Habib University

Dhanani School of Science and Engineering

Microcontrollers & Interfacing

EE 375L-T1/T2

Team 02

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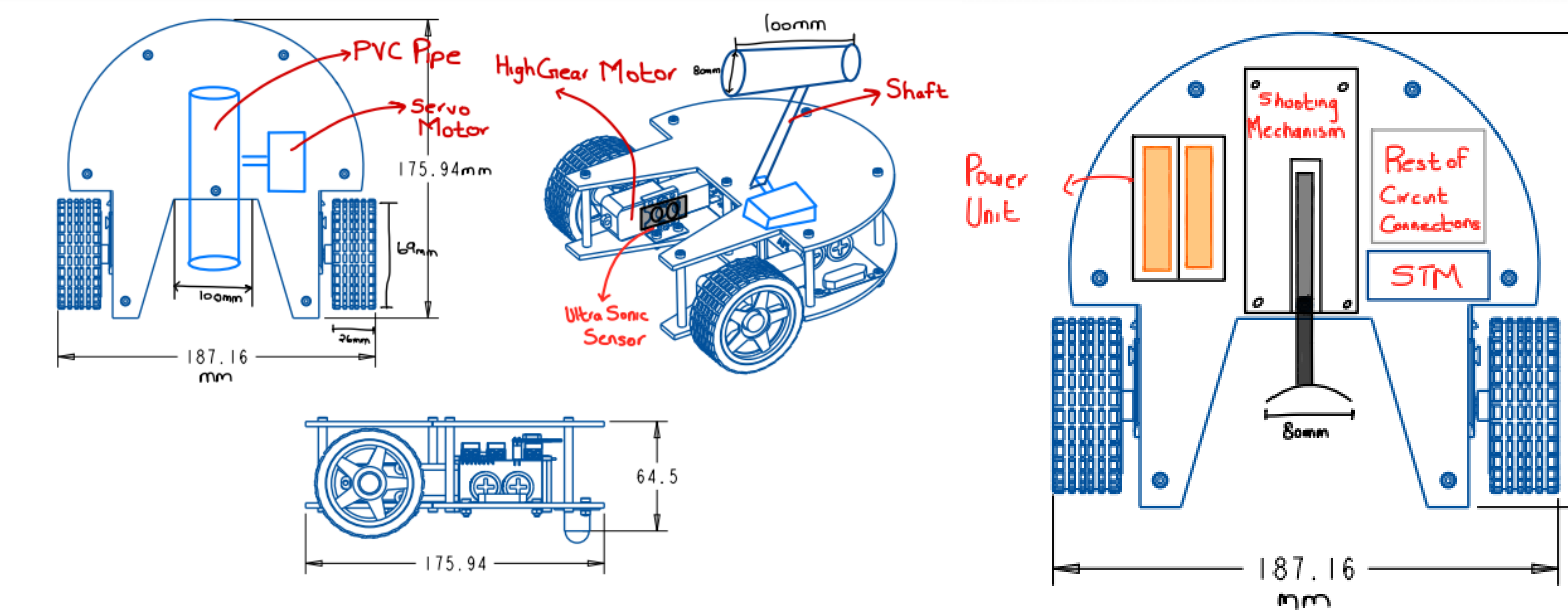
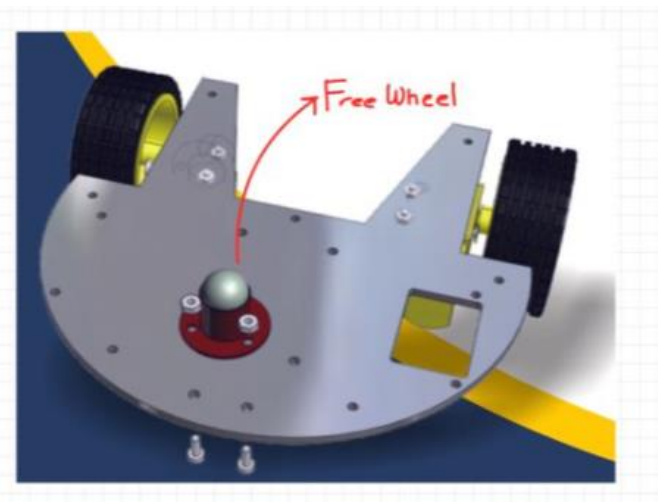
Groups Members:

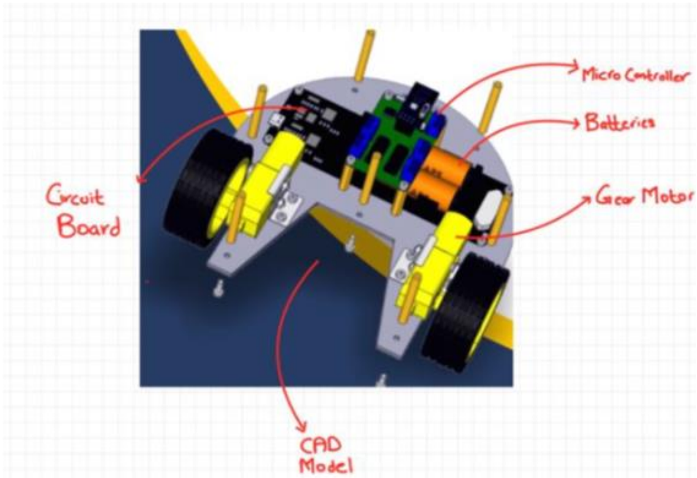
1. Mohammad Hasan Tariq – T1
2. Hamza Irfan – T2
3. Yabudullah Bakhtiar – T2
4. Ali Arif – T2

Schematics of Our Football Playing Robot:



CAD Model:





Task Division:

1. Hamza: Documentation, Arena, Structure Design
2. Ali Arif: Sensors, Control Logic, Presentation
3. Yabudullah: Actuation Mechanism, Structure Design, Hardware
4. Hasan Tariq: Control Logic, Shooting Mechanism, Integration & Testing

Sensors used:

Sensors required in our robot design can be dissected into different groups:

Compulsory sensors: Pivotal to the functioning of soccer robot

1. **Infrared proximity sensors**
    a. Measure the distances to obstacles, by emitted a beam of infrared light and detecting the reflecting of the beam
    b. Price: Can use the one provided by MCI Faculty
2. **Ultrasonic sensor**
    a. Measure the distances of nearby obstacles, by sending out a sound wave at a frequency above the range of human hearing. The transducer of the sensor acts as a microphone to receive and send the ultrasonic sound.
    b. Price: Can use the one provided by MCI Faculty
3. **Heading sensor**
    a. Will know exactly where we are going, without the need to read the data provided by external location tracking system (ELTS). Can allow us to always know the direction of the robot. Any IMU module with a magnetometer would be sufficient to work as a compass for us (see below in the optional sensor).
    b. Price: Can be requested by MCI Faculty, according to shared project kickoff document
4. **Radio Frequency Module**
    a. Will be used to receive coordinates of the location of all involved objects the robot needs to navigate accordingly and shoot at the required direction.
    b. Price: Can use the one provided by the MCI Faculty

Optional sensors: To improve the accuracy of the measurements taken in by the robot

1. **Optical Shaft Encoder**
    a. Used to measure both relative position of and rotational distance travelled by a shaft
    b. We need this to make sure our robot travels in the same direction, and also can verify the gyro sensor's readers if used to its maximum capacity.
    c. Price: 4500 or 4300
2. **IMU Module (a replacement for heading sensor)**
    a. Necessary to make sure the rotations done by our robot are correct and not over shooting or undershooting the desired position. Furthermore, to have a value of the position taken by our robot, and using that as a reference to position and move the robot henceforth. MPU6050 (6axis) or MPU9250 (9axis) will be sufficient modules.
    b. We will have to set a procedure for the robot to calibrate its angular position every time it is placed onto the field from outside of the field
    c. Price: 275
3. **Collision detection sensor**
    a. Detect the collisions that occur with the robot
    b. Could also detect collisions with different sort of obstacles?
    c. To allow detection of ball being in the grab handle

d. Not readily available, will have to engineer it, could use sound detection module.

4. **Miscellaneous**
    a. Other custom-made sensors can also be used to aid in shooting and grabbing mechanism. Our shooting mechanism is a trigger-based system which involves several moving parts (more detail below). The robot may need to know the positions of such parts in different modules to work properly. These custom sensors are expected to be as simple as push buttons if used at all.

Sustainability aspect of our robot

With our discussion with Lab RAs in the MCI Faculty and our design thinking approach from the beginning of this project, we had already incorporated sustainable methodologies due to our requirement of keeping the costs as low as possible (Unless the value obtained from the said cost was worth it).

With this approach, we have decided to reuse acrylic, etc. sheets available from previous projects at Habib, which reduces the cost and similarly, makes sure we do not contribute to additional waste within Habib. Not only will this approach prove to be cost effective, but we will also be able to learn the skill of inspecting material characteristics before being able to use it, as buying new material is easy and requires no effort in verifying the condition of the material while this approach requires us to be actively involved with the material we use, instilling the mindset of sustainability beyond this project. Staying within Habib resources available, we will also attempt to reuse pre-stored robot bases available at the lab from previous projects done.

So far, we have discussed passive sustainable approaches in our project, as they were primarily driven by cost-effective approaches. A direct sustainable approach would be undertaken by carefully putting together the robot while keeping in mind of the fact it needs to be dismantled. This will be done by soldering strongly yet with the foresight of the soldiering being removable (Any pins won’t be shortened; original materials will not ideally be tampered with).

Project Design Approach and Materials:

Materials required for the main construction of our robot design and shooting mechanism

Chassis: Main body of the robot that all components will attach to

1. **Top and Bottom plates**
    a. We will use 5mm acrylic sheet available in the Engineering Workshop to cutout the top and bottom plates for the body of our robot. We plan to use the CNC Machine in the Engineering Workshop to make our custom designed plates. We may switch to 3D printing the top and bottom plates in case there is any discrepancy in cutting the acrylic sheets accurately.
    b. Price: Can use sheet from engineering workshop inventory. 3D printing price yet to be decided by Dr. Abdullah Bajwa if needed at all, approximate budget ~ 100g of material.
2. **Pillars**
    a. We will use brass or some other metal alloy stand-offs to join the top and bottom plate together, this will act as the pillars of the chassis.
    b. Price: Extracted from an old project, will buy more if needed. Available locally for 50rs/piece.
3. **Geared DC motors and wheels**
    a. We will use available TT-Motor (yellow) assemblies with wheels from lab or buy more powerful geared dc motors if the former proves to be underpowered. These will be part of the main chassis that will drive the robot.
    b. Price: Can be issued from Circuits lab. Available locally for 180rs/piece.

Shooting Mechanism: Used to shoot the ball once it has been caught

1. **Metal Rod**
    a. Will be used as our main rod which will push the ball in the direction of the goal. The material used can either be Aluminum or Brass depending on the availability of the rod. We can also hollow it from the inside to subtract weight.
    b. Available as scrap in the Engineering Workshop.
2. **Pinion and Rack pair**
    a. A Pinion and Rack gear will be used to move the shooting rod backwards against the spring to store elastic energy in the spring. When the trigger is released in the front of the rod, the spring will release the energy with added force.
    b. Price: Can be issued from engineering workshop if available.
3. **Stepper Motor**
    a. The stepper motor is required to move the pinion precisely so that the rack is pushed backward against the spring at the right position.
    c. Price: Can be taken out from CD Drives. Larger models, if required, are available locally at Rs.500/piece.

Main Electronics: To animate the robot chassis and make it functioning

4. **Microcontroller**
    a. We will use the Blue Pill STM32F103C8 available in our kit as the main microcontroller that will drive our robot.
    b. Price: Included in MCI lab kit. Available locally for 830rs/piece.
5. **Motor Driver module**
    a. We will use the provided L298N motor driver module provided in the kit. This will provide a separate high voltage power supply to the DC motors and control their speed.
    b. Price: Included in MCI lab kit. Available locally for 220rs/piece.
6. **Servo Motors**
    a. We will MG996R high torque metal gear servos for the shooting mechanism, and lower powered SG90S/MG90S servos for the lever trap mechanism for grabbing.
    b. Price: Can be issued from Projects lab. Available locally for 680,280,250rs/piece.
7. **Battery Pack**
    a. We will use multiple (at least 3) rechargeable Li-Ion 18650 cells in series to get our desired voltage of 12V or higher to power the robot.
    b. Price: Available locally for 170rs/piece.
8. **Geared DC motors**

    Already mentioned in Chassis part as part of motor assembly.

Optional Electronics:

1. **Brushless DC motor and controller**
    a. We may use A2212 brushless DC motors for shooting mechanism incase our first design fails.
    b. Price: Available locally for 700+750rs/set (motor + controller).
2. **DC Step-down voltage regulator**
    a. We may use a dedicated step-down voltage regulator to power the Blue Pill board in case the built-in regulator of the L298N fails to provide the desired voltage for the microcontroller.
    b. Price: Available locally for 350rs/piece.

Bill of Materials (BOM)			
Part	**Qty**	**Price**	**Total**
3D Printing for top and bottom plate	100g	10 Rs/g	1000 Rs
Pillars	6 to 8	50 Rs/piece	800 Rs
Gear DC motors and wheels	2	180 Rs/piece	360 Rs
Stepper Motor	1	500 Rs/piece	500 Rs
Microcontroller	1	830 Rs/piece	830 Rs
Motor Driver Module	2	220 Rs/piece	440 Rs
Servo Motors	1	680 Rs/piece	680 Rs
Battery Pack	3	170 Rs/piece	510 Rs
Grand Total:			**5120 Rs**

Arena Design:

In order for our arena to be sustainable, we must use the locally available resources. The field requires a smooth surface with no disruptions and the floor should be in green in color to represent an actual football field. The best place on campus where we can do this is the "Power Lab Floor", right when we enter from the main entrance, we can easily setup the area over there because clear large area is available that can easily fit the requirements.

In order to create markings on field we can used white paper type to create proper field layout and design and once the competition is over, we can easily peel it off the floor without causing any harm to the lab floor.

For boundaries and goals, we can use PVC pipes along with connectors to create a solid boundary and create goals for both side, once the competition is over, we can easily remove the pipes from connectors and they can be used again in any future application. Besides this we need piece of net to cover both goals.

We also need to adjust the lighting near and over arena so that the sensors in robots could receive data smoothly without disruptions for this we will only turn on lights which focus on the arena and lights of surrounding sides will be switched off.