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Career Episode 1

Introduction

CE 1.1

In this episode, I would like to explain in detail my graduation project named as; Task Oriented Autonomous Path Guiding Robot for Hospitals. During the time I was the student of Electronic and Communication Engineering in Malineni Lakshmaiah Engineering College, Singarayakonda. I worked as Team Leader on the project. The project was started in Month/ Year and completed in Month/ Year.

Background

CE 1.2

The project was the demonstration of a path guidance robot that plans its path according to the task (i.e. the destination) assigned to it. The main purpose of the robot was to provide a collision-free path to its user for reaching the desired location. Four ultra-sonic sensors assist in dodging obstacles along the visitor's way while two optical wheel encoder sensors helped in keeping track of the location where the visitor wishes to go. The GPS system was replaced with encoder sensors for better indoor performance. Basic programming of the robot was carried out using Arduino software. The same technology was used to improve wheelchair functionality.

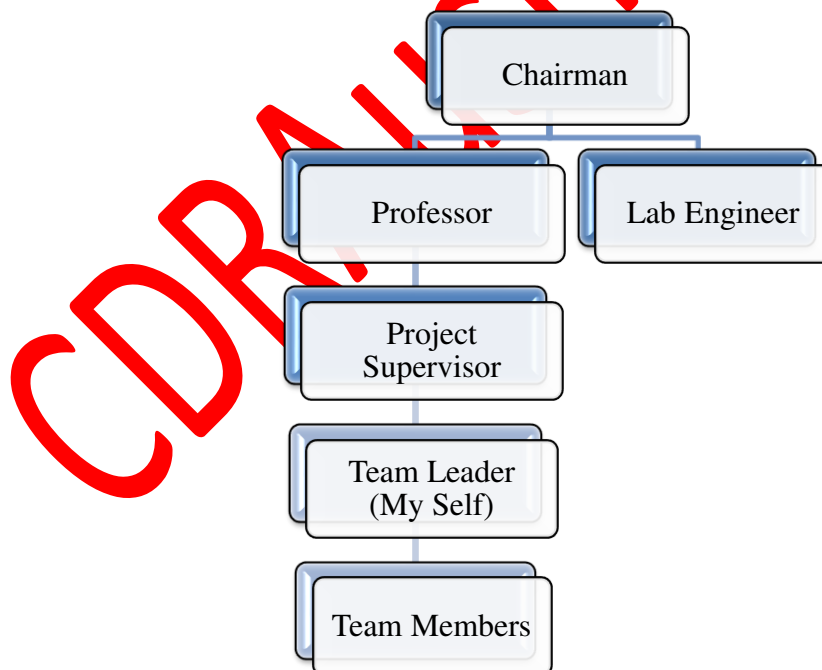
CE 1.3

Major tasks during the project;

- Conducted detailed literature review and gathered all the necessary information that can be useful for the project
- Prepared a weekly schedule for accomplishing the tasks within the given time frame
- Designed the structure of the robot. It included taking proper measurements such as preferred weight, height of the robot and also the type and width of the materials use
- Kept the height of the robot was below the average height of a human for easy accessibility of the user to the keypad
- Selected desirable motors to assist movement of the robot.
- Estimated the required torque and speed of the robot, considering the friction encountered.
- Selected DC gear motors based on the calculations so that the gear ratio can be used to match the torque and speed with the calculations
- Assigned multiple tasks to other team members like, testing out the components, developing an algorithm, inspecting the area under test, noting down progress, keeping a record of the cost incurred and performing software simulations

CE 1.4

Project Hierarchy



Personal Engineering Activity

CE 1.5

My first major milestone of the project was to conduct a detailed study regarding the project objectives. I carried out literature review and studied the previous work done on the same nature of the projects. Once, I triggered my mind and build a complete understanding, I came up with my next task which was related to preparation of Project Schedule. I mentioned each deliverables and the estimated time to complete it. I also specified individual tasks of each of the team member. I then hold a kick off meeting with the team and Project Supervisor. In this meeting, I briefed each tasks and strategy of completing the project. I presented the work methodology and work break down structure.

CE 1.6

My first design task was to develop a suitable physical structure for this robot. I considered various structures but some were big and complicated while others were too small to be inconvenient for users. While designing the structure, I considered that the autonomous path guiding robot was light weighted, easy to handle, and convenient for users. I then developed a structural layout using the AutoCAD Software. Next, I selected the required material for setting up the robot. I used the Acrylic Sheet. I selected it due to its exceptional weather ability, strength, clarity, and versatility. I used the aluminium rods for lifting the weight of the robot's upper plate. I used three wheels for the robot structure. I attached two elastic sidewheels with the motor, having a diameter of 4.72 inches with a rubber ring to reduce friction and one attached at the backside which was free moving. I designed the average height of the robot as 3.8 ft.

CE 1.7

I then developed the electronic system design for the robot. I developed a system block diagram. As per the diagram, when the user inputs a room number from the keypad, the robot started planning its task. For task planning it keep checking on four things; map of the hospital, the path assigned to it, obstacles that come in its way, and the destination allocated to it. The robot checked these four major tasks one by one and planned its movement according to it. The cycle kept on repeating until the robot reached its final destination. Developing this embedded system was a complicated task for me as many components were required to build an effective Robot. Major components of this embedded system included; ATMEGA 2560 Arduino Board, Ultra Sonic Sensor (HC-SR04), DC Gear Motor, Photo Electric Speed Sensor Encoder, 4x4 Matrix Keypad, and Rechargeable DC Batteries.

CE 1.8

I designed motor circuits to support the movement of the robot. I fixed each motor with a wheel having diameter of 12 cm. I attached an optical wheel encoder at the back of each motor that was used to count the rotation of the motor shaft and keep a check on the distance. I used motor driver IC (VNH3SP30) for the output of each motor that could resist up to 30A in case the motor drew excessive current. I also took extra safety measures such as installing 3A fuse boxes between the power supply and the motor to prevent any damage to the circuit. I calculated the required torque and speed of the robot for choosing the motors. As my major focus with this project was to facilitate patients and sick visitors, therefore, I kept the speed of the robot slow as compared to average human speed. The speed can also be made variable to cater to the needs of

all kinds of visitors. Before finalizing each component, I tested each specification on Proteus software and results were recorded.

CE 1.9

First problem that I faced in this project was regarding the power matching of both the motors. Due to small variables such as friction, I didn't think it necessary to keep the value of power for one motor equal to the same value of power for other motor. This resulted in failure of robot movement in a straight path and it deviated to the direction of the motor with less power. To solve the issue, I discussed it with my Supervisor and explained him, why I didn't consider the factor. I searched for the possible solution to this issue and conducted brainstorming. I used the hit and trial method to troubleshoot the motors. I set the several values of power and tested to check the combination that was closest to being accurate. Finally, I was able to get the desired values. This helped me in resolving the issue.

CE 1.10

The second problem that I encountered at the start of this project was unsuccessful obstacle avoidance. To get to its destination effectively, the robot often ignored the obstacle avoidance function in its program. As a result, it used to crash into any obstacle that came in its way. I called the obstacle avoidance function in an interrupt. After setting it as a preference, the robot used to stop all the other tasks and make sure it had avoided the obstacle first. For this, I interfaced the sensors with Arduino board and then developed an algorithm for obstacle detection and avoidance which worked depending upon the signals coming from sensors. I used ultrasonic sensor, commonly known as sonar. I used four HCSR-04 modules, having range of 3cm to 4m with an accuracy of 2mm. I developed a proper algorithm for preventing the any collision.

CE 1.11

I managed all tasks of the project. Being a University project, I tried to maintain the project budget and selected the material which was less expensive and easily available in the market. I coordinated with my team throughout the project. I attended meetings with them and discussed the project major issues. I took their input regarding solving the issues. I appreciated the cooperation of all the members. I also liaised with my Project Supervisor. I arranged periodical meetings with him and keep him updated with the project progress. I also took his guidance where we all were unable to resolve the issues.

CE 1.12

I followed the OSHA standards of safety while carrying out each task. While working with the motor, I made sure that personal protective equipment were used. I also advised my team to follow the same rules. I also made sure that our activities would not lead to environmental hazard. Moreover I also followed the IEEE standards while setting up the motor.

CE 1.13

At the completion of all tasks, I prepared a final report which in which I detailed all tasks carried out. I explained all the algorithm codes and design activities. I presented this report in front of the Supervisor, Professor, and other associated person. I used the MS Office (Word and Power Point) for completing the reporting and presentation task.

CE 1.14

In this project, I also focussed on developing my advanced engineering knowledge by browsing the internet and learning the latest techniques. I often visited the University library and read the engineering related books. I also attended the seminars and other related events. These all helped me in enhancing my electronic engineering knowledge.

Summary

CE 1.15

I successfully completed the design of the robot. I tested it and it worked properly. This project was my first major achievement as I was successful in implementing my engineering knowledge. Also, I showed my leadership skills by leading my team of two engineers. I got appreciation form my project supervisor. He was happy with the quality of the project. This project was the next uphill to my career. This project also provided me a learning environment. I learned technical skills under the supervision of my Project Supervisor.

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Career Episode 2

Introduction

CE 2.1

This episode presented my graduation project named as; “Visible Light communication”. During the time I was the student of Electronic and Communication Engineering in Malineni Lakshmaiah Engineering College, Singarayakonda. I worked as Team Leader on the project. The project was started in Month/ Year and completed in Month/ Year.

Background

CE 2.2

Visible light communication is very popular technology these days. It is used a communication source for the light producing devices. The purpose of this project was to explore the application of the visible light communication. Its scope included a detailed literature review and research, utilizing the old transmitter for the designing the receiver. In this project, fluorescent lamps were used for transmitting the signals.

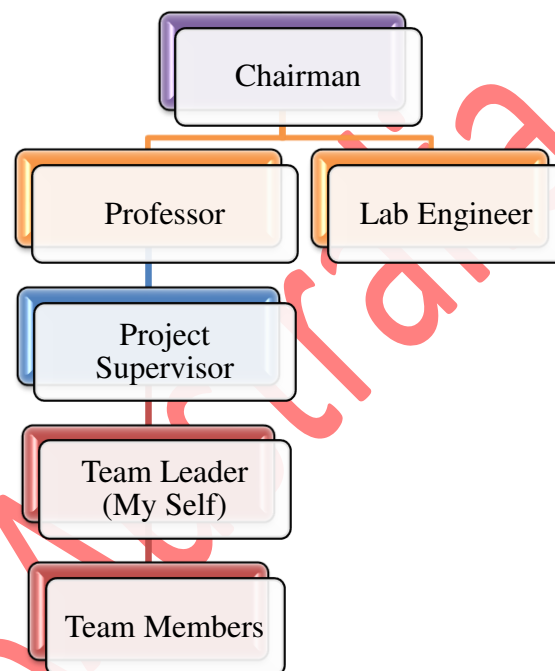
CE 2.3

Major tasks during the project;

- Conducted detailed literature review and gathered all the necessary information that can be useful for the project
- Prepared a weekly schedule for accomplishing the tasks within the given time frame
- Designed the receiver circuit utilizing my electronic engineering knowledge
- Carried out the experimental tests to check my design
- Carried out the required decoding as per the project need
- Coordinated with my team members and also collaborated with my project supervisor to took his help
- Arranged number of meetings for discussing the project progress and targets

CE 2.4

Project Hierarchy



Personal Engineering Activity

CE 2.5

My first major milestone of the project was to conduct a detailed study regarding the project objectives. I carried out the literature review and studied the previous work done on the same nature of the projects. Once, I triggered my mind and build a complete understanding, I came up with my next task which was related to preparation of Project Schedule. I mentioned each deliverable and the estimated time to complete it. I also specified individual tasks of each of the team member. I then hold a kick off meeting with the team and Project Supervisor. In this meeting, I briefed each task and strategy of completing the project. I presented the work methodology and work break down the structure.

CE 2.6

I designed the circuit of the receiver. In this design, I used an old transmitter. So, it was challenging for me to match the requirements of the receiver with the transmitter. For deploying the circuit on the existing transmitter, I selected a single photodiode. I used a spared ADC channel on the sign LED board to sample the receiving signal. For modulation and coding the transmission, my next task was to design a firmware running on the micro-controller. I used the same micro-controller for the demodulation and decoding the message. I set the Frequency of the modulation at 500Hz. I conducted few experiments and for data coding, I selected the Manchester coding method. For the BiPhase, Manchester coding provided a means of adding the data rate clock to the message to be used on the receiving end. Also, it always yielded an average DC level of 50%. This has positive implications for the demodulator's circuit design as well as managing transmitted RF spectrum after modulation. This means that in modulation types where the power output was a function of the message such as AM, the average power was constant and independent of the data stream being encoded.

CE 2.7

My first issue in this project was related to the ambient light interference as I was about to implement the project open environment. Some ambient lights like; sunlight, car head light, and street light interfere the transmission, which would result in creating the noise. To cope with challenging issues, I searched for the photodiode that was sensitive to the transmitter LED spectrum. Then, I compared the samples with dark current, responsivity, and response time, so I can find the right one for my modulation frequency. I selected the photodiode that was spectral sensitive to 500nm light, which helped in canceling the interface. For further diminishing the interference, I executed a software filter on the ADC sample. I took N times of samples of the signal and applied a median filter for reducing the spikes in the way of the signal. In the second step, the signal was passed through a moving average filter to suppress the high frequency noise. I applied another median filter to further reduce the spikes of the signal. Lastly, I subtracted the minimum value of the N samples from the other samples to cancel the DC offset.

CE 2.8

I faced issue while encoding. Since the data rate clock must be either known or discovered. The synchronization to the clock was difficult to follow. The data rate clock must be either known or discovered. To solve this issue, synchronizing the clock was required and processing the incoming stream and recovering the data using the previous two steps. Buffer or store this data for further processing. After comparing this method, I choose sample based decoding as it can apply a filter for better reliability. In this method, edge transitions were not required to be captured or acknowledged. Instead, I simply sample and buffer the state of the input at a much higher rate than the data rate of the message. Extra memory was required but it allowed to undertaken the processor intensive tasks at a less critical time and another task might take precedence without disturbing the decoding.

CE 2.9

I achieved this sampling by setting a timer to interrupt and storing the state of the pin in a large buffer. I didn't use any special timer features. I first set up the timer to interrupt every $2T / S$. I then checked the SR routine and stored the state of the microcontroller pin (1 or 0). I repeated

the second step for the desired number of bits * S occurrences. I processed through the captured buffer counting the number of consecutive ones or zeros. When the next logic value changes, I checked for the count $\geq (S/2)$. I set current bit = logic value in buffer currently pointed too. I reset count and count to the next logic change. I compared the count with $(S/2)$ and found that the count was smaller than the $(S/2)$. I reset and count to next logic change. I made sure count was also less than $(S/2)$. I stored the next bit in the data buffer.

CE 2.10

All through the project, my main aim was to build my knowledge. To complete this project, I carried out a literature review in detail and studied about the visible light communication in detail. My biggest source of this knowledge was the internet. I browsed different website pages and clear my understanding. I also read numerous books and took guidance from my supervisor. During the time, I also got a chance to attend as seminar related to the topic which helped me in building my knowledge on the coding. I also discussed with my senior engineers who also cleared my problems.

CE 2.11

I collaborated with my team members from the beginning to the end phase of the project. I distributed all the tasks equally among all. I also had given the literature review task to the team. After getting all the information, I held a meeting with them to discuss in detail. I also involved in discussions with them as the project was a bit challenging so we all tried to cooperate at each phase of the project. I carried out my research work under the codes stipulated by the Institute of Electrical and Electronics Engineers (IEEE). During the meantime, I worked with this research I kept the truthfulness of all data obtained and credited properly the team contribution. I accurately demonstrated my research results and provided a real data capture to prove my work.

CE 2.12

One of my major considerations during the project was to maintain the safe work place. Therefore, I followed the safety norms and tried to avoid any activity which could be harmful to others. I also made sure that I followed all the principle norms of engineering standards matched with the nature of the project. I also advised my team to follow the same work procedures.

CE 2.13

I was involved in documentation of the project. I compiled the final project report which I presented to my Supervisor for his review. I well documented each activity of the project. The project report entailed about the details research results, the design of the project, the material utilized, standards followed, etc. I also prepared a presentation of the project. I coordinated with the team and gave few parts of the presentation to them. Together we worked on it and at the day of final presentation, I also gave my team members a chance to speak to it. I handled the queries raised by the supervisor and lecturer.

Summary

CE 2.14

The project was successfully accomplished fulfilling all the objectives of the project. My effort was valued by the Teachers. I was extremely happy on successfully completing each milestone. This project was an important task for my career, as I got the chance to improve my coding skills. I also enhanced my team leadership and project management skills by timely planning all the activities. I showed my high communication skills by preparing reports in well-presented format.

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Career Episode 3

Introduction

CE 3.1

In the last episode, I want to explain my project that I completed during my graduation studies named as; "Maze solving robot". During the time I was the student of Electronic and Communication Engineering in Malineni Lakshmaiah Engineering College, Singarayakonda. I worked as Team Leader on the project. The project was started in Month/ Year and completed in Month/ Year.

Background

CE 3.2

I undertook this project during my 5th semester in the bachelor's program of the department of Electronic and communication. The objectives of this project were to build a robot which was to be given an image file in an SD card that contained the map of the maze that was to be solved. The maze had 2 entrance points and 2 exit points one of which in both cases was closed according to the image provided. There were 2 colored boxes placed anywhere in the maze which was represented in the image with a cross sign. The robot was to carry two coloured golf balls and it had to put those balls in the matching box. The color of the boxes was not specified in the image but had to be detected by the robot.

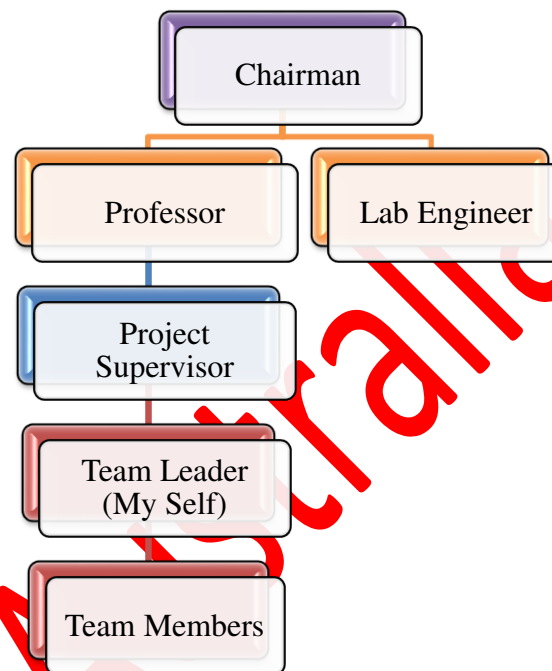
CE 3.3

Major tasks during the project;

- Conducted detailed literature review and gathered all the necessary information that can be useful for the project
- Prepared a weekly schedule for accomplishing the tasks within the given time frame
- Developed the software for the robot completely
- Identified the tasks and recommended the hardware needed to achieve the tasks
- Checked that the circuit designs were appropriate and compatible with the software design

CE 3.4

Project Hierarchy



Personal Engineering Activity

CE 3.5

The first design task that I encountered in this project was to design the flow of the code and how and in what order the robot would perform tasks. I developed a flow diagram of the tasks that included; read and analyzed the image, find the path and moved in the maze accordingly, detected the color of the boxes and put same colored balls in and exit the maze. To start with my design activities, I first read the image file from the SD card and its data stored in an array. Then I created an array with the same dimensions as the original maze and analyzed the image. I represented the obstacles with a 1 and free path with a 0 in the array. After that, I made a function to find the path from one position to another in the map using an algorithm called the Dijkstra's algorithm. Then I called the function to find the path from the entrance to the first box, then from the first box to the second box and finally from the second box to the exit. I stored these paths in an array. I made functions to move the robot, turn the robot, and detect the color of the box and to put the ball. Then I called these functions according to the paths that were stored previously.

CE 3.6

The second task was to design a mechanism that would be able to hold the 2 golf balls on the robot and could pot them while allowing control as to which ball could be pot. This was a challenging task for me. To solve this problem I came up with the idea of a mechanism similar to the rotating doors that are used in shopping malls or public parks to allow only one person at a time to enter. This idea worked perfectly with our requirements. The mechanism had a rotating disc; I separated it into four equal spaces using two plates that were perpendicular to each other. There was a small opening on one side of the plate that allowed a single ball to pass through. I placed 2 balls on the other side of the opening and there was a stepper motor attached at the bottom of the plate which could rotate it. So by turning the stepper motor in one direction or the other by a particular angle, I was able to control the ball that we had to drop.

CE 3.7

I then developed the design of the hardware. I first design the length, width, and height of the robot. I used ultrasonic sensors in the robot for scanning the area form the front back and sides. I placed an encoder for the wheel rotation near to each wheel used in the robot design. I designed the diameter of the wheel. I used a control board for the processing purpose. I also used a motor drive for driving the wheels which interfaced with the control board. The motor which I used in this project had an output of 600mA.

CE 3.8

The first problem that I faced was that the robot deviated a little from its path. It would never go in a perfectly straight line. Thus it would sometimes hit into the side walls and make it impossible to go further. The way I solved this problem was by installing four short range sensors on each corner of the robot to sense the side walls. Two sensors on each side at the front and at the bottom helped to determine whether the robot was standing straight or slightly tilted. I was able to find this by comparing the sensors values of the sensors facing the same side. If the robot was facing straight perfectly then the values of the two sensors must be almost equal. Otherwise, the robot was tilted. I created an align function which would compare the values of the sensors and would turn the robot around its axis slowly until it was straight again which was determined if the sensor values were equal.

CE 3.9

The second problem that I faced was that the sensors implemented in the previous problem were not giving similar responses even when placed at the exactly same distance thus the robot was facing difficulties in aligning correctly. I solved this problem by comparing the values of each sensor and using some interpolating functions to calculate their values under different conditions. I changed the align functions according to the recently corrected values and accounted them in my formulae for checking whether the robot was straight or not. I then fixed the positions of each sensor on the robot.

CE 3.10

The third problem that I encountered was that the two motors that moved the robot had slightly different powers which resulted in the robot to move a little to one side while moving straight and while breaking sometimes the robot would skid. To solve this problems I did a lot of test runs and decided to not keep the motors the same PWM values but instead I slightly changed them by observing which side motor had more power than the other, I then gave more PWM to the motor with less power and slightly less PWM to the motor with more power thus equaling their overall power delivered. For breaking, I changed the breaking function from applying PWM abruptly to changing the PWM from low to high in the span of 3-4 seconds which helped the robot in stopping correctly.

CE 3.11

While choosing the materials for building the mechanism I tried to get the most economical materials and tried to use anything recyclable that was available and could be implemented in our design. The special techniques which I used in this project included the Dijkstra's algorithm for the shortest path finding and some interpolation techniques I used to figure out the values of some short range distance sensors. The software that I used in this project was the Arduino IDE to write the code and burn it in the Arduino which was the microcontroller board that we used. Apart from this, I also worked on MS office for reporting, calculations and designing purpose.

CE 3.12

I also carried out some supporting calculations such as; I determined the difference between sensor values for aligning the robot according to the walls of the maze. I used some interpolation techniques to do this. To find out each square of the arena inside the image provided, I divided the arena size by the total pixels in the image both horizontally and vertically to get the pixels for each square box. I also performed calculations for the PI Control loop.

CE 3.13

All through the project, my main aim was to build my knowledge. To complete this project, I carried out a literature review in detail and studied about the visible light communication in detail. My biggest source of this knowledge was the internet. I browsed different website pages and clear my understanding. I also read numerous books and took guidance from my supervisor. During the time, I also got a chance to attend as seminar related to the topic which helped me in building my knowledge on the coding. I also discussed with my senior engineers who also cleared my problems.

CE 3.14

I collaborated with my team members from the beginning to the end phase of the project. I distributed all the tasks equally among all. I also had given the literature review task to the team. After getting all the information, I held a meeting with them to discuss in detail. I also involved in discussions with them as the project was a bit challenging so we all tried to cooperate at each phase of the project. I carried out my research work under the codes stipulated by the Institute of Electrical and Electronics Engineers (IEEE). During the meantime, I worked with this research I kept the truthfulness of all data obtained and credited properly the team contribution.

I accurately demonstrated my research results and provided a real data capture to prove my work.

CE 3.15

One of my major considerations during the project was to maintain the safe work place. Therefore, I followed the safety norms and tried to avoid any activity which could be harmful to others. I also made sure that I followed all the principle norms of engineering standards matched with the nature of the project. I also advised my team to follow the same work procedures. I kept the batteries of the robot in separate spaces and made sure that their terminals would not be close to each other. Also, fuses were implemented in the power circuit so that in case of a malfunction the whole circuit would not burn.

CE 3.16

I was involved in documentation of the project. I compiled the final project report which I presented to my Supervisor for his review. I well documented each activity of the project. The project report entailed about the details research results, the design of the project, the material utilized, standards followed, etc. I also prepared a presentation on the project; I explained my design using the PowerPoint slides.

Summary

CE 3.17

The project was successfully accomplished fulfilling all the objectives of the project. My effort was valued by the Teachers. I was extremely happy on successfully completing each milestone. I also enhanced my team leadership and project management skills by timely planning all the activities. I showed my high communication skills by preparing reports in well-presented format. I learned a lot about robots and their various aspects and the problems involved.

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