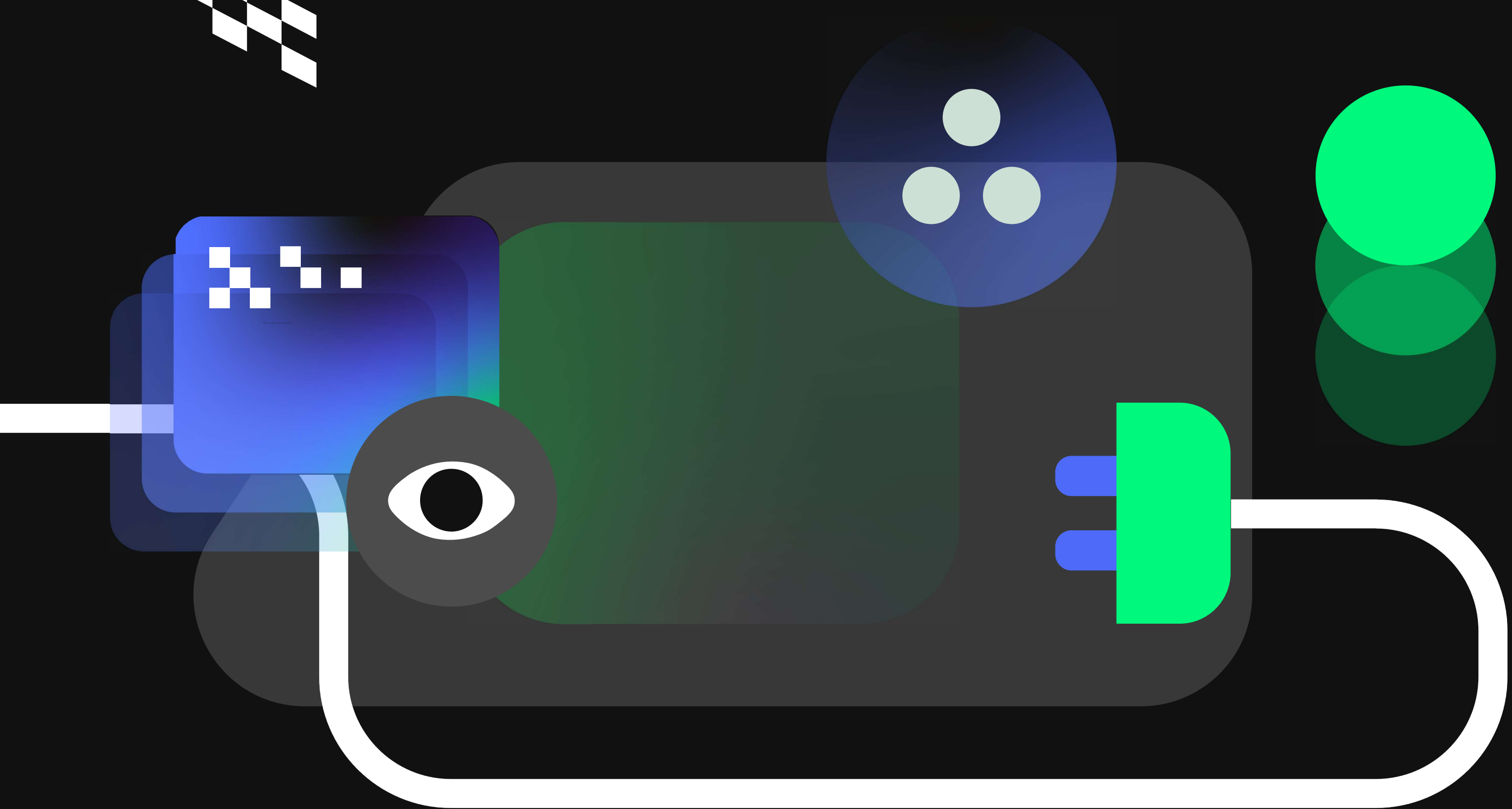
Inter IIT Tech Meet 11.0
IIT Kanpur



Mid Prep

THE ROBOTIC CHARGING CHALLENGE

With the advent of Autonomous vehicles, autonomous charging is important to provide customers a seamless experience. For the current charging technology, customers have to get out of the vehicle and plug the charging plug to the socket. Could you devise a system that can automatically detect the charging port of the vehicle and plug the socket into the charging port?

REQUIREMENTS

Your System should be able to perform two major tasks:

Task 1: Detect the location of the plug: Use any technology of your choice to accurately detect the position of the plug, which can be deployed on a production vehicle.

T***ask 2:*** Your robot's charging end should be able to move and latch/unlatch the charging plug into the socket autonomously and return to its location.

FUNCTIONALITIES AND CONSTRAINTS

Following are few desired functionalities of the system:

A complete cycle should be performed, which includes:

- Your robot's end effector (charging end) should be at the resting position initially, where the robot charger is mounted.
- Robot charger system should detect the location of the charging port on the vehicle (anywhere within the bounding box as shown in Fig 1 and 2), and the end effector should safely reach the location and plug into the port.
- Robot's end effecter should unplug itself and return to its original position once the charging cycle completes (assume a charging cycle of 30 sec.)

To achieve the aforementioned cycle, the charging end of the robot should be able to move in X, Y and Z directions, and rotate around these axes if required, as shown in the image. Use motors and Actuators with appropriate justifications.

The charging cable is an important component that needs to be considered while designing the structure of your robot. You need to consider the diameter of charging cable while designing the dexterity of the mechanism (for ex. too sharp bending angles are not practical and must be avoided.)

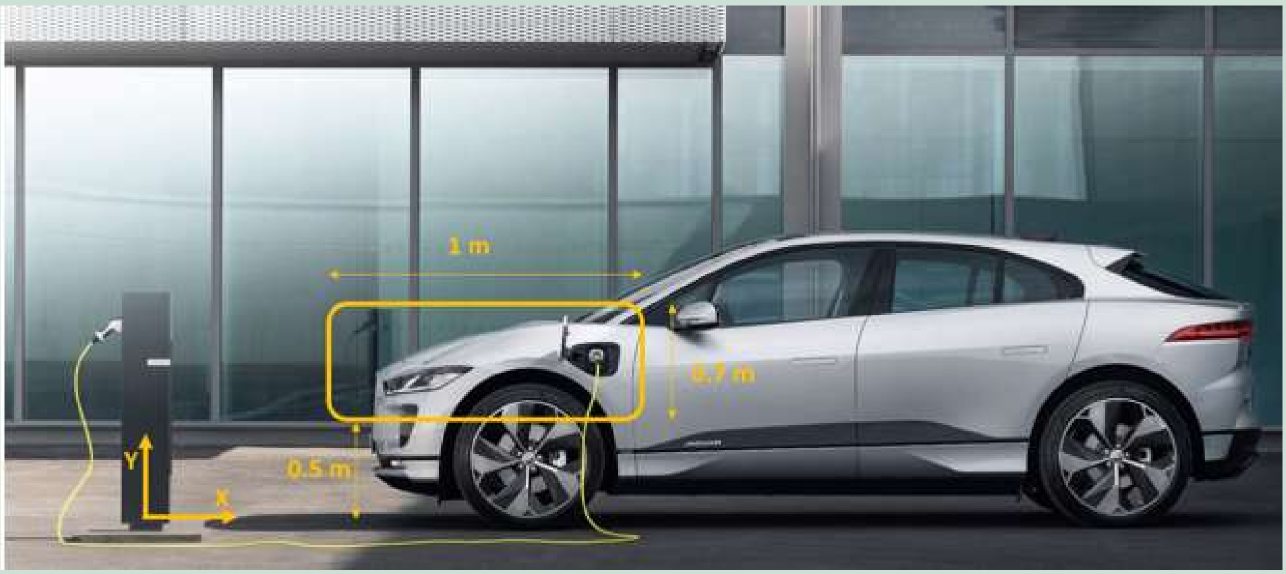


Fig. 1: Boundary within which the Charging point of the vehicle can lie (SIDE VIEW)

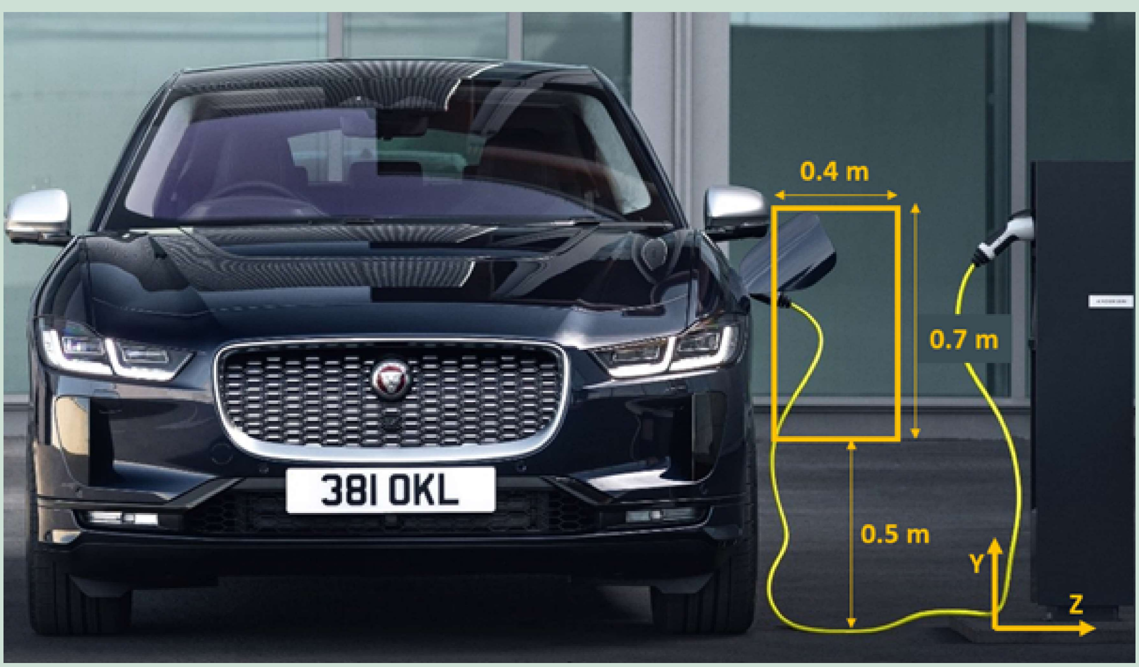
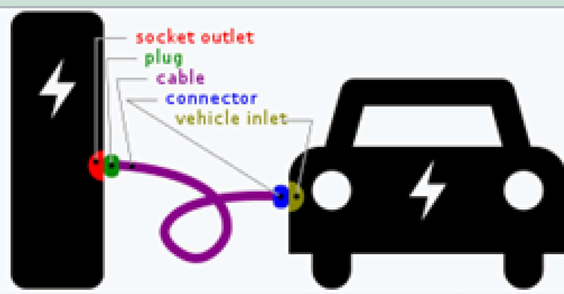


Fig. 2 Boundary within which the Charging point of the vehicle can lie (FRONT VIEW)

Fig. 3



Region / Standard	Socket outlet	Connecting cable		Vehicle inlet	Electrical		
		Plug	Connector		Phase (φ)	Current	Voltage
EU / IEC 62196-2 Type 2	Female	Male	Female	Male	1φ	70A	480V
					3φ	63A	

Fig. 4

PHYSICAL SYSTEM CONSTRAINTS

- Most vehicles use a CCS2 Plug for charging. You should consider the same plug and socket assembly as shown in the figure 3.
- Consider that your robot charger is mounted on the ground in an open charging station, you can choose the mounting point of your choice relative to the bounding box, but it has to be on ground.
- Assume that the charging port cap on the Vehicle is open as shown in figure X below.

- The robot's end effecter should be able to reach anywhere within the boundary shown in Fig-1 and 2, while the system remains fixed at its location.
- The speed of charger plugging operation should not be more than 0.1 m/sec in any direction. The rotation speed should not exceed 5 deg/sec.
- The detection system for the charging port could be based on any principle (for ex. image processing, sonar, etc.) It must necessarily meet the performance criteria.
- Please note that the system design must be realistic and practical. Any component (for ex. motor, linkages, etc.) must be available off the shelf in online Indian marketplace. You must provide link to the website where cost and performance specifications of the components you have used are given. However, the sourcing information about basic elements such as electrical wires, harnesses, nuts, bolts, screws, adhesives, etc. need not be provided. Any use of exotic materials and difficult to manufacture designs will attract penalty.

EVALUATION CRITERIA

- If your system fails to complete the cycle, it will be disqualified from evaluation.
- All the constraints mentioned must be met. System should be sized reasonably.
- Lesser the number of links and moving components, the better the system.
- The end effector should be able to perform the cycle for any arbitrary position of boundary box. During the presentation, we shall ask the teams to consider an arbitrary pose of boundary box and the initial position of end effector. Teams will have 2 minute to change the coordinates as per our criteria and show the operation.

Mid Prep

BROWNIE POINTS

Your team may fetch some extra points if they are able to present the solution for the below additional requirements (Over and above the prescribed ones):

- The system software should be able to open the charging port door after the detection of the port autonomously (may use car data over cloud.)
- The system uses two different principles to realize the solution.

SUBMISSION REQUIREMENTS

- The location of mounting point of the robotic charging system on the ground/wall.
- A working model in MATLAB/Simulink (Simscape) environment, which consists of all the physical actuation components, with all the assumptions mentioned and the details of control strategy used.
- Simple plot/animation (animations will get more points) of your robotic system performing the cycle. 3D animations should include the visual motion of end effector (make a realistic design; simple cuboid or spherical balls are boring.)
- Bill Of Material of all the components you have used in your design.
- Power Consumption of your system for a single cycle.
- Sketch or CAD model of your system, along with front, side, and isometric views showing your system clearly.

EVALUATION CRITERIA

- **20 points** for selection of the location of mounting point for the Robot and your reasoning behind doing so.

- **50 points** for a working MATLAB simulation model with all the assumptions and considerations taken by the you while designing.

- **50 points** for Valid plots/ animations showing that your designed system is able to perform the cycle mentioned in "Functionalities and Constraints" section.

- **50 points** for the CAD model of the system (Package your system wisely, keep your system very compact in the idle condition)

- **30 points** for Power Consumption of your system for a single cycle.

- **50 points** for simplicity and versatility of your system (Less moving parts in your BOM, minimum cost of components, easily adaptable to different environments)

HOW TO SUBMIT YOUR ENTRIES?

- Prepare a PowerPoint presentation containing all the details of your proposed system(s). You should include literature survey (if any), working principle, methodology, system layout, governing equations, simulation results, packaging data and 'claimed points' based on your self-assessment in it. The reason behind the use of a component has to be properly mentioned. Do not forget to add bibliography at the end; all the referenced content in your presentation (including equations, theory, etc.) must carry citations. Add your presentation and referenced documents (papers, patents, etc.) to a folder and zip it.

- Prepare a zipped folder containing your programs and models along with the instructions to use them. We will review and simulate the system model and verify your claims. Write comments liberally, and make sure your programs and models are comprehensible.

- Send both zipped folders to us.