Warman Competition 2019

MEC2402 - Team SWAR14

EXECUTIVE SUMMARY

The purpose of this project was to serve as an entry for the Warman Competition 2019 as part of our coursework under the unit MEC2402: Design 1. Our device participated in the competition held on Week 11 and scored 90 points and 49.5 points for the first and second runs respectively. These scores were attained by collecting 20 balls and 11 balls throughout the two rounds. The two Early Bird challenges of 100% and 75% the device took part in accumulated 85 points and 188.25 points respectively. A detailed discussion of this project and the stages involved is outlined in the sections below.

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INTRODUCTION

This project has been designed and built according to the objectives, rules, and constraints of the 32nd Warman Design & Build Competition 2019. The aim of the design is to autonomously navigate the rover to collect and deposit balls into designated positions within the time constraint of 60 seconds.

Throughout the duration of 11 weeks, our team of four members participated in this project through several stages, starting with the concept brainstorming, designing, building, testing and troubleshooting. This report outlines the process of building the competition device, the evolution of the rover's concept, the team's performance and its impact on the project. This report also tabulates the total budget and expenses and illustrates the custom-made components designed in the form of detail drawings.

On the Warman Competition, our team scored 90 points during the first run for collecting 20 balls, and 49.5 points during the second run for collecting 11 balls. In both runs, the device fell off track and failed to deposit the collected balls. An analysis of the competition outcome and reflections on our performance is also discussed in this report.

MODEL & DEVICE COMPARISION

The final prototype and the preliminary design are comparatively different. During the testing stage, it was found that the device did not perform exactly what it was designed to do, due to some oversights. Therefore, design refinements were made to improve and simplify the mechanism of the device, both in collecting and depositing the vessels. The two main differences between the final prototype and the preliminary design were the approach used in depositing vessels, as well as the translation of the device arm.

Depositing Mechanism:

During the preliminary submission, a design that detaches the plastic bag containing the vessels for depositing was used, as shown in **Figure 1(a)**. The arm was designed to be extendable with a pair of jaw clamps, as shown in **Figure 2(a)**. The plastic bag was to be held temporarily by the jaw clamps. During collection, the arm is extended to expand the opening in the plastic bag and retracted after collecting the vessels. The jaw clamps then release the plastic bag into the inland compound.

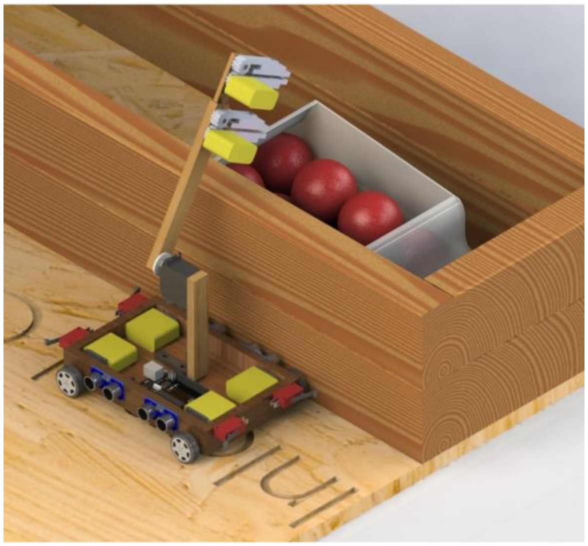


Figure 1(a): Initial Depositing Mechanism Design

Figure 1(b): Final Depositing Mechanism Design

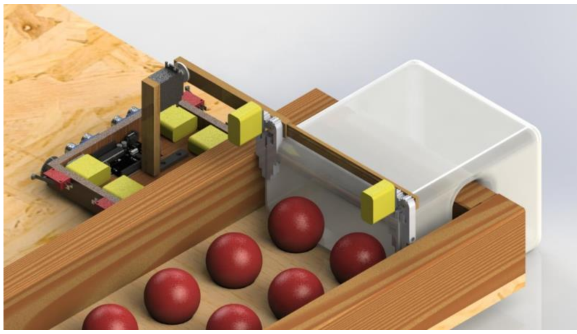
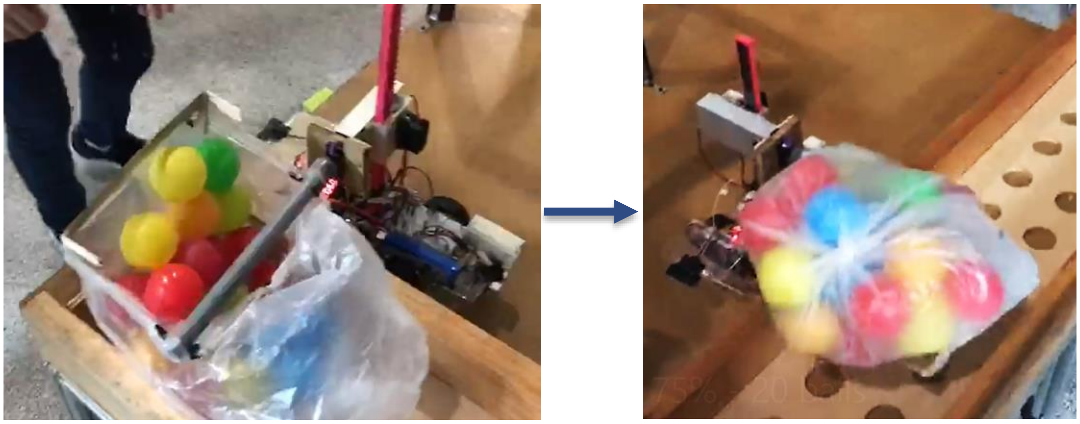


Figure 2(a): Extendable arm with jaw clamps

Figure 2(b): Fixed-length arm without jaw clamps

The idea of having a detachable plastic bag was based on a misunderstanding of the competition rules. An assumption was made that the vessels must not be in contact with the device, which is not true. In fact, any vessel fully contained within the inland compound is considered deposited, regardless of contact with the system. With that information, the depositing mechanism was modified into a simpler concept.

After discussion, the arm was designed to have the plastic bag permanently attached. The vessels were then deposited by lowering down the device arm into the inland compound, as shown in **Figure 1(b)** and **Figure 2(b)**. However, during testing, a flaw was discovered in this design, i.e. vessels may fall out of the plastic bag as the bag remains open throughout the run. This issue was solved by having a 360° rotation of the arm to scoop up and trap the vessels in the plastic bag (see **Figure 3**). By implementing these approaches, the device safely contains the vessels in the plastic bag, and deposits them in a simplistic manner.

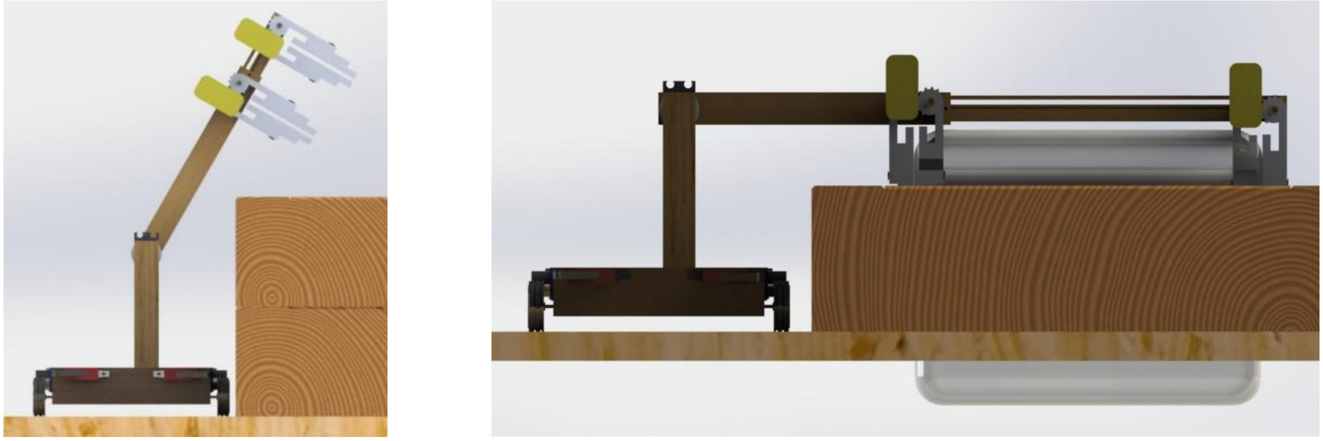


(a) (b)

Figure 3 (a) & (b): Mechanism to trap and contain vessels in plastic bag via rotation

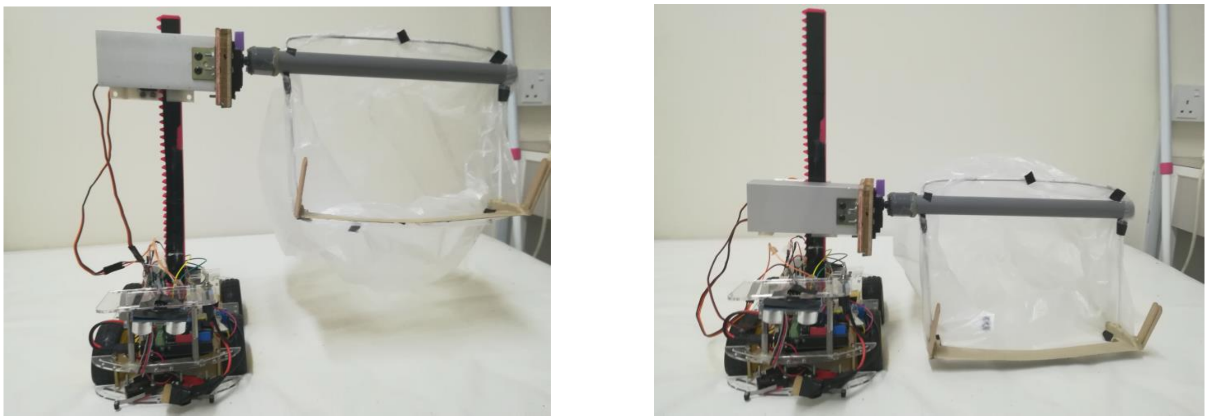
Arm Mechanism:

Initially, the device arm was designed to have rotational translation. A 180° servo was used to rotate the device arm by 90° to lower the plastic bag into the compound, as shown in **Figure 4**. The design was such that a 180° servo is attached to the joint of the arm in which the horizontal component of the arm rotates about (see **Figure 6(a)**). However, during testing, it soon came to realization that the width of the scoop was constrained by the arm's rotation. This was due to the frame of the scoop hitting the wall when lowered, especially during depositing. This caused some vessels to rest on top of the inland compound wall, which does not amount to being deposited. If the frame was made smaller, not all vessels would be collected. Therefore, to collect and deposit more vessels, a decision was made to change the translation mechanism of the arm into a different design.



(a) (b)

Figure 4 (a) & (b): Initial design for arm with rotational translation in CAD



(a) (b)

Figure 5 (a) & (b): Final design for arm with linear translation

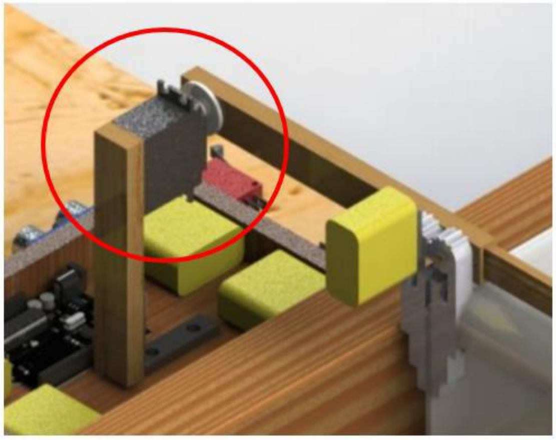


Figure 6 (a): Initial CAD design for 360-degree servo at arm joint

Figure 6 (b): Gear and pinion for final design

The final design uses linear translation for the device arm, as shown in **Figure 5**. With this design, depositing was made easier, as the plastic bag was lowered vertically into the compound. Moreover, the frame for the plastic bag could be made wider, which increased the likelihood of vessels being collected. Nevertheless, linear translation required a more complex design of the arm, since the rotational motion of the servo had to be converted into linear motion. To solve this problem, a rack and pinion system was designed in SolidWorks and 3D printed (see **Figure 6(b)**). The 180° servo was replaced with a 360° servo which was fixed to the 3D-printed gear. With these changes, translational motion of the arm was made possible.

Word Count: 722 words

REFLECTION ON TEAM PERFORMANCE

Throughout the 11-week timeline allocated for the project, our team has worked through several stages to come up with the final device to be used for the Warman competition. Below is a breakdown of those stages in further detail:

Design Stage

Based on the concept and aim of the Warman competition, an isometric sketch by each member was drafted. The sketches served as an illustrated proposal for the possible designs and sub-systems that could form the competition's device. The sketches were then analyzed to determine the feasibility of each design, the materials and processes that would be involved, the cost, and the reliability of the output produced. On such basis a single design was selected, and the building commenced.

Due to several shortcomings discovered throughout the building and testing stages, the team had to go back to the design stage on many occasions to make modifications and update the design. The final design used on the competition day and the initial design presented in the isometric sketch made use of different mechanisms, but the basic concept was unchanged.

Reflections and Possible Improvements: *Quite often the team proceeded to re-design without proper planning, which led to a wastage of time and materials unnecessarily. Starting with a rough isometric sketch or CAD drawing might have made it easier to foresee the issues with the proposed design and to resolve them before any building is involved.*

Testing Stage

Having completed the basic structure of the device, our team proceeded to implement the navigation component by programming in the relevant logic and testing it to verify if the device operates according to expectations. The device's performance was then repeatedly tested every time a new concept was built, and its logic programmed. This included the arm mechanism, the device orientation during collection and deposit, the device’s response to input from attached sensors, the transition between different actions, and the consistency of the output.

Reflections and Possible Improvements: *As a result of excessively minimizing the budget, the low-quality components bought had a negative impact on our device’s performance in the Warman competition where the consistency was greatly compromised. This issue could have been foreseen and possibly prevented had the members been more open-minded and flexible about investing in higher-quality components once the issue was recognized.*

Planning & Meetings

Meetings were held almost on a daily basis, and on average all four members were present. Prior to each meeting, an overview of the tasks to be completed was discussed and at the end the next step was decided on. The team had arranged to meet during the mid-semester break as well, with the aim of securing marks from the early bird challenge. Prior to the competition day, members of the team worked overnight to fix minor issues and finalize the device for the upcoming competition.

Reflections and Possible Improvements: *The “unlimited” allocation of time dedicated to the project may have had more of a negative impact than a positive one, because it essentially eliminated the sense of urgency to compromise and focus on producing results. The team was under the false impression that investing more time was the sole solution for every problem encountered. This ultimately led to a huge wastage of time in the initial stages and thus there was no sufficient time during the final stages of building and troubleshooting the device. Perhaps allocating a limited time and aiming for a score within the constraints of the said time would have placed the team in a better position during the competition.*

Communication & Management

The team’s means of distant communication was via a WhatsApp group for its convenience and ease in getting in touch. When it came to sharing resources, the team communicated via a combination of WhatsApp and an extensive usage of Google Drive. The management of the team’s pace was closely directed by one of the members, while the other members monitored the progress and provided feedback accordingly. Overall no disputes occurred between members, as every member generally held an open-minded and understanding attitude toward the others. The contribution towards the project might have varied among members with some dedicating additional effort, however all members had invested a fair share of time and effort such that the team dynamic was well-maintained throughout the 11-week period.

Reflections and Possible Improvements: *A clear discussion of the goals and expectations of each member might have helped align all team members on the same page and prevented possible dissatisfaction from building up, if any.*

Word Count: 747 words

PROJECT EXPENSES & ARDUINO KIT

The amount of money spent by each member was collated and the costs were distributed equally. A RM200 subsidy was also provided by Monash University to cover some costs.

Name	Daniel	Siew Wen	Jehad	Tzen Yee
Total Amount Spent	RM227.96	RM6	RM1.8	RM21.5

Table 1: Total expenses borne by each team member

ITEM	QUANTITY	COST	PAYOR
Arduino 3 axis Magnetoresistive Sensor	1	RM13.90	Daniel
Arduino 4WD 2 layer Smart Car Robot Chasis	1	RM42.40	Daniel
Arduino Ultrasonic sensor HC-SR04	3	RM 9.90	Daniel
Arduino 15A Micro Limit Switch SPDT	4	RM7.20	Daniel
Arduino LM2596 Step Down Voltage Regulator with Display	(1+2)	RM14.50+RM16	Daniel
Arduino Compatible Atmel DIP ATMEGA328P UNO R3	1	RM23.50	Daniel
Mini Garbage Bag	1	RM2.00	Daniel
Laundry net bag	1	RM5.55	Daniel
Whisk Set	1	RM10.00	Daniel
Transparent garbage bag 3 color in one set	1	RM6.96	Daniel
M3 X 14mm HEX Stand-off	2	RM2.40	Daniel
M3 X 20mm HEX Stand-off	2	RM2.80	Daniel
M3 X 30mm HEX Stand-off	2	RM3.20	Daniel
Laundry bag 30x40 cm	1	RM3.65	Daniel
PVC Electrical Tape	1	RM4.90	Tzen Yee
Corrugated board 21”x30”	1	RM5.88	Tzen Yee
Classic Acrylic Double-sided Tape	1	RM3.76	Tzen Yee
Apollo Masking Tape	1	RM3.56	Tzen Yee
Apollo Cloth Tape	1	RM3.4	Tzen Yee
Li-Po Battery	1	RM50	Daniel
180° Servo Motor MG-996R	1	RM14	Daniel
PVC Pipe *1M with End Cap	1	RM1.8	Jehad
Aluminium SHS *1M	1	RM6	Siew Wen

Table 2: Breakdown of the expenses all purchased components.

CONCLUSION

In conclusion, working as a team on this project for the past 12 weeks has been very rewarding with a mix of surprise, frustration, weariness, laugher, and many other sensations encountered throughout the long hours each one of us has invested. Starting with an idea and developing it through sketches and documentation until the final device is built has been a very insightful experience for us both as engineering students and as future engineers. Throughout the duration we had worked together, we came to notice so many aspects and variables that need to be accounted for in the process of designing and building a device. We've had first-hand experience with how things can go wrong and how as engineers we are tasked to come up with appropriate solutions to deal with any and all issues that arise. As a team, we can confidently say that the knowledge and experience we have gained from working on this project is invaluable.

APPENDIX A: ENGINEERING DRAWINGS

Detail Drawing 1: Servo Bracket

Refer to Servo Bracket.PDF

Detail Drawing 2: Rack Arm

Refer to Rack Arm.PDF

Detail Drawing 3: Scoop

Refer to Scoop.PDF

Detail Drawing 4: Indented Pinion

Refer to Indented Pinion.PDF

Receipts


MR. D.I.Y. (KUCHAI) SDN BHD
CO-REG :750441-W
LOT 1851-A & 1851-B, JALAN KPB6,
KAWASAN PERINDUSTRIAN BALAKONG
43300 SERI KEMBANGAN, SELANGOR.
(SOUTH CITY MALL)
-INVOICE-
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7 DAYS WITH RECEIPT.
STRICTLY NO CASH REFUND.

(a)


YEW SIONG INDUSTRIAL
SUPPLIES SDN BHD
178306-U
NO 24, JALAN PJS 11/22,
BANDAR SUNWAY, 46150
PETALING JAYA, SELANGOR
TEL : 03-5634 5419 FAX : 03-5634 5626
CASH SALES
CASH
RECEIPT #: CSBS029183 DATE: 24/05/2019
SALESPERSON: IMAMUL TIME: 17:55:00
CASHIER: USER

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M3 X 20MM HEX STAND-OFF			

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CASH 2.80
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(b)


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Selangor Darul Ehsan, Malaysia
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AEON BIG HYPERMARKET
SUBANG JAYA SELANGOR

(d)


MR. D.I.Y. (M) SDN BHD
(CO.REG :860671-D)
LOT 1851-A & 1851-B, JALAN KPB 6,
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43300 SERI KEMBANGAN, SELANGOR
(SUNWAY GEO)
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7 DAYS WITH RECEIPT.
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ACE
The helpful place
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GOODS SOLD ARE NOT REFUNDABLE

(f)


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NEW Dept Launching !
English | Revision | CD-Rama
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SUNWAY PYRAMID
Total RM 16.60
Cash -100.00
CHANGE 83.40
Item Count 13
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BE A POPULAR CARD MEMBER
AND ENJOY SPECIAL DISCOUNTS
THANK YOU. PLEASE COME AGAIN

(g)


ACE
The helpful place
GIANT ACE SDN BHD (424850-P)
GST ID : 002020605952
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THANK YOU FOR SHOPPING AT ACE HARDWARE
GOODS SOLD ARE NOT REFUNDABLE

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My Robot E-commerce Sdn. Bhd.
Lot 2.67, 2nd Floor, South City Plaza, Persiaran Serdang Perdana, 43300 Seri Kembangan, Selangor.
Telephone 03-89570357
robotedu.my@gmail.com
https://www.robotedu.my

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Shipping Method	Self Collect at Seri Kembangan Shop

To	Ship To (if different address)
Robotedu education 2.67 2nd floor seri kembangan 43300 Selangor Malaysia robotedu.my@gmail.com 0389570357	Robotedu education 2.67 2nd floor seri kembangan 43300 Selangor Malaysia Contact No. : 0389570357

Product	SKU	Quantity	Unit Price	Total
Arduino Compatible Atmel DIP ATMEGA328P UNO R3 + USB B type Cable - Option : Board only	Arduino-015-Boardonly	1	RM23.50	RM23.50
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(i)

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Telephone 03-89570357
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Product	SKU	Quantity	Unit Price	Total
Arduino 4WD 2 Layer Smart Car Robot Chassis Kit Base Set - V2	RB-003	1	RM42.40	RM42.40
Arduino Range Finder Ultrasound Ultrasonic Sensor HC-SR04 HC SR 04	Sensor-074	3	RM3.30	RM9.90
Arduino 15A Micro Limit Switch Touch Switch SPDT	EE-343	4	RM1.80	RM7.20
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To	Ship To (if different address)
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Product	SKU	Quantity	Unit Price	Total
Arduino LM2596 DC-DC Step Down Voltage Regulator Module with Display	Module-073	1	RM14.50	RM14.50
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23 MAY 2019
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Figures (a)-(l): Receipts for purchased components and materials