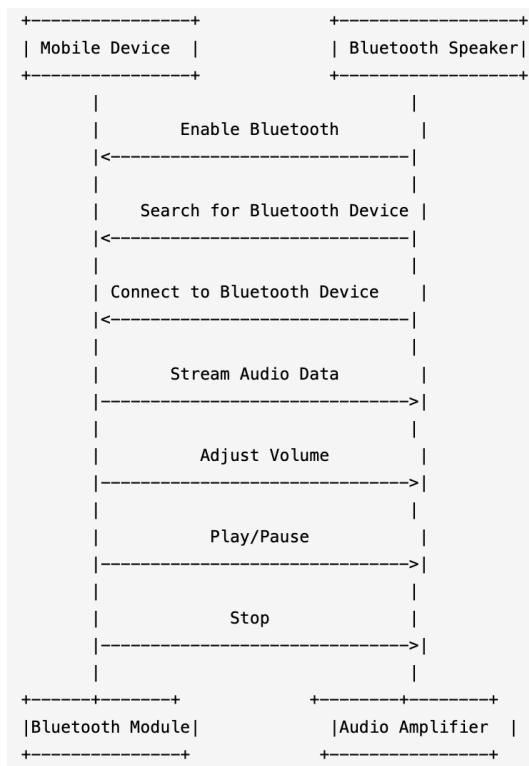


Figure 10: Music Player

1. The mobile device enables Bluetooth.
2. The mobile device searches for available Bluetooth devices.
3. The mobile device connects to the Bluetooth speaker.
4. The mobile device streams audio data to the Bluetooth module.
5. The audio data is amplified by the audio amplifier.
6. The user can adjust the volume, play/pause, or stop the audio playback.

6.4 Assembly Process

A number of steps are required to assemble the whole robot together:

1. Welding of battery, wire and motors
2. Printing of PMMA with 3mm thickness based on figures above using laser-cutting
3. Assembly of motor fixing plate onto body structure using plastic adhesive
4. Wiring of Arduino board, motors and Bluetooth module
5. Assembly of battery and ball-roller onto bottom plate using flat head screws
6. Screwing of motor and motor fixing plates together
7. Assembly of second plate onto the bottom plate using hexagon spacers
8. Assembly of Arduino board onto second plate using 3mm screws
9. Assembly of top layer onto second layer using hexagon spacers
10. Assembly of camera's stand and speaker stand onto top layer using plastic adhesive and 3mm screws

7. Bill of Material

7.1 Mechanical Components

Items	Description	Material & Thickness	Cost (HKD)
1	Group12.XDF	PMMA 3mm	\$10 (230x170)
2	Group 12	PMMA 3mm	\$13 (280x180)
3	Group 12 fix plate	PMMA 3mm	\$0 (40x20)
4	Group12_packaging_updated.dxf	CORR	\$12 (1200x900)
5	Gp12_vauccm forming	ply wood 3mm	\$6 (210x210)
6	Gp12_outerpackaging	CORR	\$12 (1200x900)
7	Vacuum forming request	0.5PET	\$8
8	Group 12 Upper-Base-plate IC	PMMA 3mm	\$8 (250x110)
9	gp12_innerpackaging	CORR	\$7 (900x700)
10	vacuum forming request	0.5PET	\$8
11	Gp12_Finalouterpack	CORR	\$12 (1200x900)
12	Gp12_Finalinnerpack	CORR	\$6 (900x600)
			Total: \$102

7.2 Electronic Components

Item	Description	Cost (HKD)
1	Arduino Uno	\$42.50
2	Screw Shield Board	\$10.00
3	Bluetooth Module (HC08)	\$28.00
4	18650 Rechargeable batteries	\$30.00
5	AA x4 Battery Holder	\$5.00
6	DC Power Cable	\$3.00
7	TB6612F Motor Driver	\$32.00
8	SS11 Main Switch	\$2.50
9	DC Motor x 2	\$50.00
10	Dupont Cable F-F, M-F and M-M	\$18.00
11	LED Lamp with wire	\$2.50
12	Camera	\$224.00
13	Bluetooth speaker	\$70.00
14	Color RGB LED ring	\$16.50

8. Marketing Strategy

Petronus has a specific target market - **busy pet owners who can't spend enough time with their pets, or who want to improve their pet monitoring capabilities.** By identifying this target market, Petronus can focus its marketing efforts on this specific group of consumers, which allows it to use its resources more efficiently and increase the effectiveness of its marketing efforts. Petronus aims to capture a large share of this market rather than winning a small share of a huge market. This approach is more realistic for a small company and allows for targeted marketing efforts.

Petronus' point of differentiation is its use of the latest trends in artificial intelligence and IoT technology to provide a unique solution for pet owners. This combination of technologies takes pet care and monitoring to a higher level than traditional pet toys and solutions can offer. By leveraging this technology, Petronus can differentiate itself from other pet care products on the market and offer a unique selling proposition that sets it apart from its competitors.

Most importantly, Petronus offers solutions that meet the specific needs of pet owners who want to ensure that their pets receive the best possible care while enhancing their monitoring capabilities. By providing solutions that meet these needs, Petronus can create a strong emotional connection with its customers and build brand loyalty. This emotional connection can also help increase customer retention and drive repeat business.



Figure 11: Marketing Strategy

1. Pet Events and Trade Shows

Our business might take part in trade fairs and events for pets, like Hong Kong Pet Show, to demonstrate the ball robot to potential clients. This may entail erecting a booth, delivering product demos, and providing attendees with exclusive discounts. Since most of the attendees at pet events are pet owners, participating in pet events is an effective way to reach our target customers and promote our ball robot.

2. Social Media Marketing

Our business can leverage social media sites to advertise the pet ball robot to certain target audiences. In order to reach pet owners, this can involve producing interesting information, such as infographics, films, and photographs that highlight the qualities and advantages of the product. As the popularity of social networking sites is high, the influence of it brought to the sales of ball robot is significant. For example, the business can make use of hashtags and engaging filters on Instagram to promote the ball robot without having extra promotion cost.

3. Influencer Marketing

Our business might collaborate with influential people in the pet sector, such as celebrities who are pet lovers, to market the product to audiences. This can involve giving influencers the pet ball robot for free or at a reduced cost in return for marketing

on their social media platforms. Also, for paid promotion strategy, our business can invite the celebrity to shoot a short reel video that accompanies their pets who are playing with our ball robot and posts the short video onto social media platform.

4. *Referral Program*

Setting up a referral program that pays clients to recommend the ball robot to their friends and family. To entice customers to recommend others, provide rewards like discounts, freebies, or exclusive access to new products.

Pricing

A cost-plus pricing strategy have been used to determine the price of its products. This involves adding a markup percentage to the cost of producing the product to determine its selling price. The price of the product have been set at HK\$1,199.

Distribution

Petronus will sell its products through a combination of online and offline channels. The product will be available for purchase on the company's website and through online marketplaces such as Amazon and Lazada. The company will also work with pet stores and distributors to make the products available at physical retail locations.

Location

The company is based in Hong Kong and will initially focus on the Hong Kong market. As the business grows, it will expand to other markets in Asia and potentially globally.

Promotion

Petronus will use a variety of marketing strategies to promote its products, including participation in pet events and trade shows, social media marketing, influencer marketing and referral programs.

The following are the concept poster of Petronus:



This poster will be used during various offline promotion to attract people. For online promotion, it can provide a quick glimpse of our product.

Capturing a large share of a small niche market

Petronus recognizes that it is a small company and therefore does not have the resources to compete with larger companies in a broad market. Instead, the company will focus on capturing a large share of a small niche - pet owners who are too busy to spend time with their pets, or those who want to improve their pet monitoring capabilities. By focusing on this niche, Petronus can create a unique product and marketing strategy that resonates with this specific customer segment and differentiates itself from its larger competitors.

Demonstrate customer interest

To gauge customer interest, Petronus will conduct market research and analyze data on pet ownership and spending habits. This will help the company understand the size and potential of its target market, as well as the demand for its products. In addition, Petronus can gather feedback from early adopters of the product to refine its features and address any concerns or issues. Petronus also plans to participate in pet events and trade shows to demonstrate the product and provide exclusive discounts to potential clients.

Document market propositions

Petronus can document market propositions by collecting and analysing data on the pet care industry, including trends, challenges and opportunities. This can include information about the number of pet owners, their spending habits, and the types of products they are interested in. In addition, Petronus can perform competitive analysis to identify the strengths and weaknesses of its competitors and determine how it can differentiate its products.

Advertising and Promotions

Petronus can use a variety of advertising and promotional strategies to reach its target customers, including attending pet events and trade shows, using social media marketing, partnering with influencers, and setting up referral programs. In addition, Petronus can invest in search engine optimization (SEO) and pay-per-click advertising (PPC) to increase its online visibility. The company can also create engaging content, such as videos and infographics, to educate customers about the benefits and workings of its products.

Influencer marketing will involve collaborating with influential pet sector personalities to market the product to audiences, and a referral program will be set up to reward customers who recommend the product to others. Social media marketing will also be utilized to create engaging content that highlights the unique features and advantages of the product, using hashtags and filters to reach pet owners.

9. Logistics Arrangement

We will cooperate with a factory in Dongguan. It will open a specialized and independent production line to yield Petronus. The weight of each unit, including its packaging, is around 2 kg. Since we estimate to transport 75,000 units per month to fulfil the customer needs, the total shipping weight is 150 tons. We choose to use sea transport to ship bulk volume. We select six 40'HQ standard container to load all the product. The maximum payload of each shipping container is 28.6 tons. The total shipping time may require four days for delivering to Hong Kong. In Figure 5, it shows that the overall shipping fee is \$23,880. Among those shipping companies, COSCO Shipping Line Company have been selected. They provide both domestic and international container shipping service. There are 57 domestic transportation routes with 9 local ports. So, it offers a flexible and reliable supply chain service.

We select a direct distribution channel for our product. After arriving to Hong Kong, we distribute them to different electrical appliance shops such as Fortress and the company for sales. We build our own brand channel in Fortress website. It can attract customers' attention based on its huge website view. Also, we establish an online shopping platform for potential customers to purchase our product directly. We can offer a lower price, special discount and better after-sales service. Also, they can enquire about our products online if there are any

problems.



Figure 12: The shipping fee from Dongguan to Hong Kong

10. Competitor analysis

Competitor analysis is a crucial part of any business plan. By analyzing competitors, businesses can identify opportunities and threats, and adjust their strategies accordingly. Here is a brief overview of competitor analysis for Petronus:

10.1 Direct Competitors

iFetch - iFetch is a popular automatic ball launcher for dogs that has been on the market for several years. It offers similar features to Petronus, such as automatic ball launch and remote control, but does not have AI and IoT technology.

PetSafe - PetSafe is another brand that offers automatic ball launchers for dogs. Similar to iFetch, PetSafe does not have AI and IoT technology.

Furbo - Furbo is a pet camera that allows pet owners to monitor and interact with their pets remotely. It has some similarities with Petronus in terms of remote interaction but does not offer the automatic ball launch feature.

10.2 Indirect Competitors

Traditional pet toys - Traditional pet toys, such as ropes, balls, and chew toys, are indirect competitors to Petronus. These toys are readily available and affordable, but they do not have the same features as Petronus.

Pet walking and pet sitting services - Pet walking and pet sitting services are indirect competitors because they offer similar services to Petronus in terms of pet care. However, these services do not provide the same level of interaction and monitoring that Petronus offers.

By analyzing competitors, Petronus can identify ways to differentiate itself and highlight its unique features to potential customers.



Figure 13: Competitors

In addition to identifying competitors, analyzing their strengths and weaknesses can help Petronus better position itself in the marketplace. For example, if iFetch and PetSafe are major direct competitors, Petronus can emphasize its artificial intelligence and IoT technology as unique selling points that differentiate it from these brands.

When it comes to traditional pet toys, Petronus can emphasize the benefits of its remote control capabilities to provide a more interactive and engaging experience for pets. Likewise, Petronus offers pet owners a more cost-effective and convenient way to monitor and interact with their pets while they are away than pet walking and care services.

Understanding the competition can also help Petronus identify potential opportunities for collaboration or partnership. For example, Furbo and Petronus could collaborate to offer a more comprehensive pet monitoring and care solution that includes cameras.

11. Costing Analysis

By using the cost-plus pricing strategy, the price of the product is HKD\$1199.

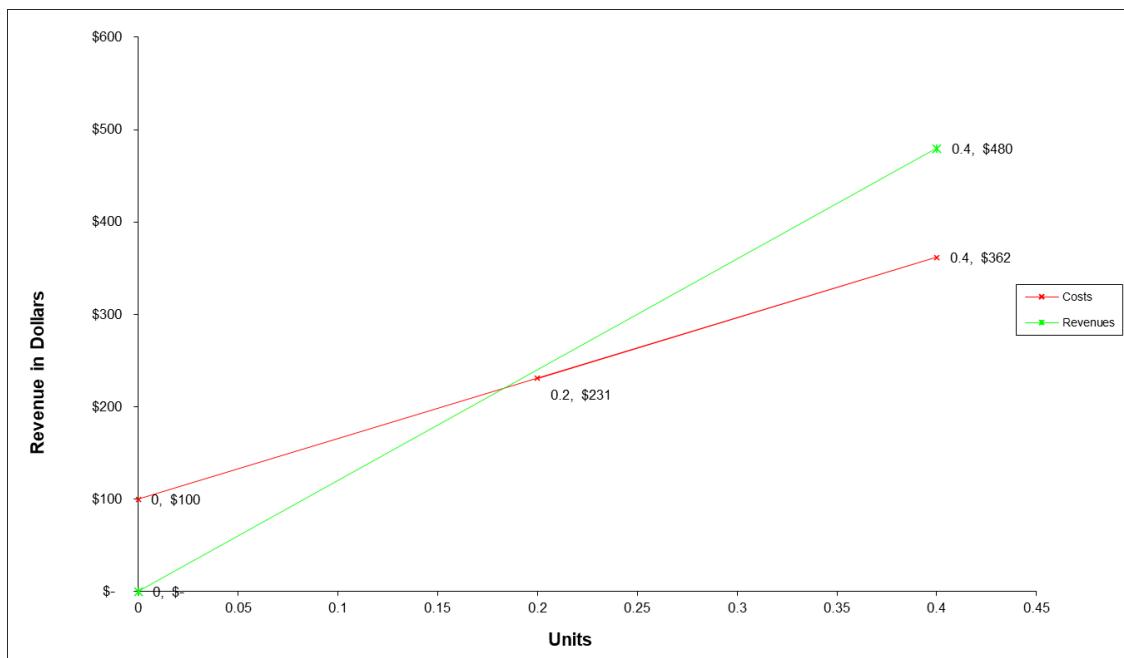


Figure 14: Costing analysis

12. Plan of Operation

Year of operations and aims to generate a net profit of HK\$2 million by the end of the second year. The company plans to reinvest a portion of its profits into research and development to strengthen its products and remain competitive in the marketplace.

The company also plans to obtain funding through a combination of equity financing and bank loans. It will seek investors who are interested in supporting the company's vision and growth potential. The company will tightly control its expenses, including marketing costs and production costs, to ensure profitability and long-term sustainability.

Petronus will also closely track its financial performance and adjust its strategy accordingly. It will regularly analyze sales data and customer feedback to identify opportunities for improvement and expansion. The company plans to grow its business progressively and sustainably, with the goal of becoming the leading supplier of pet technology products in the market.

13. Financial Data

Projected balance sheet

	Year 1	Year 2	Year 3
Assets			
Cash	\$20,000	\$35,500	\$61,500
Accounts Receivable	\$2,500	\$3,750	\$5,000
Inventory	\$7,500	\$11,250	\$15,000
Total Current Assets	\$30,000	\$50,500	\$81,500
Fixed Assets	\$12,000	\$12,000	\$12,000
Total Assets	\$42,000	\$62,500	\$93,500
Liabilities and Equity			
Accounts Payable	\$1,500	\$2,250	\$3,000
Accrued Expenses	\$3,000	\$3,300	\$3,600
Total Current Liabilities	\$4,500	\$5,550	\$6,600
Long-Term Debt	\$10,000	\$8,000	\$6,000
Equity	\$27,500	\$48,950	\$80,900
Total Liabilities and Equity	\$42,000	\$62,500	\$93,500

Figure 15: Balanced

14. Future Development

An amazing invention that has the potential to completely transform the pet toy market is the pet ball robot. These are some probable advancements for a pet ball robot in the future:

1) Implementation of AI algorithms

As the field of artificial intelligence develops, pet ball robots may become increasingly more perceptive and communicative. More sophisticated algorithms that enable the robot to learn from its encounters with pets and adjust to their behavior may be included in future developments. To better suit their preferences, the robot might, for instance, learn from its interactions with dogs.

2) Additional function of health monitoring

Pet ball robots may come with sensors that keep tabs on the health of the pets, such as their heart rates, activity levels and sleep patterns. This could give pet owners useful information that will enable them to give their animals better care.

3) Enhanced mobility

Recently, the pet ball robot can walk around and change directions, but future improvements may incorporate even more sophisticated mobility features. The robot might be built to climb stairs, traverse uneven ground, or move more quickly, for instance. The pet ball robot is supposed to not only be used at home, but also outdoors in the future.

4) Integration with smart home systems

In the future, pet ball robots may be able to integrate with smart home systems, allowing pet owners to control and monitor their pets even when they are not at home. This could include features like remotely controlling the robot's movements, checking on the pet's health status, and setting up automated routines for the robot to follow.

5) Customizable appearance and personality

As pet ball robots become more advanced, it may be possible for pet owners to customize the robot's appearance and personality. This could include options for changing the robot's colour or adding accessories, as well as programming the robot to have specific behaviours or responses to different situations.

6) Socialization with other pets

Future advancements in pet ball robots could allow them to interact with other robots and pets, enabling them to socialize and play with one another. This could provide pets with additional entertainment and companionship, and could also give pet owners a way to connect with other pet owners and their pets.

15. Conclusion

In short, Petronus offers a unique solution for pet owners who are looking for a practical and innovative way to care for their pets. By leveraging artificial intelligence and IoT technology, Petronus provides pet owners with the ability to remotely monitor and interact with their pets while improving their quality of life. With competitive pricing and various marketing strategies, Petronus is expected to become a major player in the pet care industry. Its benefits to pet owners include solutions for those who cannot physically be with their pets, improved quality of life for pets, and enhanced ability for pet owners to monitor their pets.

Individual Report

SALEH Alessandra Sylva

Through this project, I have learned a lot about how Arduino works and how to create an operating ball robot. Teamwork in this project is very important as there are a lot of tasks that needs to be done. We always seek for the opinions of others in the group even if they are part of a different team since this is a collective effort to reach our goal.

In the first few weeks of AY22/23 Semester 2, I spent time to research and try to understand how to code and connect the components, such as the HC08 Bluetooth module and RGB LED ring lights, to the Arduino. The electronic team could not test the codes and the connection of wires in the first few weeks as the ball robot was not ready yet. We trusted the mechanical team to create the mechanical parts and waited for our turn to come while learning more about the things we need to do for this project.

Wiring the connections and trying to find the correct code for the ball robot is a very exciting experience for me. I designed the code for what the LED lights will display during their movement. For example, green when moving forward, orange when moving backwards, etc. When the robot is finally operating properly, I feel happy and accomplished. I also got the chance to finalize the assembly of the robot and user guide. I am very thankful that the professors in IC3103 are very helpful and willing to guide us through our concerns. I was able to understand more about Arduino through their patient guidance and help.

KWOK Hin Chi, Haley

Experience

As part of our team project, I had the opportunity to create a spherical robot from scratch and each team member brought a unique set of skills and knowledge to the table. This project has been a great opportunity for me to develop my skills in product development, teamwork and self-learning. It allowed me to apply the theoretical knowledge I gained in a practical environment and provided me with valuable experience that I can apply in future projects.

In the second semester, we focused on the implementation of the project. We started by researching the computer vision capabilities of the camera, looking at open source code, and discussing which items to purchase. We also discussed electronic materials with our mentor, considered ideas based on input-output logic processes and theory, searched **GitHub** for source code, and learned about ultrasonic sensors. The electronics team finalized the components, while the mechanical team modified the technical design, corrected errors, printed out

prototypes, and assembled them. The design team finalized the label design and box template. We then updated the electronic materials, browsed the Arduino car video and code, did the injection molding of the wheels, and tested the code. We also checked the electronic materials, connected the camera and speaker, and tested the code for Bluetooth connectivity and the motor. In addition, we did the LED test and combined the electronic and mechanical parts. Finally, we assembled the whole product, created wire connections, tested the code for the robot movement, and demonstrated it to the supervisors. In the last week, we made sure we assembled the whole product, established the wire connections, and tested all the codes for the robot motion (ALFSN). Overall, it was a challenging but rewarding experience that allowed us to apply our knowledge and develop self-learning skills in a hands-on activity.

What I have learned

1. Project Management: This project has followed a well-defined process, with specific tasks assigned to different teams and a clear timeline for completing those tasks. By observing how the project was managed and how different teams worked together, I could learn valuable lessons about project management and how to effectively coordinate complex tasks.
2. Design Thinking: Throughout the project, there were several instances where the team had to consider the needs and preferences of the end-users. By focusing on the user experience and designing the product accordingly, I was able to create a more effective and appealing product. By understanding the design thinking process and incorporating it into own work, I could improve your ability to create products that are more user-centric.
3. Technical Skills: The project required a wide range of technical skills, including electronic design, programming, and mechanical design. By working on these aspects of the project and collaborating with team members who had expertise in these areas, I have gained new technical skills and expanded my knowledge in these areas.
4. Self-Learning: One of the challenges of the project was working on tasks that were new to me. By embracing this challenge and seeking out resources online to fill in the gaps in my knowledge, I have improved my self-learning skills and become more comfortable with taking on new challenges in the future.

I am grateful for the guidance and support of our professors who helped us understand the intricacies of Arduino and provided guidance along the way. Overall, this project was a valuable learning experience that allowed me to apply industrial technology and problem-solving skills in a real-world project.

WONG Pak Ki, Marco

As an individual, I took on the task of designing the Arduino program, business card, and user guide. My work on these has been improved and it shows the details of the work.

In the first 6 to 7 week of the project, I tried to study the relative knowledges about the programming and the Arduino then I made two program then my Arduino program works fine. I used my programming knowledge to create a car motor program and LCD program which was difficult for me. Because I was not the professional person in this area. Therefore, I have taken care to ensure that the code is well-driven so that others can understand and modify it in the future.

After making the program I started to make the user guide that make customers clearly know how to use our product. The user guide is well written and comprehensive. I've taken the time to explain each step clearly and concisely. Make it easier for users to follow up. Make it easier for users to find what they need.

After doing the another two task, I need to do the business card without QR code because this was a draft one. Business cards are simple yet. It conveys the necessary information clearly and concisely. The design refers to our packaging design. Fonts and colors are well chosen, and the layout is easy to read.

WONG Sze Nga, Celia

In this project, it provides many practice opportunities to apply industrial techniques into our product, for example, laser cutting and vacuum forming for our packaging. First, we designed a preliminary layout in CorelDraw. We need to evaluate and set appropriate dimensions for fitting the robot so it is very difficult for us. Also, some lines overlapped and didn't align so we need to use Autocad to break down those lines and delete repeated lines. Then, we integrated the lines and added folding lines via CorelDraw. In first design, we found that the sides were hard to merge together after laser cutting. Moreover, the dimension of the folding part is too large so it extended to the frame of logo. Then, we redesigned and modified the dimension a few times. Finally, we produced a well fitted packaging box. Also, we use vacuum forming to shape the plastic logo and pasted it on the frame of packaging box. We searched some pet photos for sticker printing. We used them to decorate our packaging and make it cuter.

After completing the project, I think teamwork is very significant. Our groupmates always give different ideas to solve the problems. Also, they are willing to help each other. In first three weeks, groupmate solved the motor fixing plate seriously and tried to modified the dimension to fit position in Solidworks. For packaging, they searched various packaging designs for brainstorming and added some elements into our design. During redesigning and altering the

packaging, they suggested multiple methods to solve the problems. Therefore, I can learn how to communicate and cooperate with my teammates in this project.

LUI Uen Yau, Camille

In this project, I have contributed most on the part of visual aids and packaging design, for example, the poster, name card, and the stickers. Visual art is one of the area that I am familiar with. It is grateful to contribute to the group by using my best skills. Besides creating visual aids, I also take part in designing packaging. I have never get the chances to try CorelDraw before, and it is lucky to have a chance in IC learning drawing graphs with the use of different tools, such as CarolDraw and AutoCAD. At the beginning, all the tools are, honestly, abstract for me and I have no idea how and where to start the drawing. Fortunately, with the assist of YouTube tutorial videos and instructions during IC lessons, I started taking a shape of how to use those tools. In the past, I kind of refuse to learn a new software, but after this IC course, I gain more courage to learn a new software that really convenience our learning.

After this IC course, I totally understand the importance of how teamwork makes it works. It would be definitely impossible for myself to complete this project on my own. Although, as mentioned above, I started my learning on those software and programming, I am still a beginner. Without the hard work and contribution of my groupmate, we will never finish this project in the end. I am really thankful and lucky to have my groupmate at my back.

SO Hiu Lam, Oliver

My contribution towards this project is the packaging design and production. I have designed a logo for our brand. Also, I drew the packaging design with the use of CorelDraw and AutoCAD. Since I am not familiar with both of the softwares mentioned above, I have to watch some tutorial videos on YouTube to self-learn about some techniques of drawing. I have tried to draw several designs for the packaging and asked group members for their advices to choose the most feasible one. After the decision making, I have made some adjustments and improvements regarding the chosen design. My group mate and I printed the first draft of packaging box by laser cutting and we found that it is difficult to deal with the folding part. Thus, we have to edit the design and re-print the revised version. Also, we have done the vacuum forming to put it as a part of the packaging box design. I also search some images for the label stickers to place them onto the box to make it more eye-catching and attractive. In addition, I assist in writing the business report like the part for promotion strategy.

I think that team work is significant for this project as our group members are from different programs and the aspect that is good at or familiar with also is different, and thus each group member can responsible for the specialised parts. Also, group members are willing to give a hand while others face challenges and we are able to tackle the difficulties under collaboration.

This project gives a pleasant chance for me to learn some software techniques and have hands-on experiences. I am more familiar with the drawing softwares such as CorelDraw and AutoCAD and learn more about the electronic components needed for a ball robot. These skills and experiences are meaningful that can facilitate my future career related to technical development and product production.

SIN Tak Chi, Bernard

I am responsible for CAD drawing and spherical robot assembly. The first few weeks, me and my teammate draw out the Solidwork for the components stands and the trouble shoot assembly error. In the first two times laser cutting plate, we found that the second plate unable assembly with the Arduino board, also we missed to save a space for Bluetooth module. The design of motor fixing plate are redesigned few time since using different manufacturing method. The first version is using bending, the second version is using laser cut but without side support. We test three time to fianalize our design. Besides, I meet lots of trouble during welding. Since we are not fimilar to welding, oue welding part was too large that it cannot fit in to the Arduino battery connector. Also, the welding parts are not fix enough, it always and separte and fall out. It took me many times to travel around 4/F and Platform to fix the problem. But it makes me similar to welding, now I can weld it fast and accurate. During assembly, I did some mistakes like using the wrong ssrcew for assembly battery and bottom plate, and assembly the part in incorrect sequence. At last, I finish my work at week 9 and pass it to electronic team for testing the program.

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Appendix

1. Petronus Pet Car Ball Robot User Guide

Petronus Pet Care Ball Robot User Guide



The package should include:

1. The Pet Care Ball Robot
2. Two 18650 Rechargeable batteries.
3. A user guide

I. Unboxing the Robot

1. Remove all parts from the packaging.
2. Make sure all parts are present and in good condition. If there are any damage or defects, please contact our Customer Service team as soon as possible.
3. Check the user guide for instructions.

II. Charging the batteries

1. Connect the batteries with the charging box to a power source using the charging cable.
2. Charging will take 2-3 hours to complete.
3. Ensure that the batteries are fully charged prior to first use.

III. Connecting your device as controller

1. Download **BluetoothLE app** via Apple's App Store, Android's Google Play Store or any app store.
2. Open the ball robot and take the main body out of the casing.
3. Turn on the robot using the switch on the bottom of the robot.
4. Ensure that the device you want to use as controller has its Bluetooth on.
5. Open the BluetoothLE app.
6. Search for "3103G12".
7. Click connect to pair the robot with your smartphone.

IV. Operating the Robot

1. Open the BluetoothLE app to control the robot's movement and speed.
2. Ensure that the device is properly connected.
3. Click on "Terminal".
4. Click on "FFE0".

5. Control the robot's movement by using the instructions provided.

6. There are several instruction modes available:

- Enter "A" or "a" to move forward
- Enter "B" or "b" to move backwards
- Enter "L" or "l" to turn left
- Enter "R" or "r" to turn right
- Enter "S" or "s" to spin
- Enter "N" or "n" to stop
- Enter "O" or "o" to turn off lights

V. Playing Music

1. Turn on the speaker by holding down the button on the speaker.
2. Turn on Bluetooth on your device that you would like to use as a controller.
3. Look for a device named "MT".
4. Click on "MT" to pair the speaker with your device.
5. Once paired successfully, play any sound on your device.
6. If there is no sound output, try increasing the volume or reconnecting your device.
7. If it still does not work, please contact our Customer Service team.

VI. Cleaning the Robot

1. Only clean the case of the robot with a damp cloth after each use.
2. Do not use any harsh cleaning agents.
3. Let it dry before reassembling with the main body or storing.
4. DO NOT clean the inner body with a damp cloth.
5. Clean the inner body using a brush and very lightly brush the parts/components to not potentially damage the parts.

VII. Storing the Robot

1. Store the robot in a cool, dry place.
2. Keep the robot away from direct sunlight.
3. DO NOT let the robot get into contact with any liquid.
3. Make sure the robot is fully charged and dry before storing it away.

Contact Us

If you have any questions about the Ball Robot, please contact our customer service team at petronus@ballrobot.com. Thank you for choosing Petronus.

End of Petronus Pet Care Ball Robot User Guide

2. GitHub Updates

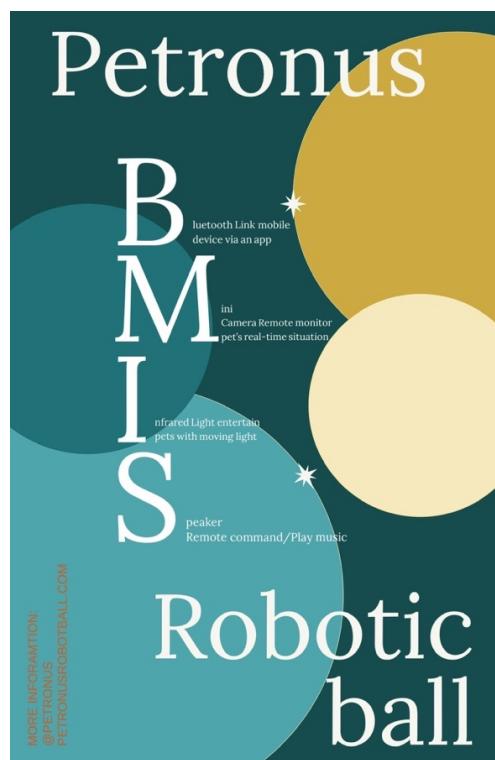
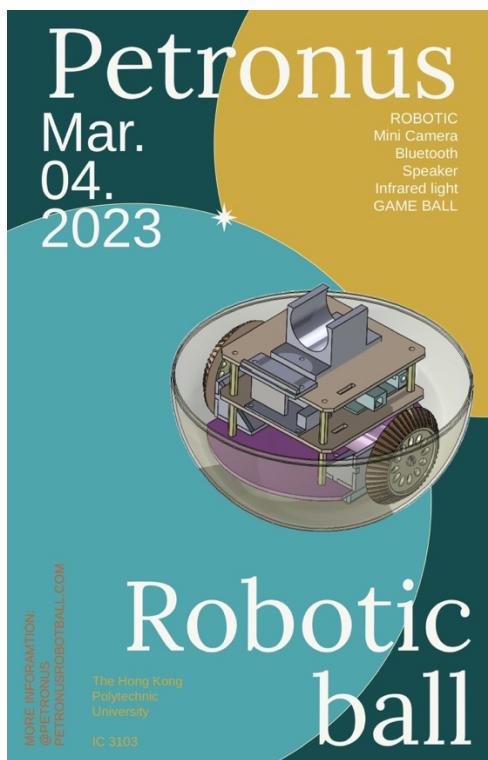


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3. Name Card



4. Posters



End of IC3103 Group 12 Business Proposal