Robomaster Standard Robot Proposal

Prepared by Team FTFT

Introduction

Name: Li Chi (Leader)
Faculty: ISS (Institute of System Science)
Year: Master Year 1
I'm a year 1 master of technology student. Previously, I obtained my bachelor of science in statistics from NUS as well. After that, I worked in credit risk modelling in financial institute. I'm interested in the field of predictive modelling, feature engineering, big data engineering and Graph & Web mining using Hadoop, R, and Python.

Name: Wang Yongtian
Faculty: FoE(Mechanical Engineering)
Year: 3
I am a year 3 Mechanical engineering student. With the knowledge that I learnt from my major courses, I can help with the fields of mechanical design, assembling and testing. In addition, I am also interested in embedded programming, python, vision system. When I was in polytechnic, I have done projects about embedded programming with pretty good results. I have learnt python at summer school with a grade of A+. I also helped to make vision system to check failure products and surface cleanliness during the internship period. I have a good understanding and skillful at CAD, circuit troubleshooting and CNC machines. I hope my inter-disciplinary knowledge and skills could help our RM team.

Name: Liew Shaun Kheng
Faculty: FoE(Mechanical engineering)
Year: 3
Experience: I am a Year 3 undergraduate student from Mechanical Engineering. I am very Interested in Robotics and planning to specialize in this field in my upcoming year. During my academic years in Singapore Polytechnic, I pursued in Diploma in Mechanical Engineering, and I have done some projects that require good designing and fabrication skills. I have great dexterity in fabrication, CAD and Solidworks drawing, and have some fundamental knowledge in Python. I will work hard and commit to this project in order to enhance my technical and team-working skills through this project.

Name: Zou Yanfeng
Faculty: FoE(Electrical engineering)

Year: 2
Experience: Interested in Robotics and planning to specialize in AI and communication systems. I have some experience in Autocad software and would like to learn more knowledge and skill taking part in this project.

Name: Jody
Faculty: FoE (Electrical Engineering)
Year: 2
Experience: I am a year 2 Electrical Engineering w/ 2nd major in Economics undergraduate. I have basic knowledge on CAD and coding on several platforms. I am interested in robotics and the idea of building a working object from scratch. I feel that it is the best way to explore my interests and apply what I have learnt so far by putting it into practical uses. I feel that this journey will provide a different angle of learning, process and fulfilment that will be both memorable and valuable.

Proposed Manpower Arrangement

No	Role	Description	Assign to
1	Mechanical	Gun; Gimbals system;Chassis; Suspension	Shaun
2	Electrical	Power management; Electric Drive; Fail-safe	Yongtian
3	Electronics	Sensor interface; Close-loop Control	Jody
4	Software	Model development; Sensor drivers	Li Chi
5	Software	Computer vision; Motion planning;	Yanfeng
6	Operation	Sponsorships; Chinese-English Translation	Open Position
7	Operation	Accounting; Publicity Materials	Open Position
8	Pilot	TX & RX system; Game-play strategy	Open Position

* For interested people to join our team, please contact Telegram @burgerkheng

Timeline & Milestones

Subject	Estimated Date
Run down of Rule book	25 Oct 2019
Mock-examination 1 of competition rule book	5 Nov 2019
Drafting of needed components for purchase, Start of technical proposal	10 Nov 2019
Mock-examination 2 of competition rule book	15 Nov 2019
Rule-book assessment	20 Sep 2019
Send draft of technical proposal, list of purchase item for approval	25 Nov 2019
Start Assembly and fabrication of required components and softwares	6 Dec 2019
Checkpoint for basic components of robot, e.g. power, communication, movement, etc	26 Dec 2019
Mid term assessment	23 Jan 2019
Checkpoint for more advanced components of robot, e.g. Sensors, computer visions, software	15 Feb 2019
Final Assessment	1 Mar 2020
Referee System Installation	1 Mar 2020
Progress check for basic components of robot, e.g. power, communication, movement, etc	1 Apr 2020
Progress check for more advanced components of robot, e.g. Sensors, computer visions, software	1 May 2020
Testing of robot 1	15 May 2020
Testing of robot 2	30 May 2020
Testing of robot 3	15 Jun 2020
Testing of robot 4	30 Jun 2020

Purpose of the Robot

The most basic type of robot, characterised by its quick, nimble movements and high firing accuracy. It replenishes its ammunitions in a timely fashion and is able to dissipate heat efficiently to keep within the power limit.

The base is constructed with a parallelogram platform that is consistently optimised to remove excess weight and increase mobility. Through testing various methods of launching projectiles, the platform will utilise the solution with the best balance of firing rate and reliability.

Key aspects of the robot to consider

- **Chassis**
    - The chassis allows it to move in multiple directions, including forwards, sideways, diagonally, and rotate. A mecanum wheel will be used on the robot.
    - A fabricated aluminium guard must be placed to cover the wheels to prevent impact.
    - A suspension system will be placed at the wheels to increase the stability of the vehicle. This is also to prevent vibration during maneuvering.
    - Chassis power not exceed 80 watt.
    - Total weight of the robot not exceed 20kg.

- **Sensors**
    - Robot should take advantage of the camera mounted to recognise armour plates, helping it to aim at enemy robot's armour plate. This can be done by recognising the shape and lighting that form the parameter of the armour plate.
    - IR Sensor can be utilised to check the distance of enemy robot. This information can then be used to alert the player when the enemy is too close/too far from the optimal shooting range.
    - Gyroscope, accelerometer and magnetometer should be used to align and calibrate the position and movement between gimbal and main body of the robot.
    - Especially in the developmental stages of robot, it is crucial to equip as many parts of the robot with sensors to enable the collection of comprehensive data that will aid in the development and tweaking of each component of the robot. Thermometer sensors, can be used to detect temperature levels at different parts of the robot such as CPU and Motors.

Accelerometer can be placed near the wheels to detect the vibration levels from the suspension system.

- **Two-Axis Gimbal**
  - Robot must be able to have a stabilized gimbal platform of which a camera and the launching mechanism would be mounted.
  - The camera should be able to transmit a live first person view of the camera with clear resolution and little time delay back to its controller.
  - The launching mechanism could be mounted on the same or different gimbal platform as the camera feed.

- **Projectile Supplying System**
  - Projectile supply system should be able to feed projectiles to the launching mechanism reliable with a low failure rate.
  - Reloading of projectile should be fast and reliable (perhaps hand-free).
  - Able to transmit the ammunition to the UI in real-time.

- **Launching Mechanism**
  - Able to fire 17mm projectiles at its maximum barrel speed of 30m/s.
  - Able to hit targets accurately at a distance of minimum 20m (arena is 28m long) with minimal spread.
  - Able to track its own firing speed to prevent point deduction due to barrel overheating violations.

Referee System:
Speed Measurement Module:

Hardware Circuit system:
Software- scratch3

Hardware Resources

Sensors

- Camera module: KS2A17
  - USB connected
  - 2MP 1920*1080 resolution
  - 120 FPS

- Accelerometer + Gyroscope:MPU-6050
    - 6 Axis
    - Accurate: 16-bits analog to digital conversion hardware for X,Y,Z channel simultaneously
    - Provide accelerations values, calculation of pose and heading based on readings
    - Connects with I2C-bus
    - Cheap

- 3D Magnetometer IST8310
    - Calibration free after strong magnetic interference
    - Connects via I2C-Bus
    - Wide dynamic range of ±1600 uT (x,y axis) and ±2500uT(Z axis)
    - Software and algorithm support available

- Current Sensor Module RB-Dfr-149
    - 50A Current Sensor (AC/DC)
    - Fully integrated Hall Effect based linear ACS758 current sensor
    - Sensitivity: 40 mV/A

- Temperature and Humidity Sensor TMP36
    - 10 mV/°C scale factor
    - ±0.5°C linearity
    - Temperature range: −40°C to +125°C

- Distance Sensor Modules Adafruit 3978
    - Accuracy of ± 2cm
    - Provides super-fast distance readings up to 1000 times per second
    - Connects via USB connector
    - Range up to 14m.
    - Laser free

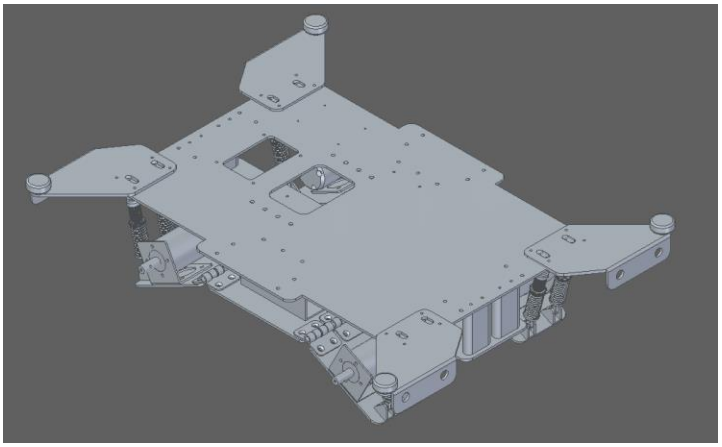
Structural Design

General Design

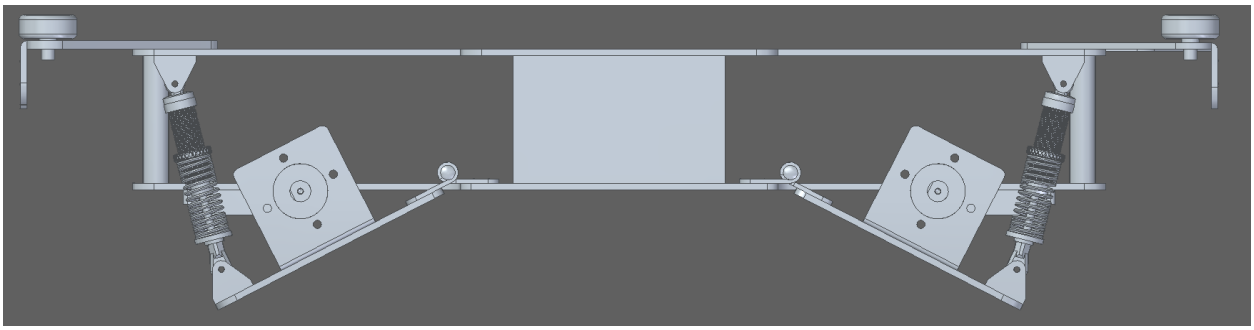
The design of the Standard robot is referred to the open source from Hubei University of Technology (HBUT).

Chassis design

The design of the chassis is simple, by using a thin aluminum plate with allowance for the motor and the CPU.

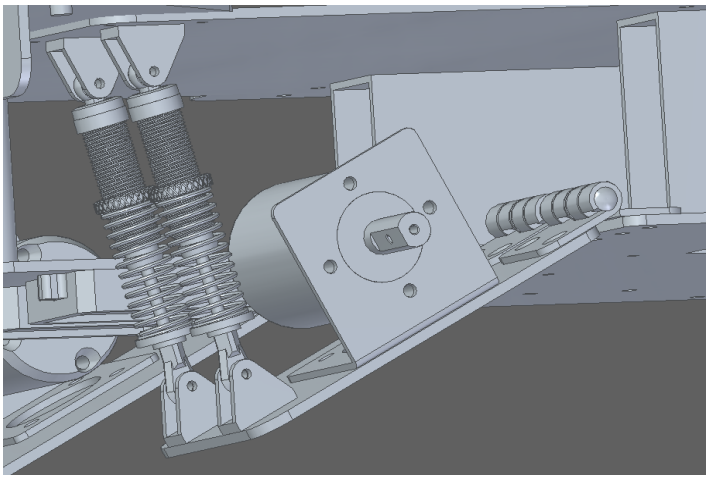


The guard for the wheels can be improved by covering the entire corner of the wheels, the improvement of the design will create a barrier or a guard for the wheels to prevent the wheels from external impact from other vehicles or structures.

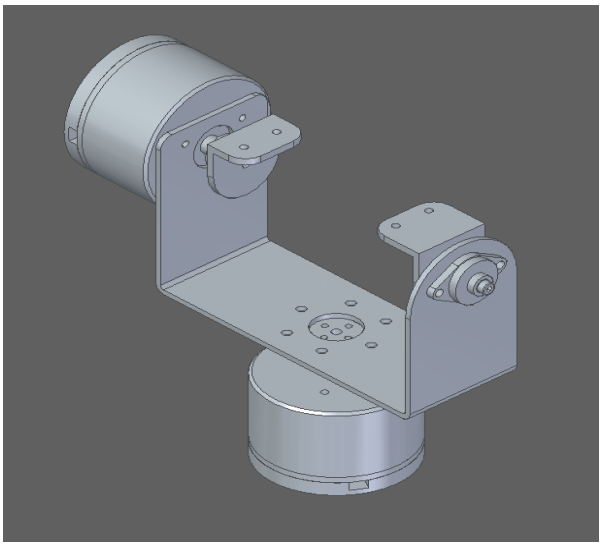


This design of the suspension system is very simple and easy to manufacture. The motor and the holder is connected to a plate hinged to the main body. Two suspension

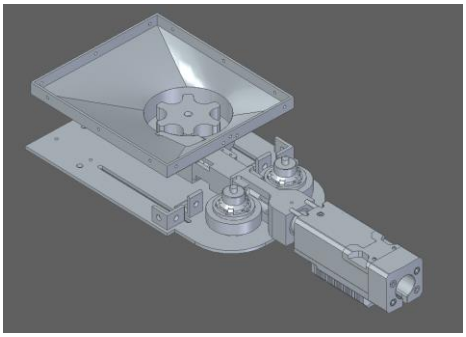
piston is connecting the hinged plate and the main chassis, serving as the suspension system for the standard robot. The function of this design is to minimize the vibration of the standard robot during maneuvering and increasing the stability of the vehicle.

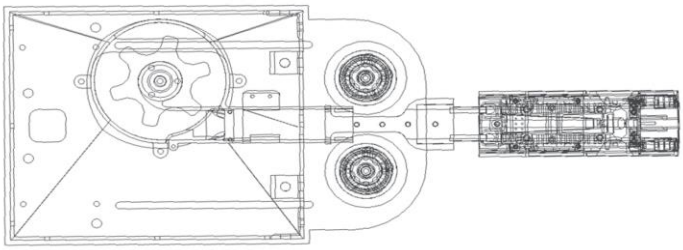


Two motors will be installed on the gimbal with two different orientation based on the axis. The motor below the frame will be controlling the x-axis, allowing the firing mechanism and the camera to turn left and right, while the motor on the side of the frame will be controlling the y-axis of the gimbal, allowing it to turn up and down. Brushed motor will be used to allow the gimbal to turn in both directions by inverting the polarity of the applied voltage.



The picture below shows the design of the firing mechanism. The aluminium plate on the top of the design acts as a funnel for the projectiles to be fed into the firing mechanism. A motor will be attached to the wheel to feed the projectiles to the accelerator at a constant speed. A motor will be controlling the accelerator to fire projectiles.





Proposed Budget

No.	Item	Item Code	Discounted Unit Price	Quantity	Total Price	Notes
1	RoboMaster Red Dot Laser	CP.RM.00000027.01	13	1	13	
2	RoboMaster GM3510 Brushless DC Motor	CP.RM.00000023.01	47	2	94	*Gimbal motor, 2 for lateral and horizontal*
3	RoboMaster Mecanum Wheel (right)	P.RM.000003	44	2	88	
4	RoboMaster Mecanum Wheel (left)	CP.RM.000005	44	2	88	
5	RoboMaster 2312 ESC-420S	CP.RM.000010	5	4	20	
6	RoboMaster TB47 Battery Charger 100W (without AC cable)	CP.RM.000020	19	1	19	
7	RoboMaster Robot Remote Controller Receiver	CP.RM.000030	16	1	16	
8	RoboMaster Robot Remote Controller Set	CP.RM.000034	56	1	56	
9	RoboMaster ESC Center Board	CP.RM.000048	5	1	5	
10	RoboMaster Rubber Roller for Mecanum Wheel	CP.RM.000049	6	4	24	
11	RoboMaster Battery Rack (compatible)	P.RM.000061	16	1	16	
12	RoboMaster TB47 Battery 100W Charger AC Cable	CP.BX.000034	4	1	4	
13	N3 Standard	CP.NZ.000035	333	1	333	*Pneumatic gas cylinder*
14	RoboMaster M3508 P19 Brushless DC Gear Motor	CP.RM.00000000.01	79	4	316	*Wheel motor*
15	RoboMaster C620 Brushless DC Motor Speed Controller	CP.RM.00000001.01	63	1	63	
16	RoboMaster M3508 Accessories Kit	CP.RM.00000005.01	54	4	216	
17	RoboMaster Development Board Type A	CP.RM.00000012.01	68	1	68	
18	RoboMaster Development Board Type B	CP.RM.00000013.01	35	1	35	
19	RoboMaster Development Board OLED	CP.RM.00000014.01	14	1	14	
20	RoboMaster M2006 P36 Brushless DC Gear Motor	CP.RM.00000015.01	41	2	82	*Propulsion motor for pellet feeding and conveyer belt*
21	RoboMaster C610 Brushless DC Motor Speed Controller	CP.RM.00000016.01	25	1	25	
22	RoboMaster Development Board Cables	CP.RM.00000033.01	40	1	40	
23	TB47D Battery	CP.TP.000130	216	2	432	*1 Battery is ~100kWh*
24	Manifold 2-G	CP.RM.00000039.01	879.2	1	879.2	*GPU Computer*
25	RoboMaster Cable Package CP02	CP.RM.000045	30	1	30	
Sum					**$2,976**	

Parts list: https://www.robomaster.com/en-US/resource/pages/1008?type=announcementSub
Remove armour plates, laser pointers, referee system out of budget as it will be loaned from DJI