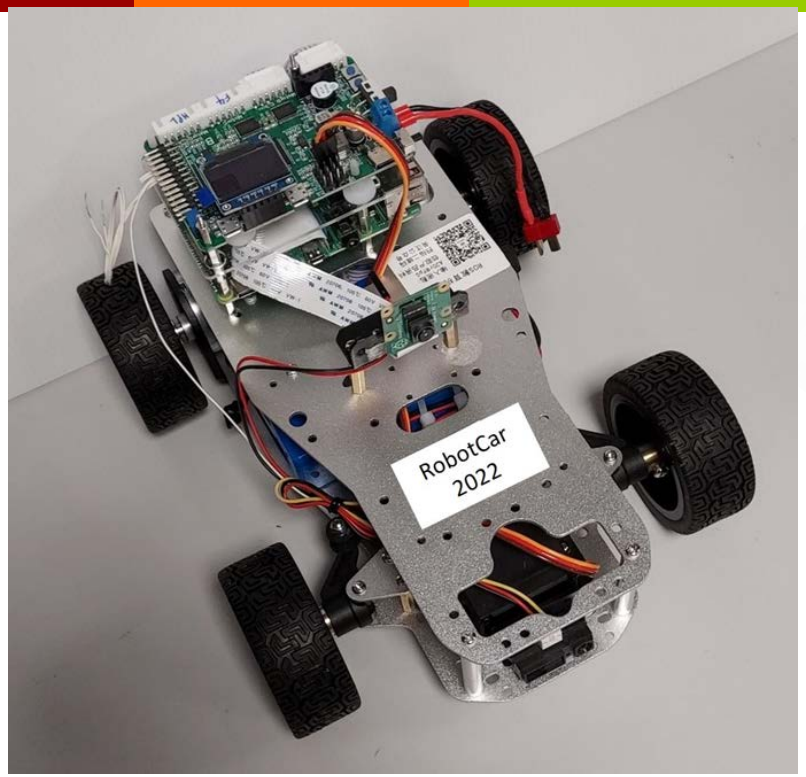
Multi-Disciplinary Design Project

Smitha K G



MDP Task

- Build a robotic system that can
  - Autonomously explore/traverse a known area, detecting images displayed on the arena
  - Obstacle avoidance by using visual markers “bulls eye”
  - Transmit and receive control signals from mobile device
  - Simulate physical robot and algorithms in software

Student Teams

- Teams of about ~(7-8) students :
  - if (you're CE and prefer to write code) || (you're CZ and want to work with hardware), that's perfectly fine
  - Work with your teammates to determine a good distribution
  - It's ok to rebalance/redistribute work as you go along

Supervisor & Lab Allocation

Academic Supervisor Allocation 2023-2024-Sem2			
	Supervisors	**Lab technician and GS**	**Teams**
Hardware Lab 1 **N4 -1a-03**	Li Fang (Dr) ASFLi@ntu.edu.sg Cham Tat Jen (Assoc Prof) ASTJCham@ntu.edu.sg	Tham Yiep Soon yiepsoon@ntu.edu.sg Feng Chengzeng S220126@e.ntu.edu.sg	Group 1 to 4
Hardware Lab 2 **N4-1b-05**	Goh Wooi Boon (Assoc Prof) ASWBGOH@ntu.edu.sg Chen Change Loy (Assoc Prof) ccloy@ntu.edu.sg	Zulkiffle Bin Kashno ASZul@ntu.edu.sg Nema Arpita ARPITA004@e.ntu.edu.sg Chua Haoyan HAOYAN001@e.ntu.edu.sg	Group 5 to 9 (5 groups)
Hardware Lab 3 **N4-b1a-05**	Qian Kemao (Assoc Prof) MKMQian@ntu.edu.sg Chan Syin (Assoc Prof) ASSCHAN@ntu.edu.sg	Lim-Tan Lay Choo ASLCTAN@ntu.edu.sg Yin Youtan YOUTAN001@e.ntu.edu.sg	Group 10 to 13
Hardware Project Lab **N4-1c-09a**	Loke Yuan Ren(Dr) yrloke@ntu.edu.sg Owen Noel Newton Fernando (Dr) OFernando@ntu.edu.sg	Tan Piah Chye ASPCTAN@ntu.edu.sg Panda Subrat Prasad SUBRATPR001@e.ntu.edu.sg	Group 14 to 17
Software Project Lab **N4-b1b-11**	Lee Bu Sung, Francis (Assoc Prof) EBSLEE@ntu.edu.sg Ong Chin Ann chinann.ong@ntu.edu.sg	Eng Hui Fang ASHFEng@ntu.edu.sg Wang Hongren HONGREN001@e.ntu.edu.sg Chen Cheng CHENG021@e.ntu.edu.sg	Group 18 to 22 (5 groups)
Software Lab 1 **N4-1a-02**	Oh Hong Lye hloh@ntu.edu.sg Deepu Rajan (Assoc Prof) ASDRajan@ntu.edu.sg	Chia Khoon Guan ASKGCHIA@ntu.edu.sg Zhao Yining YINING002@e.ntu.edu.sg	Group 23 to 26
Software Lab 2 **N4-1c-06**	Chia Liang Tien, Clement (Assoc Prof) ASLTCHIA@ntu.edu.sg Anupam Chattopadhyay (Assoc Prof) anupam@ntu.edu.sg	Tay Siew Eng SETay@ntu.edu.sg Loh Sher En Jessica LOHS0037@e.ntu.edu.sg	Group 27 to 30
Software Lab 3 **N4-b1c-14**	Lam Siew Kei (Assoc Prof) ASSKLam@ntu.edu.sg Liu Weichen (Assoc Prof) liu@ntu.edu.sg Liu Siyuan syliu@ntu.edu.sg	Goh Tong Hai THGoh@ntu.edu.sg Nie Jiahao JIAHAO007@e.ntu.edu.sg	Group 31 to 34

Contact Hours

- Weekly lab sessions: Fri 08.30-10.30
  - Wk 1: 8.30-9.30 am: Briefing LT19A.
  - Wk 1: 9.30- 10.30 am:- collection of the robotic kit for MDP from the respective labs. You can also meet your team and select a leader for admin purposes
  - Wk 2-9: Group meeting (2h)
- Recess Week: Mon (09.30- 12.30) –(1.30-4.30)
- There is no mandatory attendance taking during recess week.
- Week 9 Saturday (23rd March) 8.30am to 1pm – Competition day

Overall attendance [week 1 - 9] >= 80% required to Pass

Weekly lab sessions schedule(2-10)

- Note that for evaluation we are NOT using a FIXED arena. As the robot is having four very good wheels, the evaluation arena can be drawn in any location at NTU.

**** Sign your attendance in the lab from week 1 to week 9****

Attendance

- **Term Time:**
  - Report later than 15mins => LATE
  - Report later than 30mins => ABSENT

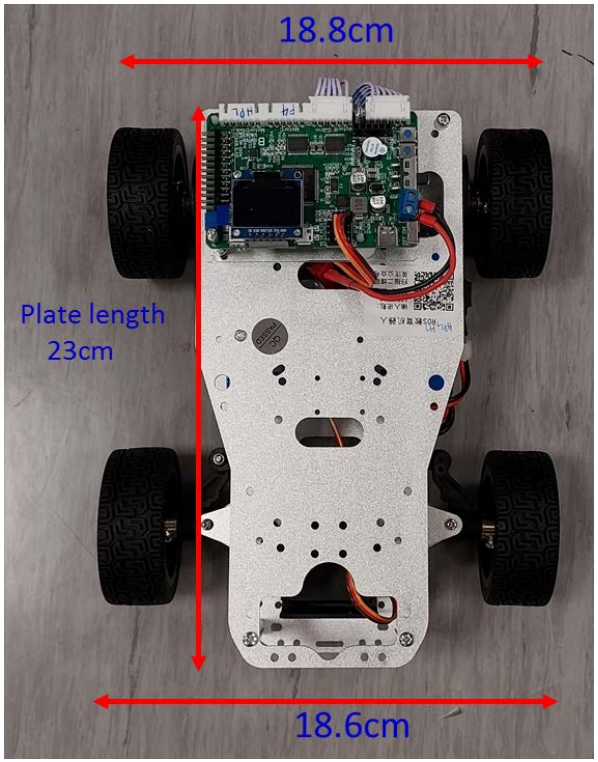
➢ 2 Late = 1 Absent

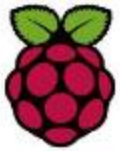
- **Overall attendance >= 80% required to Pass.**
- **Regardless of Your Team's Performance.**
- **Those who DO NOT fulfill the criteria will not be graded and will be required to RETAKE MDP.**
- **You may only know about it towards the end-of-semester.**

Learning Outcomes

- Explore a known area and recognize the images based on given specifications
- Apply skills and knowledge gained in courses so far
- Get exposure to learn and use current technical platforms
- Learn to work in a Multidisciplinary team
- Present your work using various Media

The System





Assessment and Timeline

Group assessment (35%)		
System functionality (checklist)	20%	Friday 5.00 pm Week 7
Video presentation	15%	Week 10
Task assessment (25%)		
Autonomous image recognition task	12.5%	Week 9 Saturday
Fastest robot movement task	12.5%	Week 9 Saturday
Individual assessment (40%)		
Early-stage peer review	5%	Week 5
Final-stage peer review	15%	Week 10
Individual Quiz (Android/ Rpi/ image/(Robot and STM controller)/ Algorithm)	20%	Week 7, Friday 8.30-9.30am

Checklist for system functionality

- Group assessment component (20%)
- Important functionality that you will need to complete your system
- “Checklists” for: Robot hardware , Rpi communication and image processing ; Algorithms; Android remote controller.
- Demonstrate that a functionality item has met the requirements in the list -> your supervisor will sign your checklist
- Do write in the student contributors name for each of the component in the checklist.
- To be submitted no later Friday evening (5.00pm) of **Week 7**

Example format

No.	C. Android Remote Controller Module Functional Specifications	MDP Supervisor Signature / Date	Name of Student Contributor
C.1	**The Android application (AA) is able to transmit and receive text strings over the Bluetooth serial communication link.** Note: You can use the AMD tool to help verify that your AA has successfully achieved bi-directional data transfer.		
C.2	**Functional graphical user interface (GUI) that is able to initiate the scanning, selection and connection with a Bluetooth device.** E.g. when the Connect button is touched, a list of available devices is presented to the user for selection. Once a device is selected, a connection is established with the device. You can use C.1 to show evidence of a successful connection.		
C.3	**Functional GUI that provides interactive control of the robot movement via the Bluetooth link** (e.g. move forward, left and right). The interactive control of the robot movement can be done using several labeled buttons (minimal requirement), appropriate touch gestures, button cum device tilt or any other method you can think of. You can use the AMD tool to demonstrate control of the virtual robot movement. Caution: Manually entering different string commands in a text box to control the robot movement is not a valid implementation of this requirement.		
C.4	**Functional GUI that shows remote update & status messages** (e.g. ready to start, looking for target 2, etc). You can implement this using a TextView box (minimal requirement). You can use the AMD tool to simulate information update by devising your own string-based protocol representing the various possible status of your robot. Note: Your TextView box must only display selective information and not all the text data that is being streamed to Android tablet.		

Final Report Video

- Group assessment component (15%)
- Create a video to report achievements and contributions
- In lieu of a traditional written report + presentation
- Demonstrate novelty, creativity, presentation skills, teamwork, etc
- Max 5 minutes long (5:01 onwards will NOT be graded)
- To be submitted by end of **Week 10**

Task Assessment

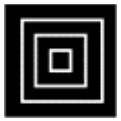
- Competitive group assessment component
  - Task 1:- Automatic movement and image recognition task (12.5%)
  - Task 2:- fastest car task using visual recognition(12.5%)
  - **Tasks are decoupled**
- **A team can have only one “Retry” chance for both Task 1 and Task 2 combined.**
- If a team goes for “retry” for Task 1 or Task 2, the score taken will be of the “retry”.
- Lab supervisors to referee attempts

Task assessment: Image Recognition

Task 1: Automatic movement and Image recognition task (12.5%)

Image pool is provided with image id for each image. Image processing algorithm need to train from this set of images

Images will be kept on the faces of 10x10 cm obstacles.



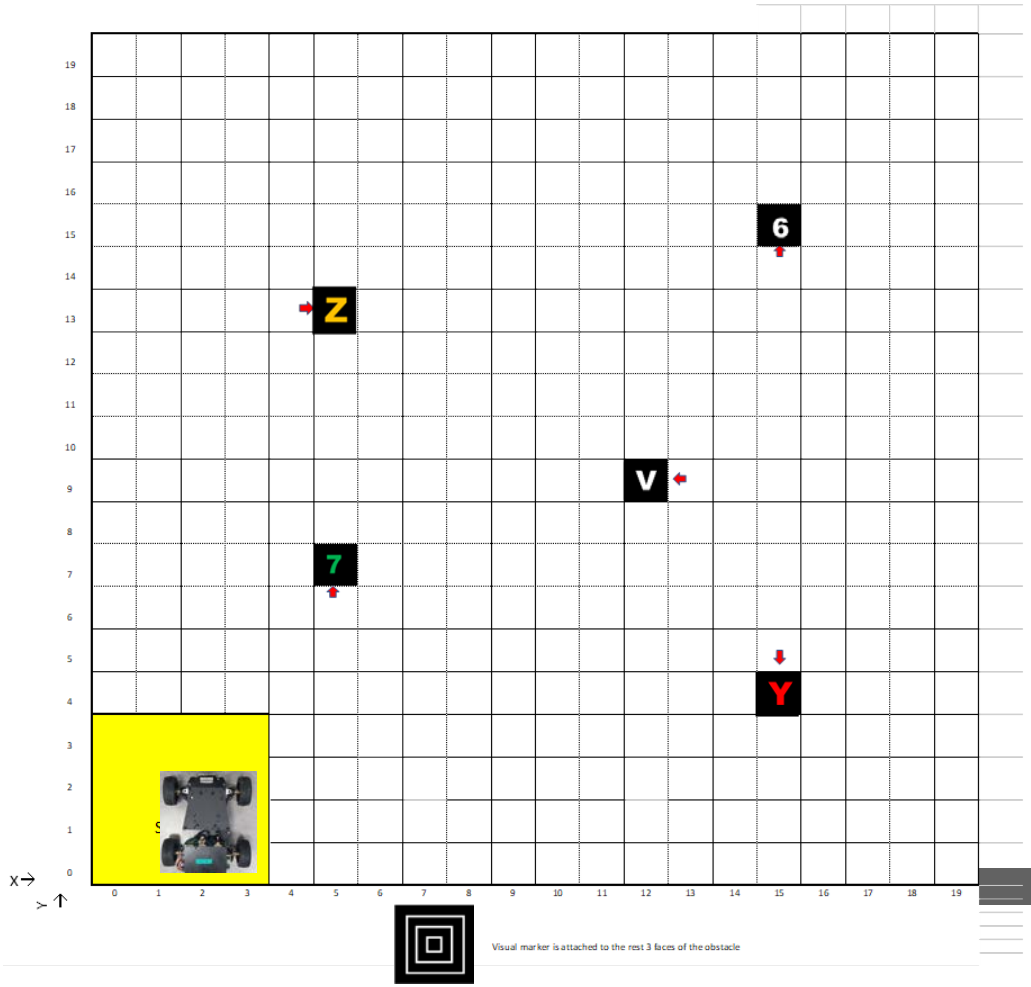
"Bulls Eye images will be kept on the other faces of 10x10 cm obstacles as visual marker

description	image	Image id
one	1	11
two	2	12
three	3	13
four	4	14
five	5	15
six	6	16
seven	7	17
eight	8	18
nine	9	19

description	image	Image id
Up arrow	↑	36
down arrow	↓	37
right arrow	→	38
left arrow	←	39
Stop	●	40

description	image	Image id
Alphabet A	A	20
Alphabet B	B	21
Alphabet C	C	22
Alphabet D	D	23
Alphabet E	E	24
Alphabet F	F	25
Alphabet G	G	26
AlphabetH	H	27
Alphabet S	S	28
Alphabet T	T	29
Alphabet U	U	30
Alphabet v	V	31
Alphabet w	W	32
Alphabet x	X	33
Alphabet y	Y	34
Alphabet z	Z	35

Task Assessment- example



description	image	Image id
one	1	11
two	2	12
three	3	13
four	4	14
five	5	15
six	6	16
seven	7	17
eight	8	18
nine	9	19

description	image	Image id
Up arrow	↑	36
down arrow	↓	37
right arrow	→	38
left arrow	←	39
Stop	●	40

description	image	Image id
Alphabet A	A	20
Alphabet B	B	21
Alphabet C	C	22
Alphabet D	D	23
Alphabet E	E	24
Alphabet F	F	25
Alphabet G	G	26
AlphabetH	H	27
Alphabet S	S	28
Alphabet T	T	29
Alphabet U	**U**	**30**
Alphabet v	V	31
Alphabet w	W	32
Alphabet x	X	33
Alphabet y	Y	34
Alphabet z	Z	35

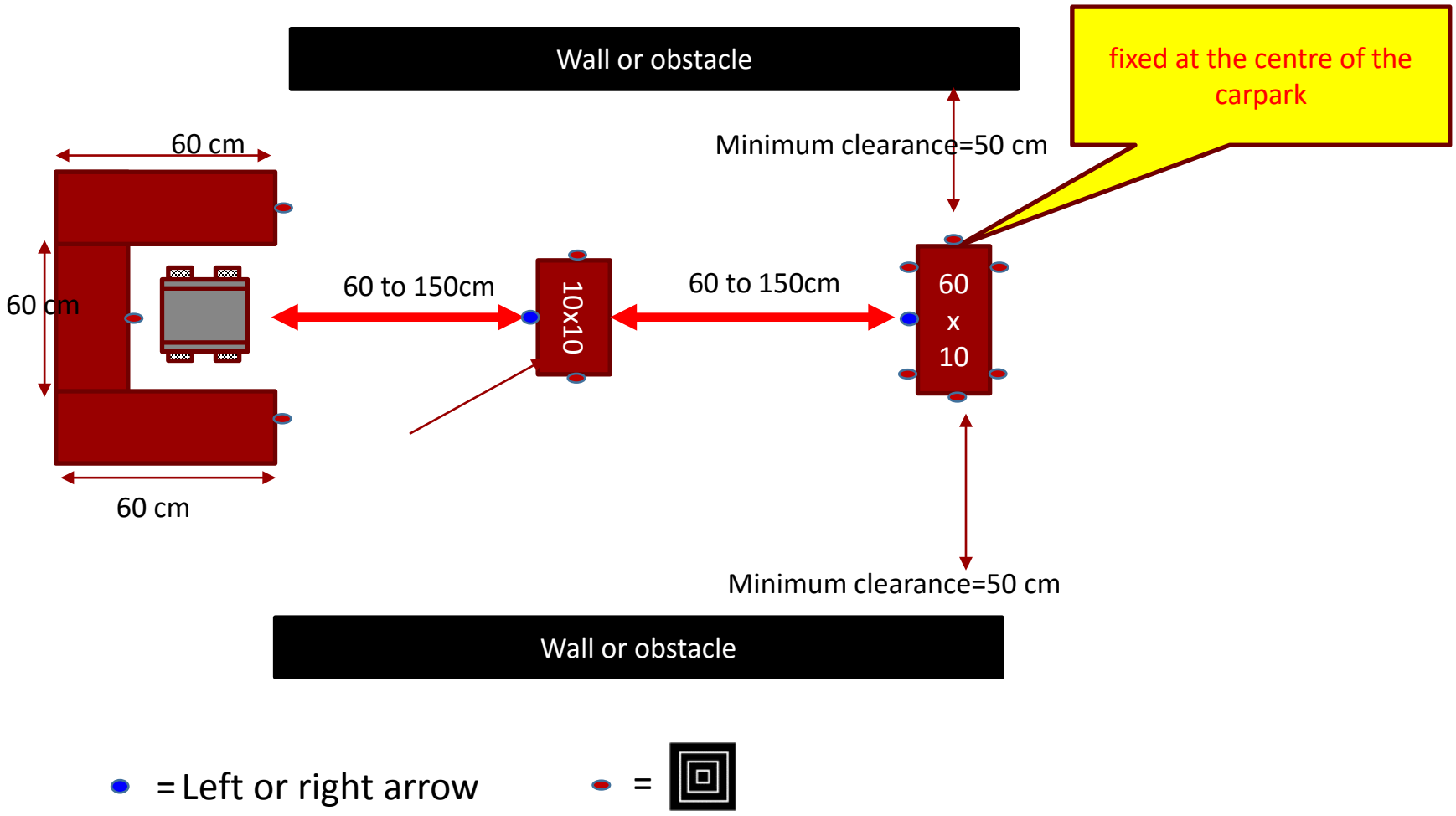
subset of 4 to 8

Images from 30 images available

Task assessment

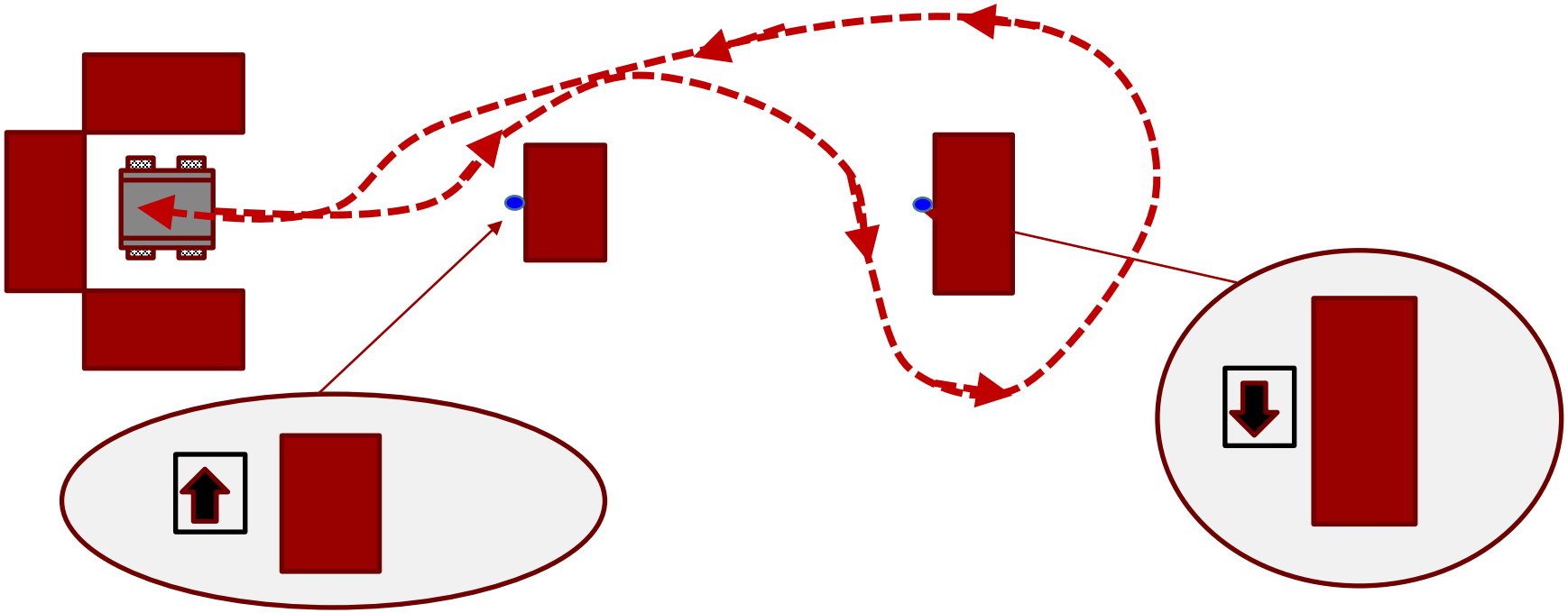
- **Full points will be given to teams who identified all the images (images can vary from 4 to 8) within 6 min (timeout)**
- **Teams with similar image recognition score will be ranked based on timing.**
- Rest of the teams will have a distribution of points.
- If a team opts for “retry” run of image recognition , they will have different maze setup.
- Teams who want to go for “retry”, need to quarantine their items through out (even after their first run)- Note that if you opt for “retry” , your first score will be invalid.
- For image challenge, the stitched RAW images taken by camera need to be shown as a single image in android or PC. (for verification)

Fastest car task



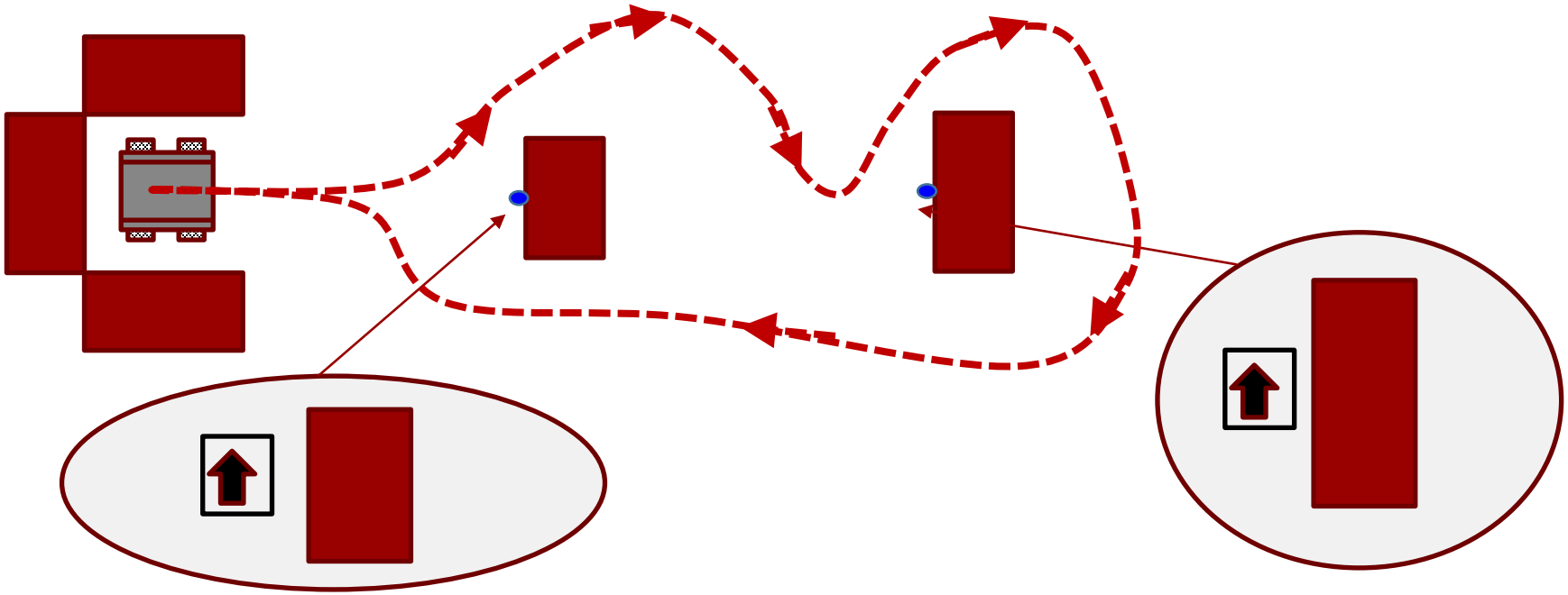
Fastest Car Task

(e.g. left then right)



Fastest Car Task

(e.g. left then left)



Fastest car task

Fastest path 12.5%

- The goal obstacles as shown in the figure will be placed directly in front of the carpark.
- You need to start the car, go to the first goal obstacle. There will be an image at the centre of the obstacle (right or left arrow). You need to move the car according to the direction and go to second obstacle and again follow the path shown by image arrow. Once doen you can move around the goal obstacle and reach back to the car park. The time taken for the same will be measured.
- They can use camera (Bulls eyes given around obstacles and carpark), IR sensor, or ultrasonic sensor to recognize obstacle.
- They need to stop in the carpark.
- Penalty of 10 sec if they hit the obstacle
- Bull dozing is not allowed (disqualified).

Task assessment- fastest car

- **Time out for this task is 3min.**
- **Note that every hit on the obstacle will add 10 s penalty to the timing**
- **If the image (right or left arrow is not properly recognized or if the car doesn't move according to the direction mentioned, the run will be invalid.**
- If a team opts for "retry" run of fastest car (if they have not opted for retry for Task 1), then it will be done immediately after the first.

Peer Evaluation

- Individual assessment component (20%)
- Confidential/anonymous
- Week 5 (5%)
- Mainly to assess contributions to design and planning phase
- Week 10 (15%)

Key points

1. You need to provide comments or valid reasons if the score is less than 5/10
2. Comments are also important when the score is 10/10
3. For the above score without valid comments cannot be taken into consideration and moderation will be done if necessary comments are unavailable

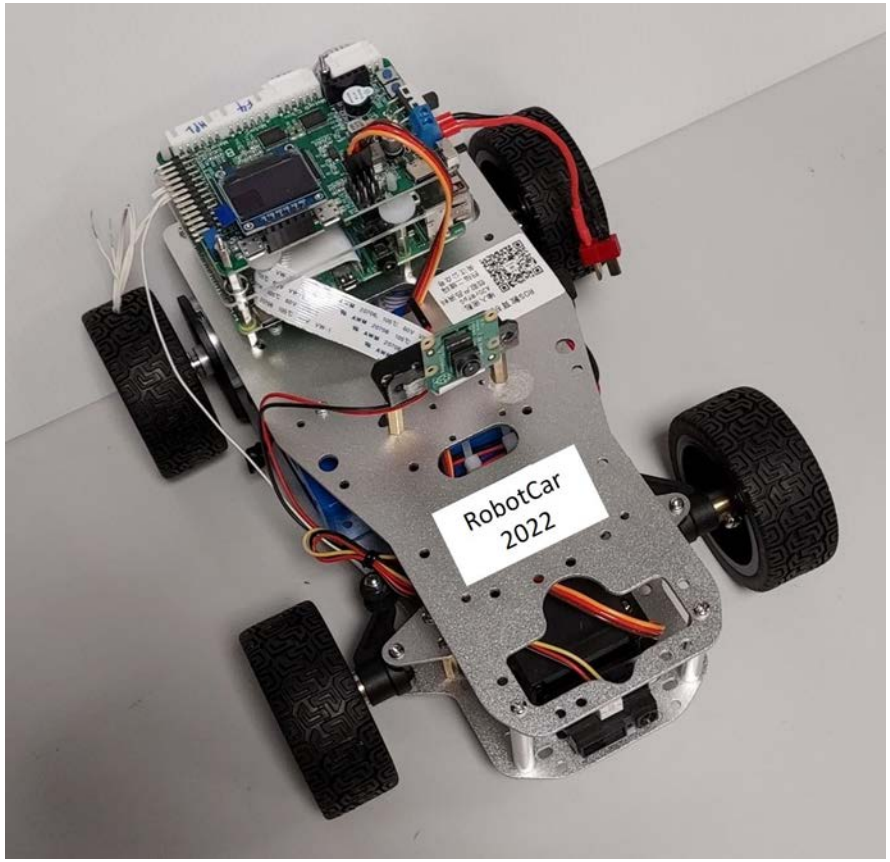
Peer Evaluation

- Students who get a **PE2 score of less than 50% compared to the rest of the members** can have their final grade greatly reduced as compared to the rest of the team-mates.
- Important for each student to keep a record of his contribution to the team to assist our investigation in the event of issues raised from the team mates.
- Main aim is to prevent free-loaders in the team.

What do I do Today?

- Go to your respective labs at 9.30 am and Meet your teammates and sign your attendance
- Choose a team leader (administrative contact)
- Team leader can collect hardware kit from lab executives from the respective labs.
- During collection ensure that all items are present. After the labs session, any item missing will be considered as being LOST by the team.
- Start discussing division of responsibilities
- Determine who gets what part of the system to play with, etc
- Let us know about missing members and ensure that they understand their role
- Timing from week 2 onwards:- physical lab session: Friday 8.30 am to 10.30 am

Robot car assembly



How to assemble is available
inside briefing materials-> Robot car setup

Sample cars for showcase are available at Hardware Project Lab and Software Project Lab.

sample robot cars are mounted with RPi, Rpi camera and IR sensor. M2 pillars and nuts are added to the cars for mounting of Rpi.

Briefing Materials

- Robot and STM32F407vet6 controller board : Loke Yuan Ren (Dr) yrloke@ntu.edu.sg
- Rpi and image processing : Oh Hong Lye, HLOH@ntu.edu.sg
- Algorithms : Huang Shell Ying (Dr) ASSYHUANG@ntu.edu.sg
- Android: Goh Wooi Boon (Assoc Prof) ASWBGOH@ntu.edu.sg

Exchange & Replacement

- Within week 2 and week 3, items can be exchanged only if the team can prove to the Lab Supervisor/Lab TE that the item is faulty.
- After the exchange deadline, damaged parts can only be replaced if team can justify that damaged of parts were not due to negligence or carelessness.
- Group can exchange a maximum limit of three exchanges per team after week 3, if they can justify that damaged of parts were not due to negligence or carelessness
  - Otherwise you are expected to replace with SAME item (on their own) without Penalty.
  - Request for replacement item from Lab (subject to availability) with Penalty Marks being deducted.
    - In this case, the item is considered to be an additional draw-out.
    - At the end of the MDP, the group must return BOTH (original + additional) items.

Return of Equipment

- At the end of MDP, you will be required to return all the items to your respective labs. More information will be send to you via email later.

- Failure to return your items by due date
  - **Penalty Marks Deducted**

The End!

Q & A!