## **Purdue ECE Senior Design Semester Report**

## **(Team Section)**

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| **Course Number and Title** | ECE 47700 *Digital Systems Senior Design Project* |
| **Semester / Year** | Spring 2022 |
| **Advisors** | Phil Walter |
| **Team Number** | 8 |
| **Project Title** | Gimbal Vehicle |

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| Senior Design Students – Team Composition | | | |
| **Name** | **Major** | **Area(s) of Expertise Utilized in Project** | **Expected Graduation Date** |
| Zeren Li | CompE | Software | 5/11/2022 |
| Bohang Ni | EE | Software & Hardware | 5/11/2022 |
| Deyuan Sun | CompE | Software | 5/11/2022 |
| Haiwen Zhang | CompE | Software | 5/11/2022 |

**Project Description:** Provide a brief (2-3 page) technical description of the design project, as outlined below:

1. Provide a general description of the product to be delivered by this design project.

## Our Product is a gimbal vehicle which has four major components, consisting of a set of four mecanum wheels, a chassis, a gimbal, and a remote controller. The primary function of this product is to create a stabilized mobile filming platform for a camera or a cellphone. The gimbal system of this platform has two modes. The first mode is manual control mode. Under manual control mode, the user can rotate the gimbal using the remote controller. The user can controller the gimbal to track some moving objects that he would like to capture. The second mode is self-stabilizing mode. Under this mode, the gimbal will face the same direction regardless of the movement of the chassis. By switching to this mode, the user can shoot a smooth footage utilizing the help of the self-stabilizing gimbal.

1. What is the purpose of this product? For whom is it intended?

This product's goal is to allow stabilized filming on mobile platforms like a camera or a cellphone. The user can manipulate either the chassis or the gimbal to physically track and film a moving object using the self-stabilizing gimbal and the vehicle's remarkable agility. This product is meant for capturing outdoor activities such as workouts and extreme sports, and its intended audience includes online sports entertainers as well as outdoor aficionados. The gimble platform would provide a mobile filming platform with a minimal profile. This product might replace a cameraman with a gimble platform, making stabilized video for outdoor sports more affordable.

1. Describe how the engineering design process used to create your product was utilized in this project. Include how you were able to develop and conduct appropriate experiments, analyze and interpret data, and use engineering judgment to draw conclusions related to the development of your product.

In the overall design, we took a top-to-bottom approach. However, for implementation, we took a bottom-up approach to implement each module. Before the semester starts, we finalized the overall design as well as the major components that we need to accomplish. We started from the overall idea of a gimbal vehicle. After numerous discussions and tradeoffs, we separated the modules into different tasks and subtasks, isolating each module into the maximum extends and test each individual module as thorough as possible. In each isolated module, we tested our module using non-exhaustive testing, making sure our testing is robust with most of the variations.

1. Describe the design constraints, and resulting specifications, incorporated into your product (list a minimum of 3).

For this project, we made a lot of tradeoffs due to different constraints. First, we had to consider about the constraint of power supply. We eventually decided to use the 12V battery and a buck convertor to convert the voltage from 12v into 5 volts, then use a linear regulator to convert to 3.3v. We could have used the 5 volts battery but that might not provide enough current. Second, we had to choose from various versions of the stm32 microcontroller family. This was not an easy selection. In fact, we dedicated to stm32F446 and STM32F091 right after we burned a few stm32 f401 chips, recognizing the defect of it. Third, we also faced the decision between various types of wheels of different torques. The final decision was made since it best fits our design’s power and torque requirement. We have made many other tradeoffs. The most essential lesson that we learned in this course is that we have to make our own decisions in accordance with the overall design.

1. Describe how each of the following factors influenced your design specifications and constraints.

## **Public Health, Safety, and Welfare:** We paid considerable attention to safety during the packaging design process. The package of the remote controller was designed in a way that the user will not be in contact with any electronic components. For the vehicle, we made sure no wires are exposed to the user. The placement of the battery was specially designed that it is safe and easy to replace and recharge the batteries.

## **Global Factors:** Our product has a global provision. Nowadays, people around the globe are brought together by the internet. People are sharing text, images, and videos on the internet with other from all over the world. Our product will act as catalyst to this trend. Our product is very powerful tool of recording movements in people’s life for them to share on social platforms.

## **Cultural Factors:** Using our product, people can easily shoot high quality videos and then share the videos on the internet. Our product will increase the interaction and communication between people from different culture and backgrounds. This will contribute to the peace of the world.

## **Social Factors:** We believe our product will bring some degree of social impact. Our product introduces people a new way of recording. It makes recording more fun. Therefore, more and more people will be recording and start sharing on the internet. This will unite the society more closely.

## **Environmental Factors:** We paid a lot of attention to the environmental factor while designing our product. For our packaging design, we minimize the use of materials such as plastic. On the vehicle part, we design the packaging in a way that no extra plastic is used besides the necessary wirings. The major structure of the vehicle and the gimbal is made of metal which is relatively environmental-friendly.

## **Economic Factors:** Our design will bring an impact to the market due to the unique and innovative design. It has been rarely seen products like ours in the market. Our product not only has an innovative look but also useful functions. With appropriate commercialization, our product will make a big splash in the market. This is because the uniqueness of our product, as well as the fact that our product is truly useful for taking videos and images of good quality.

1. Describe the appropriate engineering standards incorporated into the creation of your product.  
     
   There are several engineering standards for our product. The first one is our product will ensure the communication between the remote controller and the vehicle within a specific range. The communication between the remote controller and the vehicle is the key to our product. It enables the switching of modes and the control of the vehicle movement and gimbal movement. Another standard we met is that our product ensures there exist a way to reprogram the microcontroller both on the remote controller and the vehicle. Another standard is that the ability to reset the system by implementing a reset button on the PCB. We abided by all the standards including federal communications commissions, restriction of hazardous substance directives, and electronic capability for European committee.
2. Describe the final status of your product.

We finish all the 3 main parts as we described in the midterm proposal. Chassis, gimbal, controller. We successfully finish all three modes of the vehicle, self-stabilized mode, manual control mode, and stiff mode. Our product is robust enough to travel in most of the terrain in regular modern city. Our gimbal is stable in the self-stabilized mode, and we have full control over it in the manual control mode. The packaging design was simple but good looking at the same time. It also provides sufficient protection to the PCB and wires.

1. Describe the makeup of your project team and how you were organized to establish goals, plan tasks, and meet the objectives of this project.

We have the idea of creating a gimbal vehicle since last semester. We all believe that this will be a highly intuitive yet challenging project to accomplish, and that is how the teams are formed. We all have a general idea of what need to be implement then we adopt the part that we are each good at. For completing the project, we distributed different tasks to each team member. Zeren was working on building the functions of wireless transmission between controller and vehicle. Also, Zeren helped teammates to debug the program of IMU module and improved the time complexity of OLED display module. Bohang worked on PCB design, nrf24 wireless module configuration, and motor controller module configuration. Deyuan worked on mainly algorithm part, including mecanum kinematics and hall effect sensor rotary encoder. Haiwen mainly worked on the gimbal part, including manual control and self-stabilizing functions of the gimbal.

We believe having frequency conversation would be the key of solving any kind of problem. Every time there is certain task the relative free person would go and pick up the task. If there are any difficulties encountered, we will have another person join the task trying to figure it out together. In the end, everybody would be involved and eventually conquer the problem.

1. Did your project require the production of any written documentation other than this document (i.e., manuals, educational materials, etc.)? If so, describe the types, composition, and nature of the audiences for whom these materials were intended.

Our design is relatively intuitive. However, I believe we will still need the help of our user manual to ensure the proper use of our design. The user will need to choose from three modes, manual control mode, self-stabilizing mode, and stiff mode.

Manual control mode:

We are allowed to control the chassis using the left joystick, x1 and y1. Also, we are allowed to control the gimbal using the right-side joystick.

Self-stabilized mode:

We are allowed to control the chassis using left joystick just like previous mode. However, the gimbal itself will stay in the same spatial position.

Stiff mode:

We are not allowed to control the gimbal anymore, and it will point at the same direction forever. However, are gain more control toward the chassis part, making it possible to rotate freely, achieving true omnidirectional.

Another important document we wrote for this project was the legal analysis which discussed the engineering standards our projects abide by.

We had written a user manual which instructs the user to use our product in the correct and safe way.

A documentation of safety and reliability was created for the audiences who want to use or re-create our project. The documentation analyzes the reliability and service life of each components using MTTF Tables. Besides, FMECA Worksheet analyzes the Failure Mode, Effects, Method of Detection and Possible causes of each component that can possibly have failures when it is running.

## Describe the types, composition, and nature of the audiences in attendance for the final oral design review. Discuss how you prepared for this audience.

We recognize the audience of our final presentation will be our peers and the course staffs. For our peers, since they are not familiar with our product, we will first introduce our product a little bit. We will introduce our design from three approaches, the chassis, the gimbal, and the controller. Each of the components have different functionalities and need to be implemented by several modules. We will try to explain everything in lowest level possible. For enhanced understanding, core algorithms and coding would be introduced in detail. Many of the module that we are using from other opensource software would be mentioned by reference. The three of us would be introducing each of three parts of the design. The course staff would want to hear more about the difficulties since they already have a fair amount of knowledge on our product. We will talk about several difficulties we faced during this project.

## **Purdue ECE Senior Design Semester Report**

## **(Individual Reflections Section)**

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| **Course Number and Title** | ECE 47700 *Digital Systems Senior Design Project* |
| **Semester / Year** | Spring 2022 |
| **Advisors** | Phil Walter |
| **Team Number** | 8 |
| **Project Title** | Gimbal Vehicle |

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| Senior Design Student Completing This Section | | | |
| **Name** | **Major** | **Area(s) of Expertise Utilized in Project** | **Expected Graduation Date** |
| Haiwen Zhang | CompE | Software | 5/11/2022 |

**Individual Reflection:** Provide a brief (1-2 page) individual reflection of the design project, as outlined below:

1. Describe your personal contributions to the project.

## For our project, I mainly worked on the gimbal part. There are two modes of the gimbal. One is the manual control mode, and the other one is the self-stabilizing mode. For the manual control mode, I wrote a couple of functions that take the readings from the joysticks as input and control the servos so that the gimbal is rotated to the desired position. For the self-stabilizing mode, I implemented some open-sourced programs found on GitHub that take the IMU’s accelerometer and gyroscope readings, do some calculations, and then return the tilt angles of the IMU that implemented on the vehicle. Then, the tilt-angle data are passed to the functions I wrote for driving the servos. I also worked with Zeren on displaying rpm/IMU data on the OLED screen. We found and implemented an open-sourced program on GitHub which utilizes I2C and DMA to display text on SSD1306-based OLED.

1. Describe how your contributions to this project built on the knowledge and skills you acquired in earlier course work.

## The course from which I acquired required knowledge and skills for my contributions to this project is ECE362. In ECE362, I learned how to program a microcontroller, specifically the STM32s. In our project, we used STM32F446RE which is similar in all aspects from the STM32F091RC we used in ECE362. From ECE362, I also learned how to use the microcontroller programming IDE, STM32 system workbench, which is very similar to the IDE we used for our project – STM32CUBEIDE. The servos are controlled by a STM32F446 microcontroller with its PWM function. The data from IMU is read in using I2C. The OLED display is also driven by I2C. I learned all these microcontroller communication protocols from ECE362. Debugging a microcontroller program is also something very important that I learned from ECE362 that helped me a lot in doing this project. All the programming for microcontroller is written in C language. I acquired my C programming skills from ECE264 and ECE368.

1. Describe how you acquired and applied new knowledge as needed to contribute to this project. What learning strategies did you employ to do so?

## Even though I am equipped with some basic knowledge and skills about microcontroller programming. There are a lot of peripheral specific knowledge I need to learn and apply in this project. For example, I need to learn the principles for controlling a servo motor using PWM. I also learned on my own the algorithm that calculates the Yaw angle of an IMU. I figured out the implementation of a couple of open-sourced programs that are utilized by our project such as Kalman Filter and OLED display driver. I learned most of the new knowledge from the internet. There are a lot of difficulties whiling learning from the internet. Because there always exist some microcontroller-specific issues that are not explicitly talked about on the general threads on the internet. Therefore, I and my teammates spent a lot of time searching online and debugging using STM32CUBEIDE and STM32MONITOR.

1. Discuss your ethical and professional responsibilities as they relate to this engineering design experience.

## There are some ethical and professional responsibilities I took while working on this project. During the design of the project, we paid a lot of attention to the safety of our product. For the packaging design part, we made sure that the wire is well organized and there is no exposure of wires that the users can touch. We also consider the convenience of operation of our product. We placed the battery in a place that the user can recharge it safely and conveniently. We minimized our use of plastic which is bad for the environment. We also tried to maximize the durance and performance of our project through our design of the software and hardware.

1. Consider what the impact of the product of this engineering design experience could have in economic, environmental, societal, and global contexts. Discuss how you would make (or did make) an informed judgement as to your product’s impact in each of these four contexts?

## Economically, our product will be very successfully, making an impact to the market. It is mainly due to the uniqueness of our product. Our product is unique and at the same time very useful. As the internet and technology develop quickly nowadays, more and more people start to shoot videos and post them online. There rarely exist similar product that shoot the same type of video in the market. Our packaging design is an innovative one which is sleek at the same time environmental-friendly. We minimize the materials that usually found on other products such as plastic which is very harmful to the environment. In the societal perspective, our product will be a good tool that will attract more and more people to shoot video and sharing them on the internet. Globally, this product will help the interactions and communication between people from different countries and background to share their videos together.

## **Purdue ECE Senior Design Semester Report**

## **(Individual Reflections Section)**

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| **Semester / Year** | Spring 2022 |
| **Advisors** | Phil Walter |
| **Team Number** | 8 |
| **Project Title** | Gimbal Vehicle |

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| Senior Design Student Completing This Section | | | |
| **Name** | **Major** | **Area(s) of Expertise Utilized in Project** | **Expected Graduation Date** |
| Zeren Li | CompE | Software | 5/11/2022 |

**Individual Reflection:** Provide a brief (1-2 page) individual reflection of the design project, as outlined below:

1. Describe your personal contributions to the project.

## My contributions to the project include nearly all the software programs. I designed a program that configures the wireless transmission module and sends two types of data between controller and the gimbal vehicle. I participated designing the algorithm that realizes Mecanum wheel kinematics, which allows the vehicle to move omnidirectionally based on the speed data from the controller. I also helped my teammate to implement and improve the program that initializes the OLED module and displays information on the OLED screen without bring latency to the whole system. Lastly, I solved the IMU initialization problem, which made the IMU module capture garbage value and therefore deactivate one of the modes that makes the gimbal stabilize itself.

1. Describe how your contributions to this project built on the knowledge and skills you acquired in earlier course work.

Most of the knowledge and skills that were used on this project are from ECE362 where I learnt many basic ideas about programming an embedded system and different protocols that communicate between microcontrollers. ECE362 is a course that provides me a general idea about how I should design the system and the program. Also, ECE368 is also an important course where I improved my C programming skill and enhanced my understanding of data structure. I was able to quickly and effetely design a program that calculates, transmits and receives all kind of data from the peripherals and microcontrollers. Besides, the knowledge of using electronic parts and devices and breadboard from ECE20007 provide me an ability to integrate microcontroller and other peripherals into a whole system.

1. Describe how you acquired and applied new knowledge as needed to contribute to this project. What learning strategies did you employ to do so?

## The strategies I used the most is to find resources that are similar to what I want to implement. For example, when I have trouble initializing the OLED screen using i2C DMA mode, I looked up on the internet and found a person who had initialized his device using i2C DMA mode. Also, looking up the documentations of the microcontroller and peripheral modules is another method that helps me debug the program. Finally, since we used STM32 cube IDE to help us auto-generate some codes, to ensure we use the code snippets correctly, I would read some functions of a specific file in HAl library that implements a certain function.

1. Discuss your ethical and professional responsibilities as they relate to this engineering design experience.

## My ethical and professional responsibilities mainly consist of preventing user and other people from getting injured by the vehicle. Our project is made of metal. When the vehicle is driving in high-speed, there is a possibility that a person is tripped by the vehicle. Therefore, I have set up a maximum speed limit to each wheel so that the vehicle will not be out of control when it is running in full speed. Also, to prevent the user from hitting by the vehicle, I set the initial speed of each wheel to zero. When the user starts the vehicle, the vehicle will remain static until the user gives instructions.

1. Consider what the impact of the product of this engineering design experience could have in economic, environmental, societal, and global contexts. Discuss how you would make (or did make) an informed judgement as to your product’s impact in each of these four contexts?

Economically, the project will not cause any economic impact. Our product provides an infrastructure for individual users. Due to the quality of the materials that we selected, replicating our project would cost around 150 dollars, which is expensive for a business to put the project into a mass-production. Environmentally, most parts of our project are made of environmentally friendly alloy except for the packaging of the controller, which is made of acrylic sheets. Although the production of acrylic sheets is not environmentally friendly, it is not necessary to replace the packaging of the controller every once a while because the controller hardly wears out. In terms of the societal impact, the project creates a small impact to the open-source embedded system domain. Our project can attract more electronics enthusiasts to add their own favorite features to our project. In a global context, our built-in feature self-tracking can free the people from all over the world who used to record videos by themselves.

## **Purdue ECE Senior Design Semester Report**

## **(Individual Reflections Section)**

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| **Semester / Year** | Spring2022 |
| **Advisors** | Phil Walter |
| **Team Number** | 8 |
| **Project Title** | Gimbal Vehicle |

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| Senior Design Student Completing This Section | | | |
| **Name** | **Major** | **Area(s) of Expertise Utilized in Project** | **Expected Graduation Date** |
| Deyuan Sun | CompE | Software | 5/11/2022 |

**Individual Reflection:** Provide a brief (1-2 page) individual reflection of the design project, as outlined below:

1. Describe your personal contributions to the project.

For our project, I mainly working on the camera and software part. Besides, testing and cooperating different design and make aggregations. I have worked for the Mecanum kinematics, that is, a module directly decoding the input joystick value to become the PWM output value of each wheel. Notice that our wheel is not just normal wheel, it is rather an omnidirectional move capable Mecanum wheel therefore, the output of each wheel is in fact a combinational logic of the input of joysticks. I also worked for the hall effect rotary encoder, reading from the hall effect sensor to demonstrate the real time RPM of the wheels. I have used the frequency of the RPM to output to a excel sheet, the result shows that the maximum RPM behave like what we expect. I have also implemented a tracking algorithm using Openpose. However, with my current Vram in rtx3070, I am only able to achieve 0.5 fps, which is not every effective. So, we will not add this into the final design. However, I still put here a camera, using either openMV or just cell phone.

1. Describe how your contributions to this project built on the knowledge and skills you acquired in earlier course work.

Mostly using the knowledge gained from ECE362 and ECE595 computer vision. Having an overall understanding of microcontroller is very important to my design in the ece477 course project. From the design in the very top, all the way down to fixing the individual module in detail, an overall understanding of what I can do or what I should do is a must have knowledge. Moreover, now we can do our project faster and easier by use some developed dependencies like Hal library. I would also like to thank the knowledge I learned in ece595 computer vision. I knew the open-source software Openpose during the final presentation and final project. With the help of openpose, many feature are finally capable to be achieved.

1. Describe how you acquired and applied new knowledge as needed to contribute to this project. What learning strategies did you employ to do so?

Most of the time we will discuss as many times as possible. However, for each of the technical difficulties that we encountered, we really need to search the user manual and the technical documents to clear our confusions. I call this is a bottom-up building strategy. We solve each error at each isolated module level. Try to get them right and integrated together. So that when we meet higher level of module that is built up using smaller module, we are more unlikely to make any mistakes and it would be easier to debug later.

1. Discuss your ethical and professional responsibilities as they relate to this engineering design experience.

As a gimbal vehicle infrastructure provide, we need to make sure our vehicle is reliable (of course). For my part, I need to deal with the camera and potential data collection field of the vehicle. I need to make sure that the potential videos recorded are not released to others. One way is making sure this data stored locally for small group of people to use. If it is an actually commercialized product, I would actually make all the data collection online to a remote database. However, centralized idea is still making sure that all the data is not handed to the wrong person. Other than privacy, I believe we generally will make the system robust enough. Our customers wouldn’t be very happy if our vehicle dies every 5 min.

1. Consider what the impact of the product of this engineering design experience could have in economic, environmental, societal, and global contexts. Discuss how you would make (or did make) an informed judgement as to your product’s impact in each of these four contexts?

For Economic content: We are making such filming feature become more affordable.

Environmental: We can replace many smaller filming tasks or delivering task with our robot instead of traditional vehicle, which saving the world.

Societal: We enable individual video content creator or small media business to share their value easier and at lower cost.

Global content: We encourage people who has robotic endeavor to add on to our product and making their own variation.

## **Purdue ECE Senior Design Semester Report**

## **(Individual Reflections Section)**

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| **Semester / Year** | Spring 2022 |
| **Advisors** | Phil Walter |
| **Team Number** | 08 |
| **Project Title** | Gimbal vehicle |

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| Senior Design Student Completing This Section | | | |
| **Name** | **Major** | **Area(s) of Expertise Utilized in Project** | **Expected Graduation Date** |
| Bohang Ni | EE | Hardware, Software | May 2022 |

**Individual Reflection:** Provide a brief (1-2 page) individual reflection of the design project, as outlined below:

1. Describe your personal contributions to the project.

My contributed to every aspect of this project. Our project is divided into two parts, the remote controller, and the vehicle. For the remote controller, I designed the system, schematic, and the PCB of the controller, wrote the interaction program of the wireless module through the SPI communication subsystem, designed the packaging for the controller, and assembled everything on the PCB. For the vehicle, I designed the working system, schematic, and the PCB of the controller, wrote the code for the mecanum wheel kinematic analysis real-time speed of the vehicle, and designed the packaging by using CAD software, and assembled everything on the PCB. I was involved in every aspect of the project. I did so since I was the project's initiator, and as the team's only electrical engineer, I wanted to work closely with my group to improve team productivity.

1. Describe how your contributions to this project built on the knowledge and skills you acquired in earlier course work.

## Throughout the project, I made full use of the knowledge I gained at university to fulfill the task. I use the circuit design and implementation techniques I learned from ECE 20700(electronic measurement techniques) and ECE 20800 to complete the prototype and avoid the potential problem of the system. For the system design, ECE33700(ASIC design Lab) provide me with some useful strategies from start everything with a flow chart, convert it to a state machine, then think about how to implement each unit. For the hardware, ECE 362（Microprocessor Systems and Interfacing provide me with the experience of using MCU to build many projects, which is probably the most useful course for senior design. In this course, I learned how different features in the Microcontroller work such as ADC sampling that used in the joystick on the remote controller, SPI communication protocol that used in the communication of NRF24 wireless module.

1. Describe how you acquired and applied new knowledge as needed to contribute to this project. What learning strategies did you employ to do so?

## I learned about most of the things I didn't study in class because they piqued my curiosity. Simply put, as an electronic engineer, I have a hobby of doing electronic projects, and I accumulated a lot of extra knowledge needed for senior design at a very early time. For example, the skill for designing PCB, soldering and so on. However, even though I possess some extra knowledge that is necessary for completing the senior design, I still need to learn a lot more new knowledge to excel at the tasks given. When I design the packaging for the vehicle part, I do not know how to use the CAD tool to build the 3D model. The way I learned this skill is by asking my friend who majored in computer graphics technology. He taught me how to use Solidwork and Autodesk (CAD tools) to build the model and generate the correct file for the manufacturing purposes. I also utilized many trusted sources, such as the Software manual and official tutorial video. Throughout the project, the first thing I do is to seek help from experts in the relevant field because I believe that learning from the experience of others will allow me to progress more quickly. When I can't find an expert, I look for credible resources and come up with my own solution through practice. After determining that the solution is feasible, I will then apply it to my own project.

1. Discuss your ethical and professional responsibilities as they relate to this engineering design experience.

## In this engineering experience, my ethical and professional responsibilities are focused on the design's reliability and safety. The reliability of the design means our designs are guaranteed to work well under specified conditions. Our robot is designed for filming purposes. Therefore, we need to ensure that it can run on unflattering terrain. To accomplish this, I used mecanum wheels and a split chassis. In addition, to ensure that every component on the PCB is working correctly, I added several debug LEDs on the PCB. Suppose one of the LEDs is not illuminated. Our users will know which part is not working instantaneously, and they can solve the problem by themselves by following the user manual we provide. The safety of the design means our users will not be harmed while using our product in any way. A good example of this practice will be the packaging. During the manufacturing of the PCB, many harmful chemical effects could be used. To ensure we keep away from the harmful material, I design the packaging so that it can isolate the user and PCB, minimize the harm from the chemical products.

1. Consider what the impact of the product of this engineering design experience could have in economic, environmental, societal, and global contexts. Discuss how you would make (or did make) an informed judgement as to your product’s impact in each of these four contexts?

## For the economic impact, our product target on the independent filming industry. With the help of our product, the entry to professional photography and cinematography will become more affordable.

For the environmental impact, all of our parts are recyclable. The only part that may cause environmental problems is the battery on the remote control, but our users can also use rechargeable batteries that can be used repeatedly, thus minimizing environmental harm. We also recommend the use of rechargeable batteries in the user manual.

In a societal context, users of this product would benefit from the versatility of this affordable package, creating higher quality media and entertainments.

For the global context, we are attempting to create a new generation of filming devices to make entry to professional photography and cinematography more affordable in hoping to allow for advancements of independent filming industry around the world.