ELECTROHUB : WIRED AUTONOMOUS DOCKING SYSTEM FOR ELECTRIC VEHICLES

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EXTENDED ABSTRACT

Electrohub represents a groundbreaking initiative aimed at revolutionizing the Electric Vehicle (EV) charging infrastructure through the development of a wired autonomous docking system. This project integrates advanced robotics, computer vision, and machine learning technologies to create a highly efficient and user-friendly solution for EV charging. The primary objective is to automate the charging process, thereby minimizing human intervention and enhancing the convenience and reliability of EV ownership.

In this prototype, a robotic arm with a charger as its end effector is mounted on a mobile platform, specifically a four-wheeled vehicle. This configuration enables the system to approach and align with various EV models dynamically. A sophisticated camera system, positioned atop the end effector, facilitates real-time detection of car models and the rough positioning of the charging port on each vehicle. The machine learning algorithms employed are trained to identify specific vehicle models and their corresponding charging port locations accurately, ensuring precise docking of the charger.

The Electrohub system is powered by a Raspberry Pi 4 microcontroller, which provides the necessary computational power for real-time image processing and control of the robotic arm. The robotic arm itself is equipped with MG995 and Orange OT5320M servo motors, which deliver exceptional control and precision in movement, essential for the delicate task of aligning the charger with the vehicle's port. The arm is constructed from robust metal components, ensuring stability and durability during docking and undocking procedures. Additionally, the charger and port components are 3D-printed, allowing for easy customization and adaptation to different vehicle designs.

One of the key innovations of Electrohub is its ability to autonomously detect and identify compatible EVs and accurately locate their charging ports. This is achieved through the integration of machine learning algorithms that process the data captured by the camera system. The real-time analysis and decision-making capabilities of the system enable it to dynamically adjust the position of the robotic arm, ensuring a precise and secure connection between the charger and the vehicle's port. This automated process significantly reduces the need for human intervention, streamlining the overall charging experience for EV owners.

Despite its promising potential, the Electrohub project encountered several challenges during its development. The machine learning model initially struggled with accurate detection of vehicles and charging ports, leading to inconsistencies in port alignment. Resource constraints also posed limitations on hardware components and computing power, affecting the project's progress. The complexity of Robot Operating System (ROS) programming added another layer of difficulty, requiring substantial time and effort to master. Moreover, selecting an appropriate design for the robotic arm and end effector was challenging, as it required balancing functionality, stability, and manufacturability. Originally envisioned as a stationary charging station, the project had to evolve into a mobile platform to meet dynamic charging requirements, leading to the adoption of a four-wheeled base for the robotic arm.

In practical applications, Electrohub can be implemented in various settings, including parking lots, residential complexes, commercial areas, and public charging stations. By leveraging existing infrastructure and resources, this system can be easily deployed to enhance EV charging accessibility and efficiency. The autonomous capabilities of Electrohub not only streamline the charging process but also reduce the likelihood of human error, ensuring a reliable and user-friendly experience.

In essence, Electrohub exemplifies a significant step forward in the electrification of transportation. By offering a practical and innovative solution to the challenges of EV charging, it addresses the evolving needs of both electric vehicle owners and charging infrastructure providers. Through continued refinement and deployment, Electrohub has the potential to play a pivotal role in shaping the future of sustainable mobility, promoting the widespread adoption of electric vehicles and contributing to a cleaner, more efficient transportation ecosystem.

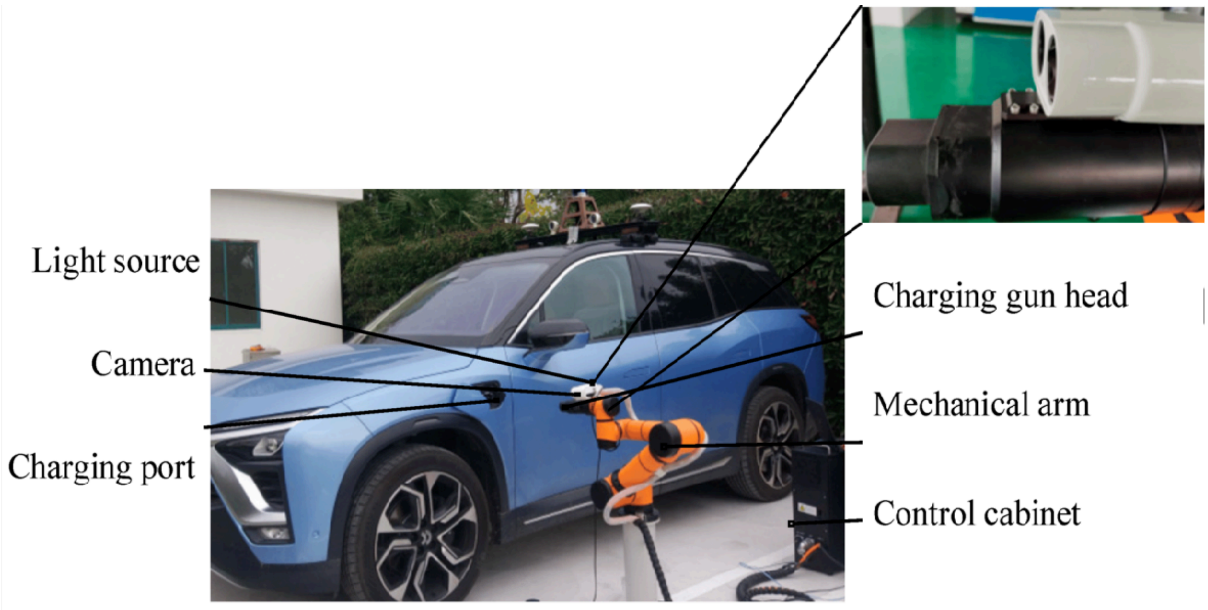

Figure : Proposed System

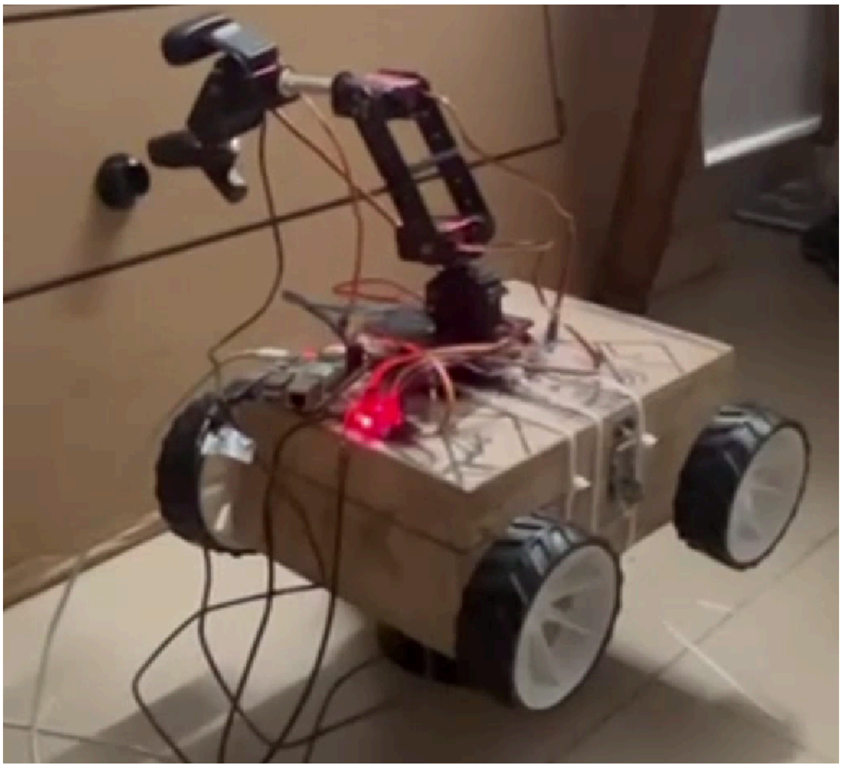

Figure : Actual System

CONCLUSIONS:

In conclusion, the Electrohub project represents a significant advancement in electric vehicle charging infrastructure, offering a wired autonomous docking system that streamlines the charging process while reducing human intervention. By integrating robotics, computer vision, and machine learning technologies, Electrohub demonstrates the potential to revolutionize the way electric vehicles are charged in real-world scenarios.

Despite its promising potential, the Electrohub project encountered several challenges throughout its development. One of the primary difficulties arose from the machine learning model's struggle to accurately detect vehicles and locate charging ports, leading to inconsistencies in charging port alignment. Additionally, resource constraints posed limitations on the availability of hardware components and computing resources, hindering the project's progress. The complexity of Robot Operating System (ROS) programming presented another obstacle, requiring significant time and effort to navigate effectively. Furthermore, selecting an appropriate design for the robotic arm and charger end effector proved challenging, as it necessitated balancing functionality, stability, and manufacturability.

Originally envisioned as a stationary charging station, the project's requirements evolved necessitating a change in approach. To address this, the base of the robotic arm was modified to a four-wheeled platform, enabling mobility and adaptability to various charging scenarios. This strategic shift allowed Electrohub to overcome spatial constraints and cater to dynamic charging needs in real-world environments. Despite these challenges, the team's perseverance and collaborative efforts ultimately led to the successful development of Electrohub—an innovative solution poised to revolutionize electric vehicle charging infrastructure.

In real-life scenarios, Electrohub could be implemented in parking lots, residential complexes, commercial areas, and public charging stations, catering to the growing demand for electric vehicle charging solutions. By leveraging existing resources and infrastructure, organizations and individuals can easily deploy Electrohub to enhance EV charging accessibility and efficiency, ultimately contributing to the widespread adoption of sustainable transportation practices.

In essence, Electrohub exemplifies a promising step forward in the electrification of transportation, offering a practical and innovative solution to address the evolving needs of electric vehicle owners and charging infrastructure providers alike. Through continued refinement and deployment, Electrohub has the potential to play a pivotal role in shaping the future of sustainable mobility.