Conceptual Design

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INTRODUCTION:

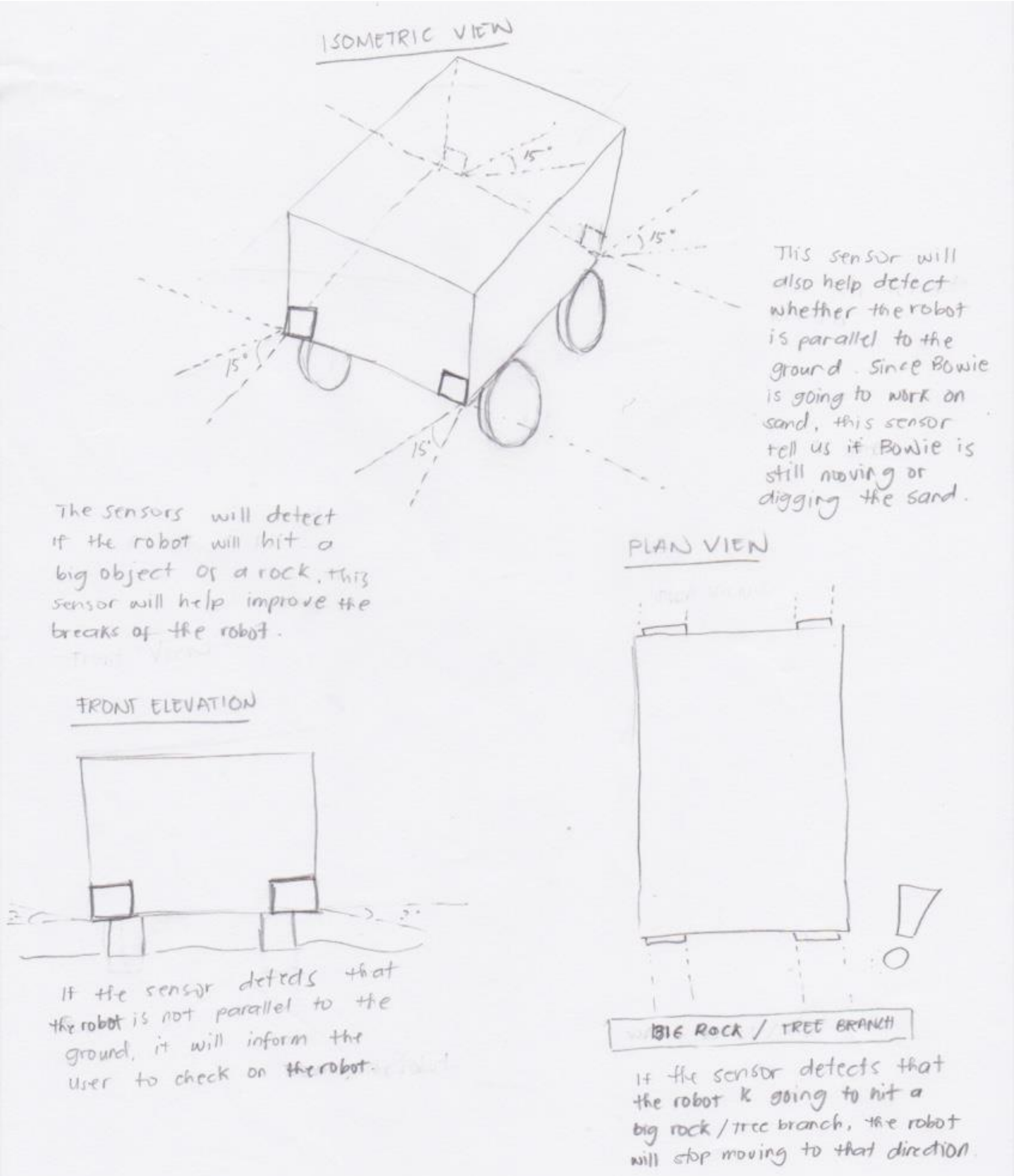
After we created a list of prioritized design criteria and gather relative benchmarking information base on our client's needs, we are moving to the ideate stage of design process which generate as many as design concepts as possible in order to come up one of the most suitable and reliable solutions for our further project development. In this deliverable, we will demonstrate and explain our group's global conceptual designs for the solution, and also present the evaluation and analysis for each concept in the purpose of selecting one of best solution for further development bases on our design criteria and benchmarking.

Note: Due to the reason of our group has already combine and refine each team member's three design concepts into three global conceptual designs during our team meeting and lab section, we will not present each design of team members. However, there will have identifications for the contributions of each team member (what parts come from which team member) in the demonstration of global conceptual. In addition, Ben Paul was not included in the conceptual design process due to his own individual issues that he missed the lab section as well as the lectures.

DESIGN-CONCEPT GENERATION:

1. First global design:
   a) Team contribution:
      The original idea comes from Meneses, which he wants to use one sensor turning in 360 degree under the platform of the robot to detect the big barriers around robot to predict braking. However, it is not effective enough because it hard to find a suitable turning speed for the sensor, and it will miss some objects during the turning. Thus, we combine the idea of Musetti that put a sensor in each hole of robot legs, and the ideas from both Guo and Chen that use the sensor to inform the robot whether it is parallel to ground or not to avoid filliping of the robot.
   b) Overall Explanation of how it works:
      For this design, we are using for detective sensors in each corner of the robot to help robot trigger braking effective and avoid flipping. In order to do this, sensors will detect the distance between itself with big barriers to predict whether trigger braking or not, and each sensor's detective is in 15 degree, which works as a spirit level, to ensure there is not a big angle difference respect to original to avoid flipping.
   c) Advantages & Drawbacks:
      This solution is easily to execute, prototype, and modify at a low cost. However, for some large-scale piece of garbage, sensors may consider it as barrier instead of picking it up to the storage can. In addition, it also did not meet the minor requirement of helping wildlife monitoring. However, we may combine this idea with others after perform overall analysis and evaluation.

d) Sketches of design:



This sensor will also help detect whether the robot is parallel to the ground. Since Bowie is going to work on sand, this sensor tell us if Bowie is still moving or digging the sand.

The sensors will detect if the robot will hit a big object or a rock, this sensor will help improve the breaks of the robot.

If the sensor detects that the robot is not parallel to the ground, it will inform the user to check on the robot.

If the sensor detects that the robot is going to hit a big rock / tree branch, the robot will stop moving to that direction

2. Second global design:

a) Team contribution:

The main idea of this design come from Chen, who would like to improve the minor requirement in the problem statement-wildlife monitoring. He was intensively to put two infrared sensors in the front of the robot to detect the temperature of the wild life. However, this idea does not fulfill our group's main objective, but it is only one idea that includes minor requirement in our group. Thus, we combine it with one of the design from Guo that put one detective sensor under the end effector of the robot to predict braking. In addition, we do a further refinement for this design by adding temperature detection design from both Meneses and Chen.

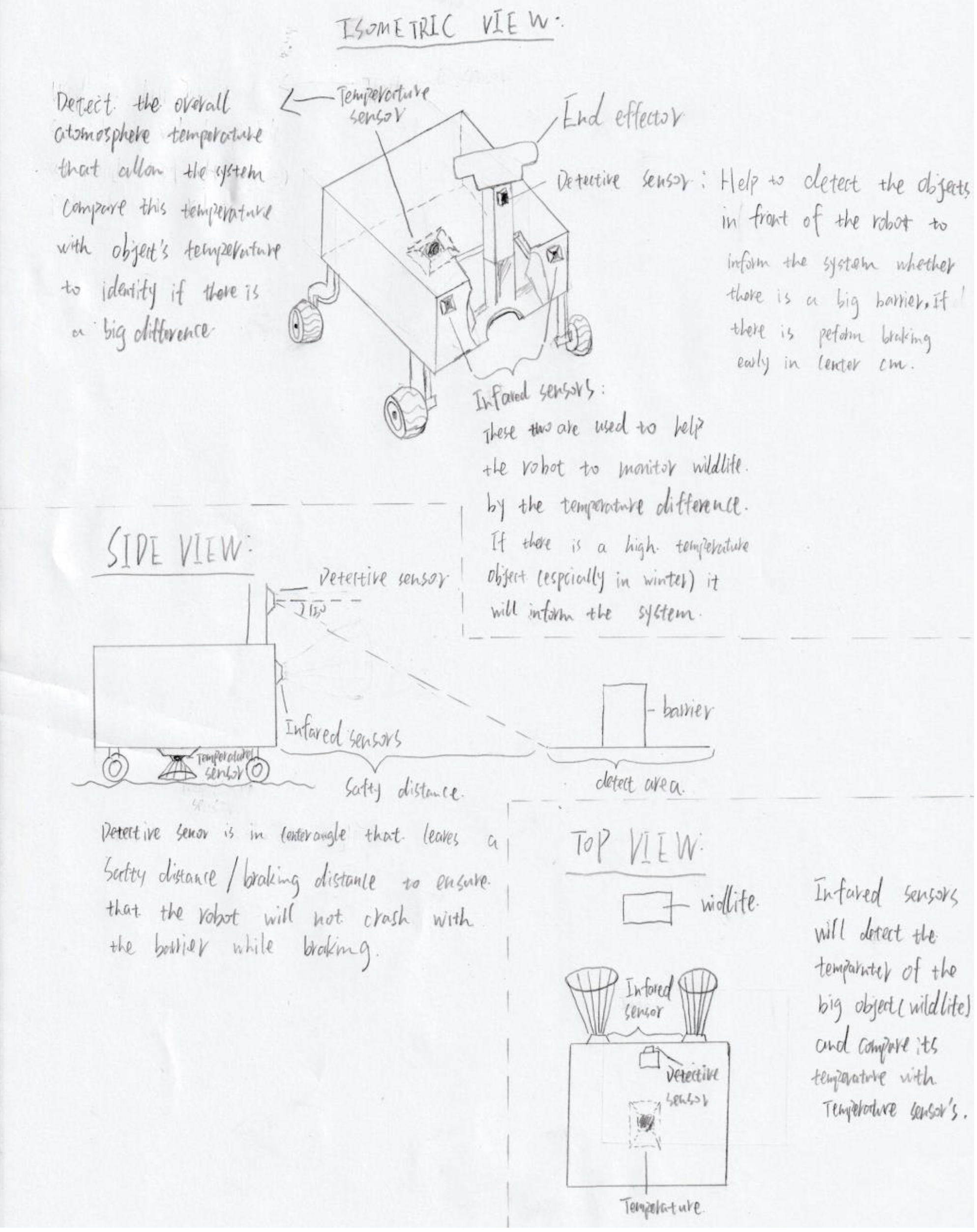
b) Overall explanation of how it works:

The sensor under the end effector will help robot to detect barrier in front of it, and it is set up in 15-degree respect to horizontal and plus itself detective angle that will leave a blank area which not be detected as the safety/braking distance to ensure robot will not crash with barriers while braking. The temperature sensor used to send the average atmosphere temperature back to the robot, and the system of robot can used it as the standard to find the difference between the atmosphere and object's temperature, and according to this difference, robot can decide whether the object is wildlife or not.

c) Advantages & Drawbacks:

The biggest advantage of this design is it ensure that there would be enough distance for robot to perform braking, as well as it satisfy the need of wildlife monitoring. However, due to the reason that the detective sensor is set up under the end effector, we need to ensure that detective sensor is turn off while robot is picking up garbage. In addition, the position of this sensor may short its product life, because of the friction between it with ground.

d) Sketches of design:



Detect the overall atomosphere temperature that allow the system compare this temperature with object's temperature to identity if there is a big difference

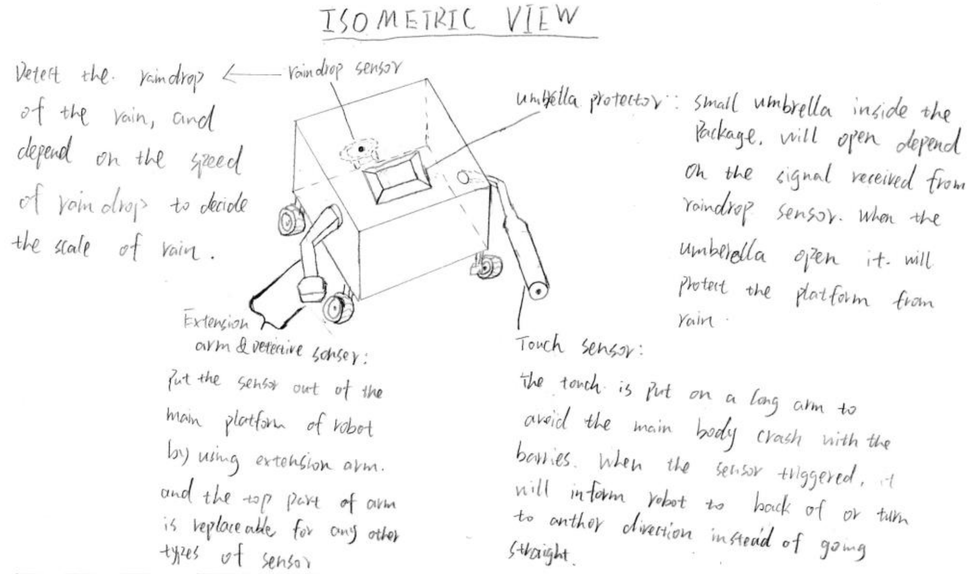
Detective sensor: Help to detect the objects in front of the robot to inform the system whether there is a big barrier, if there is perform braking early in center cm.

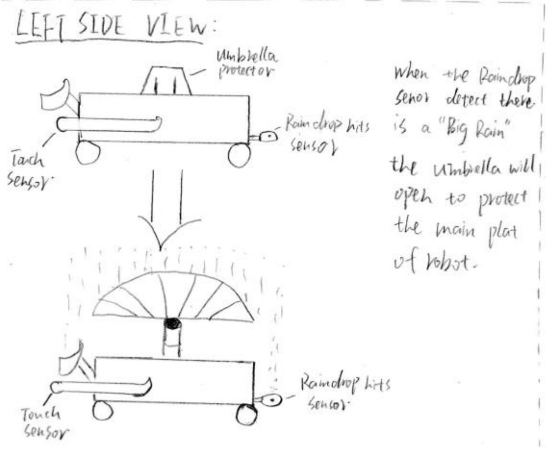
Infared sensors: These two are used to help the robot to monitor wildlife by the temperature difference. If there is a high temperature object (espcially in winter) it will inform the system.

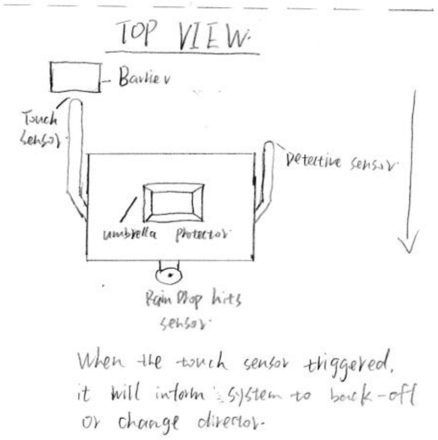
Detective senor is in centerangle that leaves a Safety distance / braking distance to ensure that the robot will not crash with the barrier while braking.

Infared sensors will detect the temparnter of the big object (wildlite) and compare its temperature with Temperature sensor's.

3. Third global design:
   a) Team contribution:
      This design’s main part is come form Musetti, which use a small umbrella package to protect the robot from rainy day. Then, we decide to use the touch sensor arm design of Chen as the main way to improve the braking system of the robot after our group discussion. Next, we combine the rest of idea from Guo and Meneses, which is an extensive arm with sensor inside, to the design to partially help the detection of the barrier.
   b) Overall explanation about how it works:
      There is a sensor at the back of Bowie that goes on when mode in contact with liquid (raindrops), it will detect the speed of raindrops and send the information back to system to decide whether open the umbrella or not. Thus, there is an umbrella package protector at the top of Bowie and it expands when rain hits the sensor. It protects Bowie from rain (water can damage the interior and flaw its functionality. Furthermore, the touch sensor will keep robot from crash with barriers, and the extension arm has detective sensor in it to help the prediction of perform braking.
   c) Advantages & Drawbacks:
      The first advantage is this design enables the robot to work in raining or even snow days, because the umbrella at the top will protect the main body from water. The second advantage is that the touching sensor normally will not miss the object when they are in touch, so it works precisely. Furthermore, the top part of extension arm is replaceable, which it could be any types of sensor by require. However, the umbrella may become extra load during sunny day that may affect the speed as well as the battery run time of the robot, and touch sensor may lower the robot’s collecting efficiency.
   d) Sketches of design:


ISOMETRIC VIEW
Detect the raindrop of the rain, and depend on the speed of rain drop to decide the scale of rain.
raindrop sensor
umbrella protector: Small umbrella inside the Package. will open depend on the signal received from raindrop sensor. When the umbelella open it will protect the platform from rain.
Extension arm & detective sonser: Put the sensor out of the main platform of robot by using extension arm. and the top part of arm is replaceable for any other types of sensor
Touch sensor: the touch is put on a long arm to avoid the main body crash with the barries. When the sensor triggered, it will inform robot to back of or turn to anthor direction instead of going straight.


LEFT SIDE VIEW:
Umbrella protector
Raindrop hits sensor
Tach Sensor
When the Raindrop senor detect there is a "Big Rain" the umbrella will open to protect the main plat of robot.
Raindrop hits sensor
Touch sensor


TOP VIEW.
Barlier
Touch Sensor
Detective sensor
umbrella protector
Rain Drop hits sensor
When the touch sensor triggered, it will inform system to back-off or change director.

ANALYSIS & EVALUATION:

- Functional Requirement:

#	Conceptual Design Specifications	Imp (Weight)	First design	Second design	Third design
1	Shaking frequency for storage tank	3	1	1	1
2	Charging voltage for robot	3	3	3	2
3	Breaking/stopping distance	5	2	3	3
4	Time of detect and response	5	2	2	3
5	GPS & GPRS	2	1	1	1
6	Breaking Speed for breaks/sensor	4	2	2	3
7	Sensor Angle	5	3	3	2
8	Sensor Current	5	3	3	2
9	Sensor detective distance	5	2	3	3
10	Sensor voltage	5	3	3	3
	Total		97	102	103

- Non-functional Requirement:

#	Conceptual Design Specifications	Imp	First design	Second design	Third design
1	Number of cameras & sensors	2	3	3	3
2	Aesthetics	1	1	1	1
3	Product life	2	3	2	3
	Total		15	13	15

- Constraints:

#	Conceptual Design Specifications	Imp (Weight)	First design	Second design	Third design
1	Weight	3	3	3	1
2	Motor capacity	4	3	3	1
3	Size of storage tank	3	1	1	1
4	Specialized outfits size for different weather (Platform)	3	1	1	3
5	Operation Temperature	4	2	3	2
6	Battery Capacity	4	3	2	1
7	Cost of sensors and other related accessories	2	3	2	1
8	Maximum Payload	2	3	3	1
	Total		59	57	35

- Total score:

Conceptual Design	First design	Second design	Third design
Score	**171**	**172**	**153**

- Reasons of analysis and evaluation for each conceptual design:
  a) Functional requirement:
    1) All three designs are not related to storage tank,
    2) Both first and second design are only involved four sensor which will not affect voltage, but the third one has umbrella protector and two extension arms.
    3) First design cannot grantee the breaking distance
    4) Third design has a touch sensor inside the extension arm, which physical response faster.
    5) None of three are related to this criterion.
    6) The extension arm of third design will physically stop the robot, while other two need time to response.
    7) Both first and second sensor are in 15 degree.
    8) Because there are many bigger devices involved in third one, the current may change.
    9) Second design is under the end effector which can detect further, and third one has an extension arm.
    10) All sensors used in three design reach the requirement.
  b) Non-functional Requirement:
    1) All three design have more than 2 sensors.
    2) None of three are related to this criterion.
    3) As the description of the drawback of second design in previous parts, its detective sensor's product life may shorter than others.
  c) Constraints:
    1) Third design has heavier devices associated with.
    2) Due to the reason of third design is heavier than others, its motor capacity will reduce.
    3) None of three are related to this criterion.
    4) Only third design has the solution for working in rainy/ snow day.
    5) Second design has both inferred and temperature sensors.
    6) The sensors in second design may required more electrical support, as well as the third design which is larger than second one.
    7) First design only involves four detective sensors which is much cheaper than second and third design. Third design has extension arms and umbrella protector which need more budgets.
    8) Third design is much heavier than first and second one, which reduces the maximum payload of the robot.

LIFE-LONG LEARNING:

We use design thinking as the engineer design process to develop our project. In the last several weeks, we had already gone through the stages of empathy and define which are included in deliverable b and c respectively. In deliverable b, we use both knowledge of identification of customer needs and how to interpret needs to transfer customer statement into need statement, and give relative importance to each need. In addition, we create our own problem statement base on these prioritized needs, which used as a guide for the design criteria, target specification, as well as the direction of whole project. In deliverable c, we created a list of prioritized design criteria and assign specification to each one based on the list of client's needs and benchmarking. In this deliverable, we use the knowledge/process of brainstorming and freehand sketching to ideate and visually perform these solutions. Then, we analysis and evaluate our conceptual designs by using the list of design criteria that developed in deliverable c, that helps us to select one of the best and suitable design for further development. Thus, every knowledge and deliverable are connected, and when we accumulate these to the end, we will get an integration of previous works which is our final project.

CONCLUSION:

During the lab section and team meeting, our team came up three global conceptual designs, which are the integration of our team members' individual design, as the solutions to partially stratify the needs of our client. According to the analysis and evaluation of these conceptual designs by performing the lists of design criteria form previous work, we decide to use second conceptual deign as the solution for further development due to its highest score-172. In next step, we will follow this conceptual design and create a first stage physical prototype and perform it during next client meeting to seek for improvements.