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Wireless EV Charging Dock Mechanism for Urban Use

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Abstract: Increasing demand of Electric Vehicles (EVs) demand for additional infrastructure for setting up charging docks for them. The current design for charging docks is not ergonomic and requires a large amount of additional space for set up. Hence a retractable dock mechanism for charging EVs is proposed, which supports wireless charging, to combat the ever increasing congestion.
Keywords: Electric Vehicle, wireless charging, charging mechanism, charging dock, electromagnetic induction

I. INTRODUCTION

With the ever increasing spread of Electric Vehicles, the Government of India has advocated and promoted the use of EVs, with various policies to benefit both end-users and manufacturers [Singh (2018)]. But with rapid urbanization, land congestion is greater than ever.

With a decreasing rate of cultivable land due to urbanization, especially in and nearby metropolitan areas [A Kavitha (2015)], allocation of land for installation of the existing, space consuming charging stations is not viable. This problem is tackled through the introduction of a retractable charging dock for EVs, that supports wireless charging, and has a minimal size profile for ease of installation in dense urban areas.

II. PROBLEM STATEMENT

The existing public wired charging system for charging of EVs currently require a lot of space for installation. The charging 'docks' additionally require allotted parking space, making it difficult to install in high population density areas. Moreover, recent push for EVs by the Government of India mandates reservation of 20% parking space for EV charging in residential and commercial complexes [Singh (2019)]. Charging stations will also be required to set up beside roads and highways for emergency charging, requiring additional allocation of land for them.

III. DOCK DESIGN AND MECHANISM

A. Design

The dock features a double-fold design as shown (Fig. 1). The dock is divided into two parts -the charging plate and the non-charging component.

The non-charging component is mounted on a wall vertically using a slider mechanism. A charging plate (with a thin hollow cut-out to fix the transmitting circuit of wireless charging) is attached to the non-charging component, to be adjusted for vehicles with different ground clearances, where it comes into contact with the receiver circuit attached to the chassis of a vehicle, and initiate charging wirelessly.

B. Mechanism

The non-charging component of the dock can be mounted onto a wall vertically, using a slider mechanism. The charging plate is attached to the non-charging dock, and can be moved at right angles to the non-charging dock using a stop-hinge (Fig. 1). This allows the whole dock to be moved up and down, and can be fixed at any position to adjust for multiple ground clearances for different vehicles.

When not in use, the charging dock can be folded towards the non-charging dock, keeping it flush with the wall. This aids in freeing up ground space, which can be used as a normal parking space, aiding ergonomics.

The folding design creates a sleek profile for the dock, which aids its installation in cramped urban spaces.

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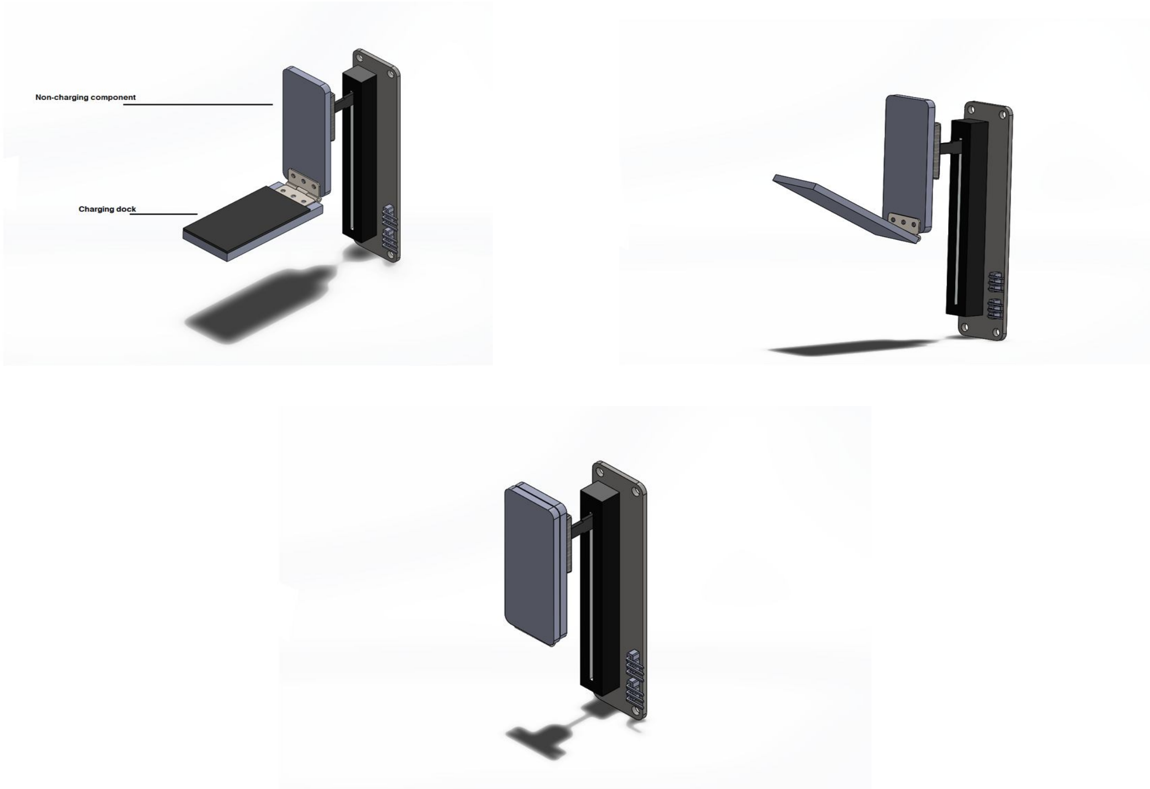


Fig. 1 Opening and closing mechanism for the dock

IV. MATERIAL SELECTION

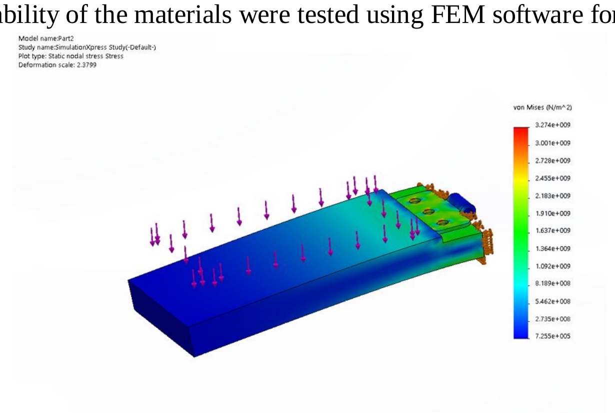
The main criteria to aid wireless charging was the selection of materials to be used for the fabrication of the dock.

An ideal material should be durable and withstand environmental corrosion, while be strong enough to withstand force on it for firm contact with the charging plate on the chassis of the car, as well as withstand any accidental damage. This also ensures minimal deformation of the charging plate on the dock.

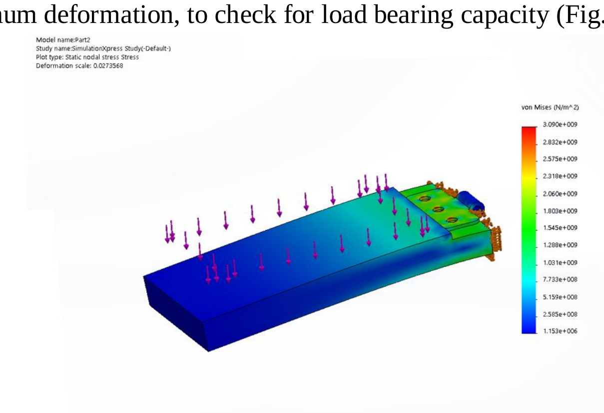
The material should also be able to support charging through electromagnetic induction; wherein the chosen material should have the least power loss due to eddy currents and hysteresis, and cause minimum power loss due to heat dissipation.

This immediately eliminates any metals for the material of choice. Glass is a popular material used for wireless charging in many mobile devices today (“Glass is better for wireless charging”, n.d.). But due to the fragile nature of the material, it is prone to structural damage.

Based on current availability and use of materials, four materials were chosen for the dock: Ceramic, Polyvinyl Chloride (PVC), Polyethylene, High Density Polyethylene and Melamine. Since all the materials have shown capacity to support inductive charging, durability of the materials were tested using FEM software for maximum deformation, to check for load bearing capacity (Fig. 2).



(i) Ceramic



(ii) PVC

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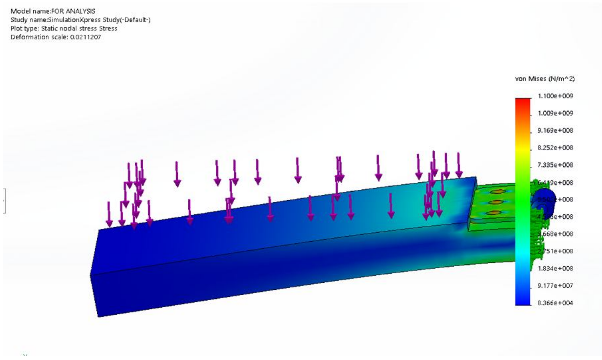
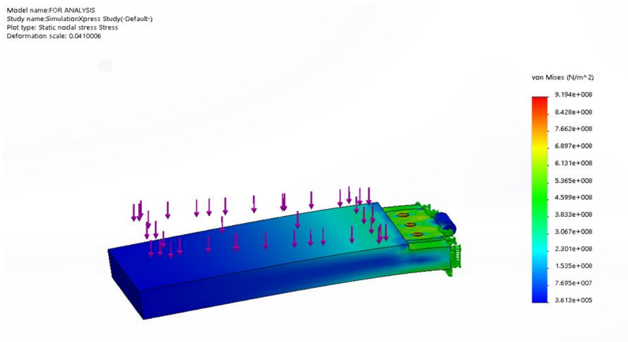
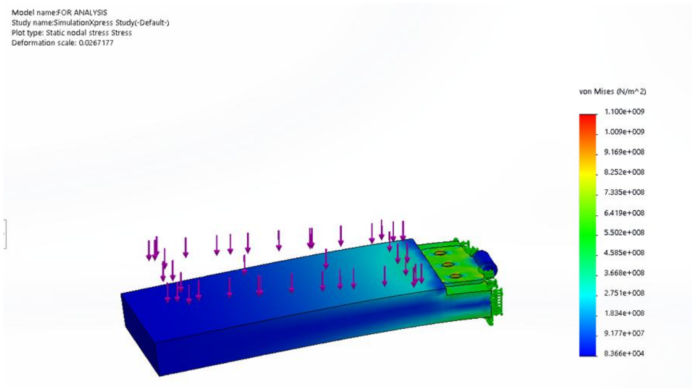


(iii) Polyethylene



(iv) High Density Polyethylene



(v) Melamine

Fig. 2 Test for deformation on various materials

From the deformation tests, it was evident that Polyethylene has the least deformation, followed by Melamine, whereas ceramic has the least deformation and breaks easily. Therefore, Polyethylene is considered as a good material for construction of the charging dock, as it is also cheap and readily available.

V. ELECTRONICS

The mechanism of charging wirelessly is the same as that of any electronic device, and uses inductive charging for wireless transmission of power (Lu, 2016), the schematics of which have been depicted in a basic block diagram in Fig. 3. The coils required have an extremely thin profile, and can be easily fitted into the thin hollow cutout of the charging plate.

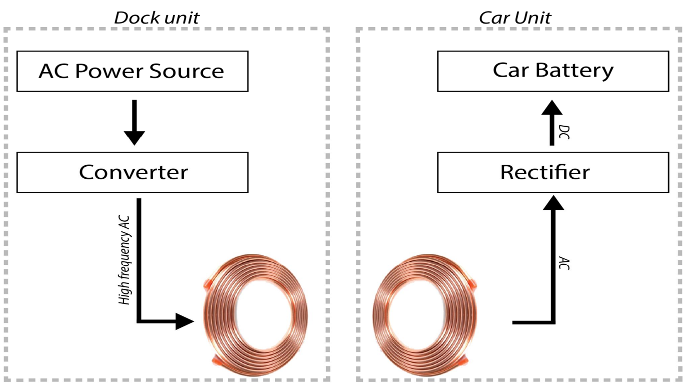


Fig. 3 Basic block diagram to depict the arrangement of electronics.

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VI. CONCLUSION

The devised mechanism for a foldable charging dock shown has a sleek profile that promotes its installation in cramped spaces and places with high population density like metropolitan cities. Wireless charging promotes a hassle-free use with lesser dependency on wires, increasing safety factor for docks installed in public areas. The dock materials have been chosen via an iterative analysis process, yielding a weather-proof design that supports wireless charging. The minimalist design also has lower maintenance costs, and fewer components give it a scope for further hardware upgrades if required.

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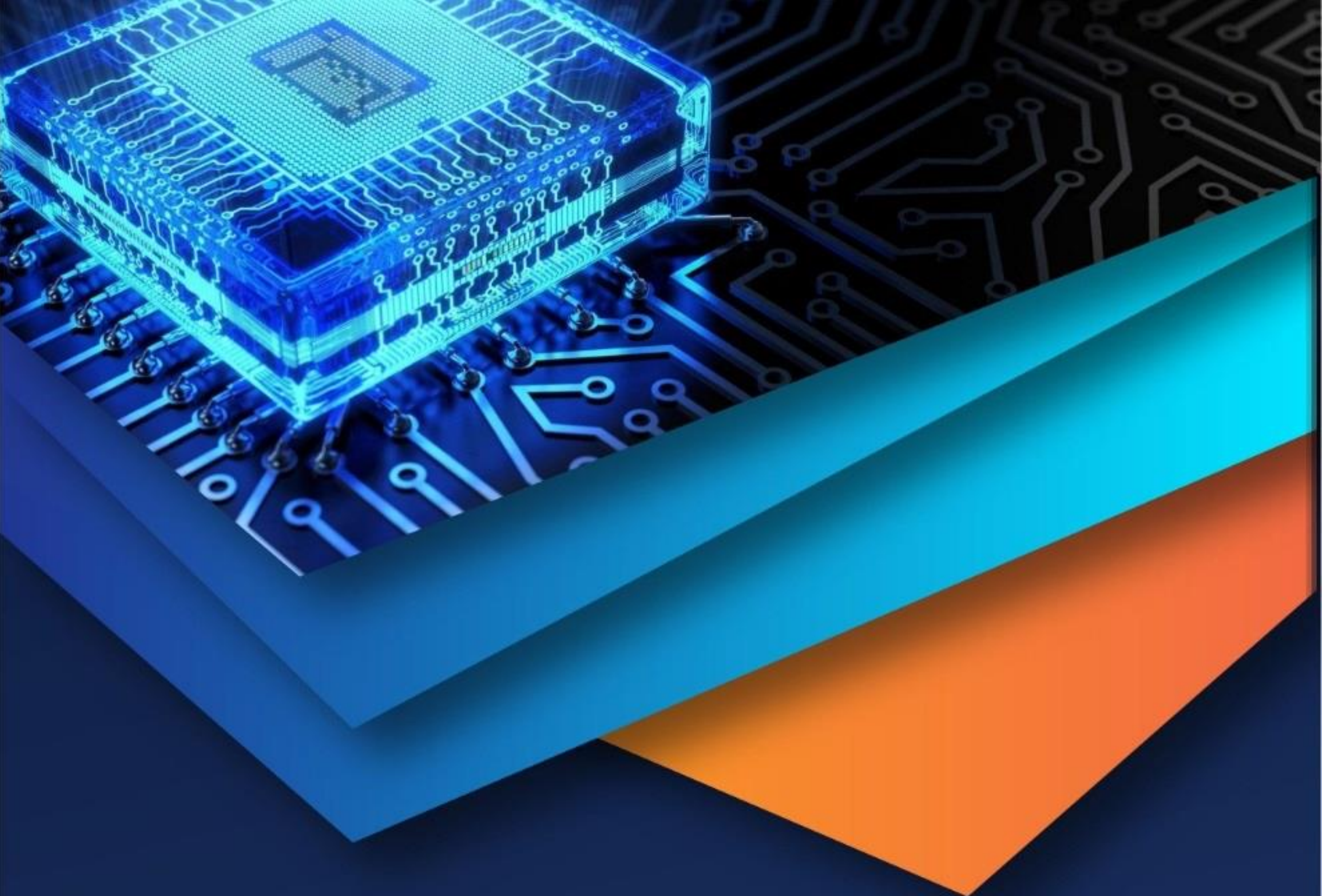

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