EEBug Design Project Stage 1 Report

TEAM

Mariam Sarfraz; Haosheng Qian; Yanni She
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1. INTRODUCTION

The main aim of the EE Bug Project is to verify theoretical concepts introduced in the lectures experimentally and to attain technical skills for ______________________________.

GOAL

The goal of the project was to enhance the design of the EE bug to:

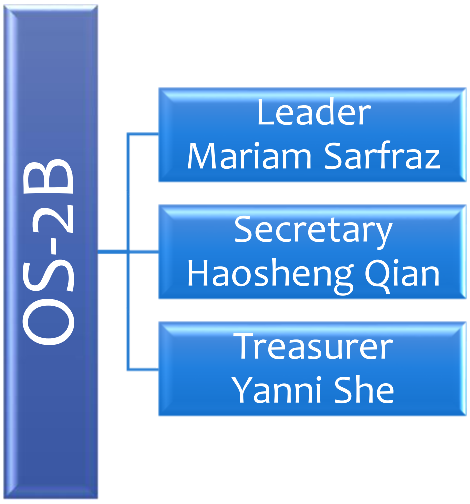
1. Make the bug follow a track that is marked in fading greyscale on a white background, leaving an impression to show where it had been;
2. Enable the bug to continue straight for 10cm as after the track ends; and
3. Draw a spiral with decreasing radius, completing at least one full turn before stopping.

The management report comprises of details of the management structure with outline of their roles and responsibilities; project workplan with timelines and deliverables; an analysis of the original bug with details of the proposed design enhancements

2 PROJECT MANAGEMENT

TEAM STRUCTURE

The structure of the team is reflected in the figure as below:



PROJECT ORGANIZATION

A wokplan was developed that outlined the decision of work between the three team members and specified the timelines and deliverables for each. Progress was monitored against the defined milestones. This is depicted in the table below:

EEBug Design Project		2015											
S.NO	ACTIVITIES	OCT				NOV				DEC			
		1	2	3	4	1	2	3	4	1	2	3	4
1	Review of the background reading materials						x						
2	Defining roles						x						
3	Defining the workplan and deliverables						x						
4	Defining the respective responsibilities						x	x					
5	Analysis of original bugs						x	x					
6	Comparison of bugs								x				
7	Work on design enhancement								x	x			
8	Client meeting and it's review										x		
9	Finalizing the report										x		
9	Submission of report											x	

TERMS OF REFERENCE FOR THE PROJECT TEAM

The following protocol was found to be instrumental in putting a robust mechanism in place for the smooth execution of the project.

- Meetings were held on a regular basis to ensure that progress was being made at a steady pace. The meetings were kept on every Wednesday and Saturday.
- Each meeting lasted on an average for about three hours.
- A WhatsApp group was created to eliminate communication gaps between members and to coordinate the meeting time and venue.
- A Dropbox folder was created so that members could upload their respective work in the folder and hold all documents in one place for easy accessibility for all team members
- A folder was created to hold details of each meeting and its minutes. (This was shown to the GPA in the Client Meeting)
- If a member missed out on more than two meetings for an invalid reason, a red flag was issued.
- If there was a conflict between members, voting was done to settle the issue.
- If the member was unable to perform his/her required task in the given time, a warning was issued.

ROLES AND RESPONSIBILITIES

In order to give the team a firm management structure, the workload was divided equally between the three team members.

Team Member's Name	Team Member's Roles and Responsibilities
Mariam Sarfraz	▪ To lead the group i.e. appointing and managing all tasks and making sure that the work plan is followed effectively ▪ To arrange the date and time for meetings ▪ To edit the Management Report ▪ To write an overview of all the meetings including their dates and minutes ▪ To draft the initial section of the report, comprising of the management structure ▪ To obtain simulated and experimental measurements/ data for bug type D ▪ To edit the draft report
Haosheng Qian	▪ To compile and upload the final draft of the Management Report ▪ To efficiently compile all the documents realted to the work on the EE bug ▪ To obtain simulated and experimental measurements/ data for bug type C ▪ To draft the final section of the report i.e. the enhancements on the original bug

Yanni She	▪ To manage and record the entire cost of the project effectively ▪ To make sure that all simulated and experimental graphs and data are correct ▪ To obtain simulated and experimental measurements/ data for bug type E ▪ To draft the section of the report comprising of the analysis of the EE bug

PROJECT MONITORING

Progress was monitored closely against the defined outputs as below enabling us to work effectively and efficiently

Timeline	Activity	Deliverable
Week 6	• Discussion on work in hand and how it should be distributed amongst the team members • Allotment of respective roles • Develop the outline of the report • Develop the work plan t to be followed	• Team structure and responsibilities defined • Report format defined • Workplan developed
Week 7	• Analysis of the original bug circuits and all its components Review of the Fundamental concepts required for the project execution	• Clarity developed in related theoretical concepts
Week 8	• Comparison of respective bugs through use of PSPICE and experimental graphs	• Ideas for the future bug's components and circuit design established
Week 9	• Scrutinize the requirements of the enhanced bug • Interchange ideas for the design enhancements • Initiate work on management report	• Outline developed for the enhanced features in the bug's structure

Week 10	• Discussion on the implementation of enhancements • Strategy to be followed in the Spring term made	• Outline developed of the enhanced features in the bug's structure (continued)
Week 11	• Compilation of the final draft of the management report	• Submission of the Management report

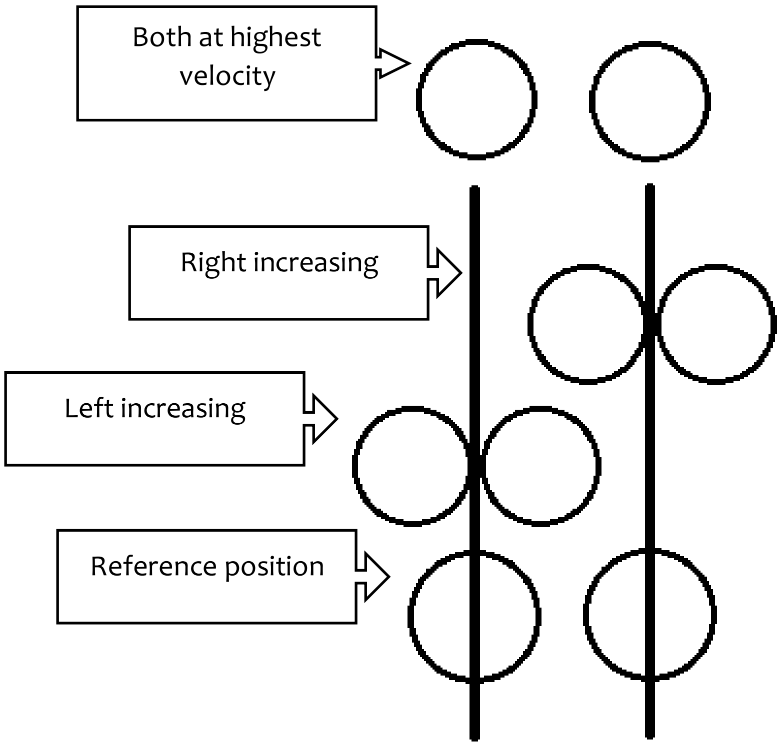
3 CLIENT MEETING FEEDBACK

THE POSITION SETTING OF SENSORS

For each sensor, set half of the sensor inside the bug and the other half outside the bug. Establish the middle line as the reference position and the error is the displacement from reference position. The velocity of wheel is proportional to the error distance.

CHOOSE A SPECIFIC SIGNAL INSTEAD OF WHITE LIGHT

Firstly, find the sensitivity range of sensor. Then choose a specific range from spectrum in order to give a good quality signal. (E.g. Red light) Because the background noise light would be strong, which will disturb the sensor.



THE CONVERSION FROM ANALOG TO DIGITAL

We decide to use a microcontroller to control the bug, which is controlled by digital system. Therefore, we need to converse the analog inputs to digital outputs.

INCREASE SPEED WITH LESS LIGHT INTENSITY

Set a high initial speed to the bug. When the total light intensity is less than the reference value, the sensor on the side where it receives a greater light intensity will increase the speed of the wheel on that side in order to make the bug go back to the reference position.

4 EE BUG ANALYSIS

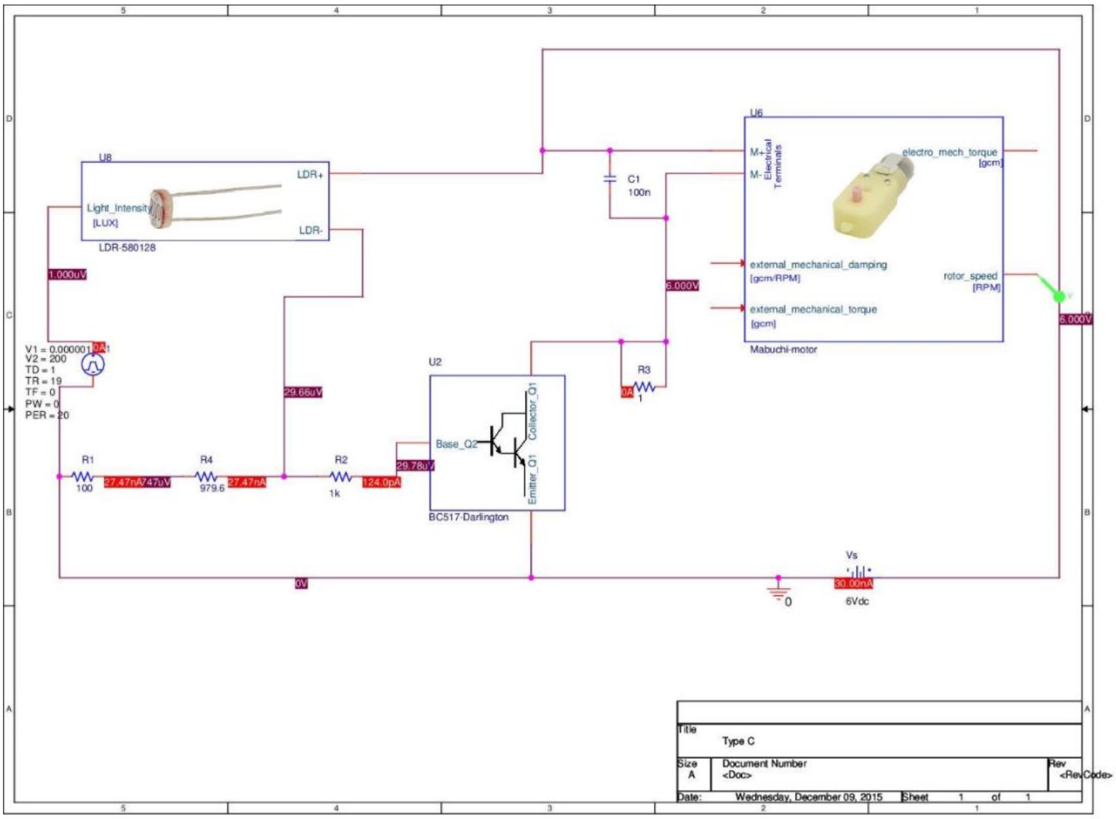
ANALYSIS OF ORIGINAL BUG FUNCTIONS AND CIRCUITS

The Bug types and main components available to the group are depicted in the table below:

Member	Type	Transistor	Component
Haosheng Qian	C	NPN Darlington	LDR
Mariam Sarfraz	D	NPN Darlington	SFH300 3/4
Yanni She	E	PNP	LDR

The general circuit diagram of EE Bug type C is shown as below:

(Note: Type D uses SFH300 3/4 phototransistor instead of LDR.)

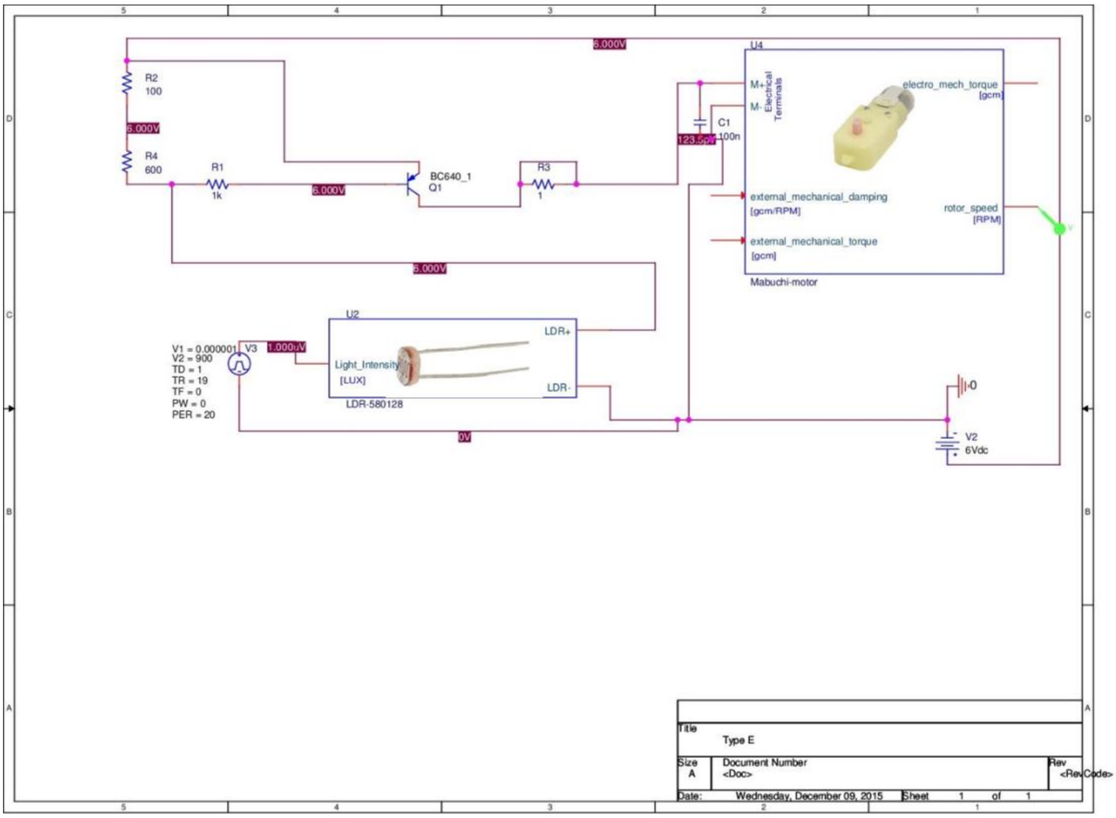


For type C and D when the light intensity is very low, the LDR and phototransistor give out a low voltage. Thus, due to the low voltage on the base of NPN transistor, no current flows through the collector and emitter disabling the motor from running as no current through it.

With the increasing light intensity, a higher output voltage is given by the LDR and phototransistor. The current will flow through the transistor when the voltage on the base is over a threshold value, enabling the motor to run. The speed of the motor will increase to a nearly maximum value with the enhancement of light intensity.

The transistor also works as an amplifier, which amplifies the low current in collector to a very large one in emitter. NPN Darlington gives out a more significant amplification factor than NPN transistor.

The general circuit diagram of EE Bug type E is shown as below:



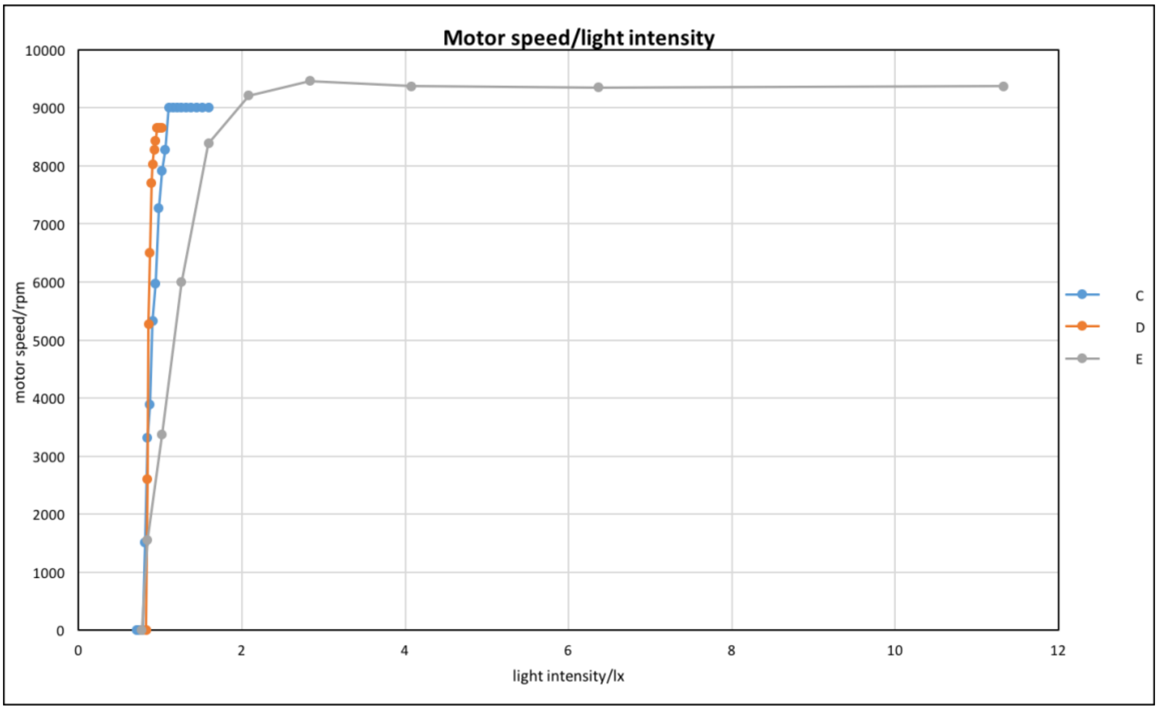
For type E when the light intensity is very low, the LDR gives out a high resistance. Thus, due to the parallel connection there is a high voltage on the base of PNP transistor and no current flows through the collector and emitter. Therefore, the motor does not run.

With the increasing light intensity, the resistance of LDR decreases and the voltage on the base of transistor also decreases. The current will flow from emitter to collector when the voltage on the base is below a threshold value, which will lead the motor to run. The speed of the motor will increase with the enhancement of light intensity.

The type C/D Bug and the type E Bug have fundamentally the same function. The circuit connections differ due to different settings of NPN and PNP transistors.

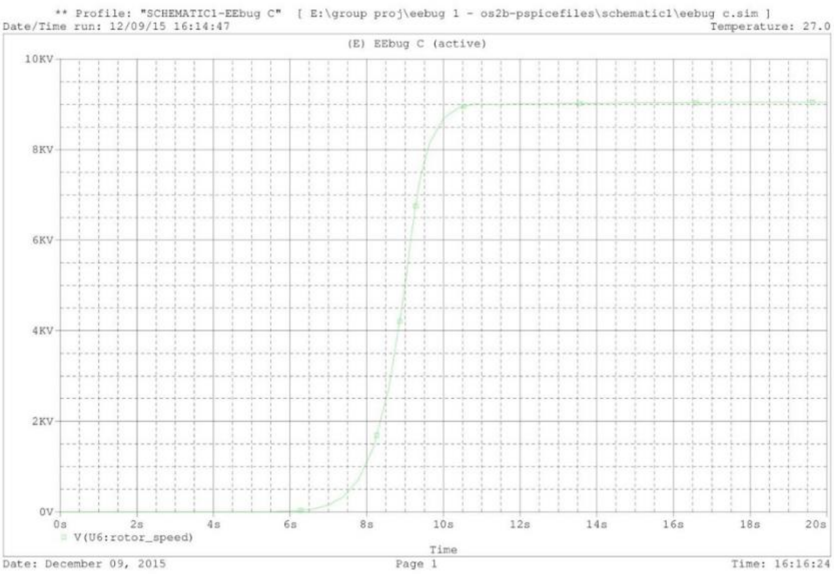
COMPARISON OF MEASURED DATA WITH SIMULATION/ANALYSIS

The graph below shows the variation of motor speed due to the light intensity of different types of Bug.

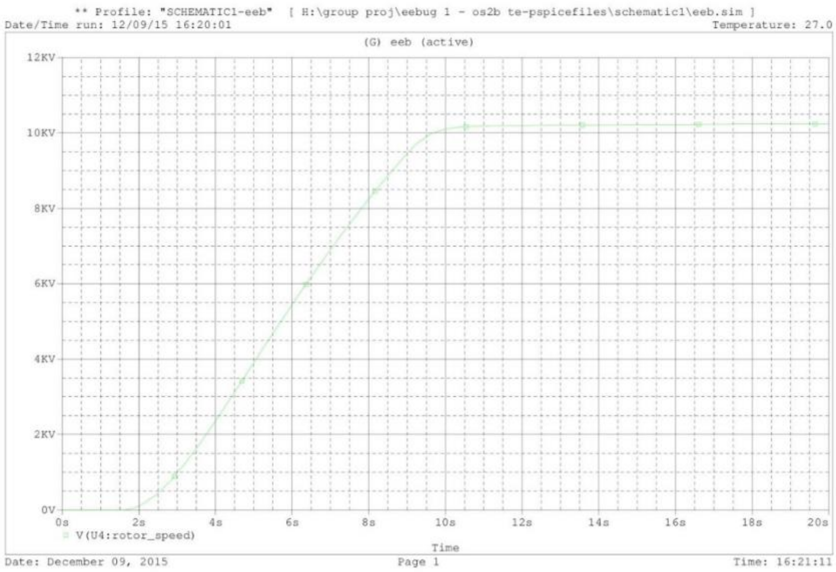


The waveforms below show the simulation variation of Vmotor and light intensity.

Type C



Type E



*The unit of y-axis: 1 KV=1K rpm

The table below shows the simulation and practical results of B, C, and D type Bugs.

	Light intensity when the motor starts to run (lx)		**Light intensity when the motor reaches maximum speed (lx)**		**Maximum speed reached by motor (rpm)**	
	Simulation	Practical	Simulation	Practical	Simulation	Practical
C	53	0.81	105	1.11	9000	9000
D	300	0.84	620	0.96	9200	8662
E	33	0.84	470	2.83	10000	9400

* The big difference between the practical and simulation result may be caused by the uncertainty of the light sensors, light resources and transistors, but the simulation graph shows the similar shape as the practical graph. As a result, we assume they are fit.

PROS & CONS OF CIRCUIT TYPES

Bug Type	Pros	Cons
C	▪ Relatively sensitive bug ▪ Relatively quick reaction time	▪ Low maximum speed at low light intensity interval ▪ A little difficult to control the speed
D	▪ A very sensitive bug due to a very short reaction time	▪ Low maximum speed reached in a lowest light intensity interval ▪ Hard to control the speed of the bug
E	▪ The easiest one to control the speed	▪ Not sensitive enough to small change of light intensity

DRAWING THE CONCLUSION

According to the comparison above, we choose the function of Bug C.

The combination of NPN Darlington transistor and LDR gives us a bug which is sensitive enough for our future project and also easy to control.

5 DESIGN ENHANCEMENT

Requirements

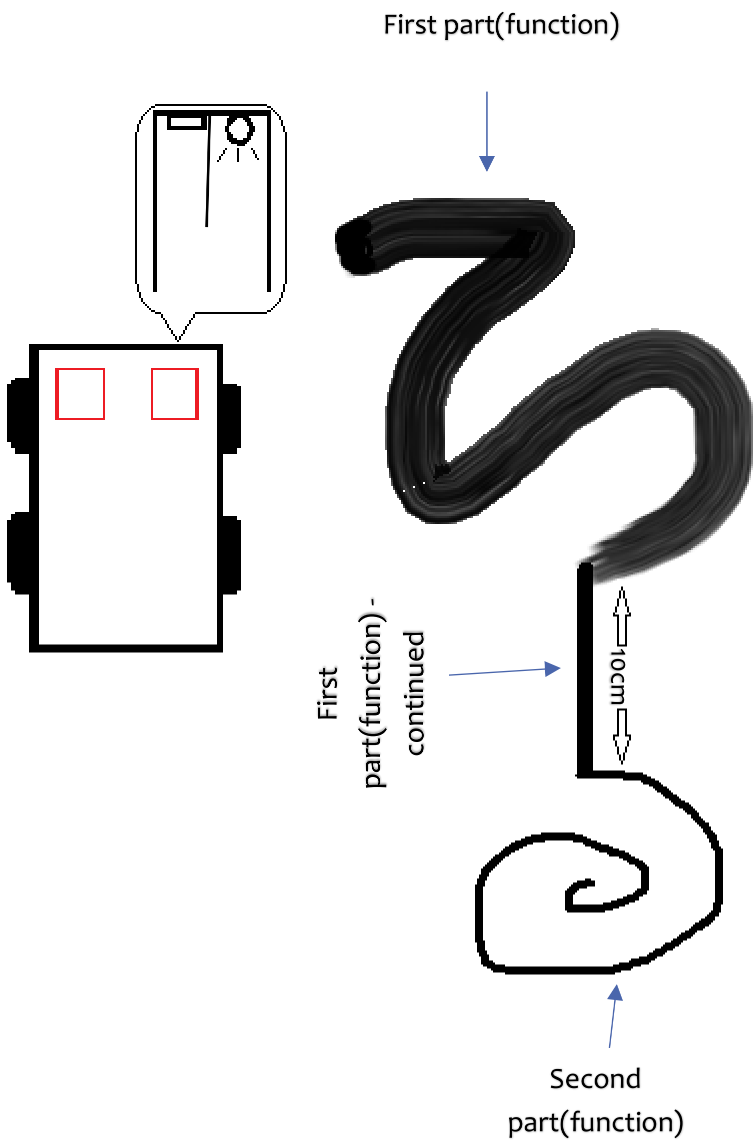
The enhancements in the design are expected to:

1. Make the bug follow a track that is marked in fading greyscale on a white background, leaving an impression to show where it had been;
2. Enable the bug to continue straight for 10cm as after the track ends; and
3. Draw a spiral with decreasing radius, completing at least one full turn before stopping.

Enhancements of the EE Bug

According to the requirements provided, the whole route is separated into three different parts.

Firstly, the car will follow the track. To detect the route given, we choose two detectors to control the direction of the car. Each sensor contains two electronic components: A light detector (LDR) and a light generator (LED). The light emitted by the LED will be reflected on the white surface and detected by the LDR. As the white surface will reflect more light than the black one, there will be a positive feedback in form of voltage when the LDR receives it. When the sensor on one side detects the black line, it will force the voltage across the motor(s) of that side to decrease. Then the car will turn back onto the track.



Secondly, as the track has ended, the bug should move straight for 10 cm. As the velocity of the bug depends on the surface, it will be constant as soon as the track ends.

Thirdly, we are going to use a microcontroller which has a wheel revolution recorder. There will be a condition; after a particular number of revolutions, it will switch to a second function directly.

The third part is to draw a spiral with decreasing radius, so there will be a function in the microcontroller which will decrease the voltages across the motors at different rate. So the whole car will follow a decreasing spiral path and will stop at the end.

The pen will be fixed on the car throughout the whole motion.

Some additional ideas of the car:

1. Add a special switch, which can be remotely controlled, for example via phone.
2. We may add a flashing touch, e.g. flickering light or a musical note, to show (and celebrate!) the end of the project.

FUTURE IMPLEMENTATION OF ENHANCEMENTS

1. Designing the enhanced circuit
    a. Using suitable components
    b. Using suitable sensors
2. Circuit implementation
3. Testing and optimization
4. Microcontroller implementation
5. Switch design, penholder design, IR/WIFI remote control system implementation
6. Final testing