

# Robotics Application (COT 5930)

Project Report

On

Car Servicing: Electric Cars  
Recharging stations



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**Submitted To**  
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A close-up, slightly blurred image of a white industrial robotic arm in a factory setting. The arm is positioned vertically, with various cables and mechanical components visible. The background shows other industrial equipment and a bright, possibly outdoor or well-lit indoor environment.

# Car Servicing: Electric Cars Recharging stations

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To complete this research

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# Introduction

Robotics plays a significant role in car servicing and electric vehicle (EV) recharging stations, improving efficiency and convenience. In car servicing, robotics are used for tasks like automated diagnostics, autonomous maintenance, and even vehicle inspections. These technologies enhance precision and reduce human error, leading to safer and more reliable car servicing processes. Robotic charging of electric vehicles is indeed an innovative system aimed at automating the recharging process for electric cars. This technology involves the use of robotic arms or automated systems to connect charging cables to electric vehicles. It provides several advantages, including enhanced convenience for EV owners and more efficient utilization of recharging infrastructure. Robotic charging systems can contribute to reducing the time required for recharging and make the process more user-friendly, ultimately promoting the adoption of electric vehicles as a sustainable mode of transportation.



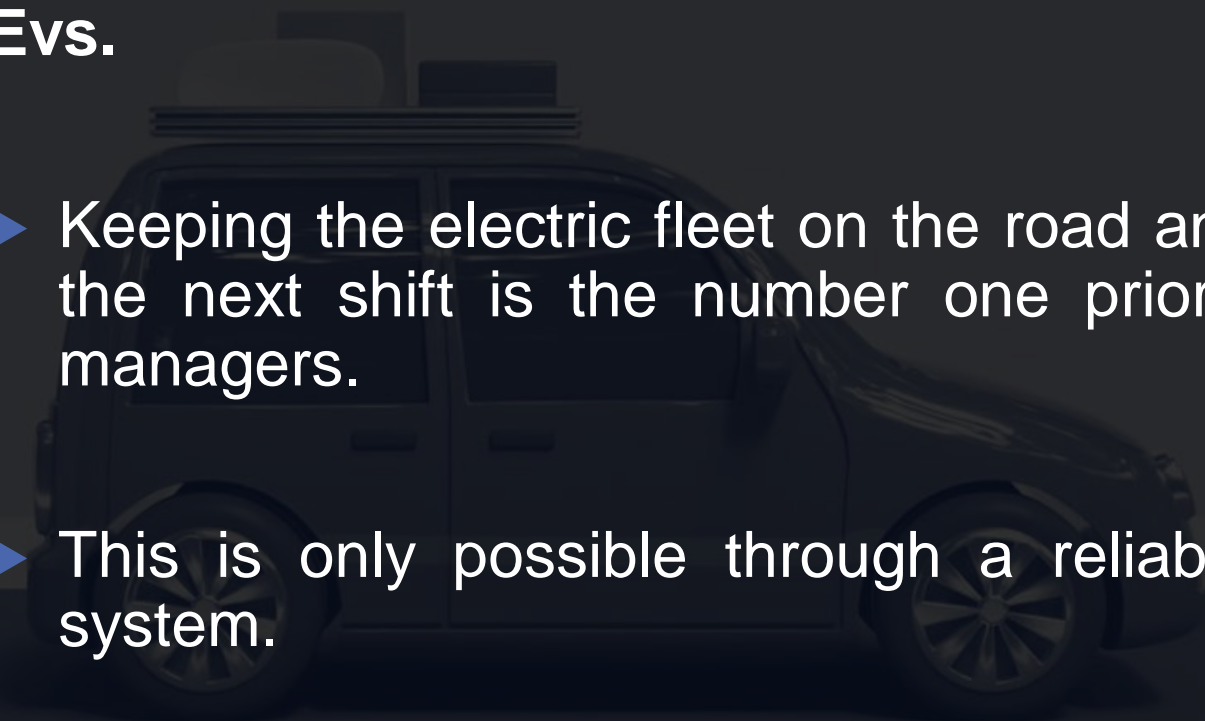


# Autonomous charging of electric vehicles with robotics: How it works

- ▶ The electric vehicle (EV) market is scaling rapidly, requiring a timely roll-out of supporting charging infrastructure.
- ▶ Autonomous charging is key in setting up a reliable, safe, and cost-efficient charging process.
- ▶ More specifically, robotics provide an essential contribution by automating the charging of standard EV connectors.

# Benefits

**Autonomous charging will be a game changer for Evs.**

- 
- ▶ Keeping the electric fleet on the road and ready for the next shift is the number one priority for fleet managers.
  - ▶ This is only possible through a reliable charging system.
  - ▶ For unoccupied self-driving EVs, autonomous charging is even more essential to remain operational, as there is no driver present to connect

# Benefits

## ▶ Automating the charging of standard EV connectors results in the following benefits:

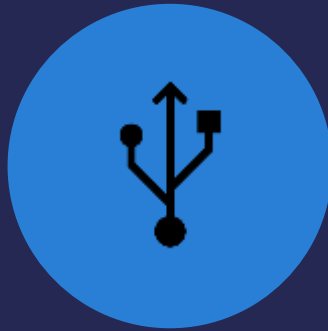
- Reduction of charger downtime
- Improved user experience and safety
- More efficient use of charging site and assets
- Reduction of cable wear and tear
- Readiness for autonomous vehicles

*Compared to manual charging, automating the process significantly reduces queuing. By eliminating 80% of the switch time, the throughput can be enhanced by 15%.*

# Stages Of Implementation



PARKING



PLUGGING IN  
PLUGGING OUT



CHARGING





# Parking

Vehicle Placement: Instead of manually plugging in their electric vehicle, drivers park their cars near charging stations.

- ▶ Autonomous Activation: An autonomous charging system is activated once the vehicle is parked. In the future, this could also include automated valet parking in parking garages and at public charging stations.
- ▶ Driver/Passenger Absence: The driver or passenger does not need to be present during the charging cycle. This means the vehicle can be charged without any human intervention.

# Plugging In and Out



- ▶ **Vehicle Communication:** The electric vehicle communicates directly with the charging robot, initiating the charging process.
- ▶ **Opening the Charge Port:** The robot autonomously opens the charge port cover on the electric vehicle.
- ▶ **Visual Recognition:** Using an intelligent camera system, the robot can identify the location of the vehicle's charging inlet. It essentially "sees" where the charging port is on the car.

# Plugging In and Out

- ▶ **Connector Insertion:** A robotic arm, guided by the visual data, gently and safely inserts the charging plug into the vehicle's charge port.
- ▶ **Disconnection:** When the vehicle is ready to leave (or has reached a sufficient charge level), it disengages the CCS (Combined Charging System) lock. The robot then safely unplugs the connector from the vehicle.
- ▶ **Communication with the Vehicle:** The robot communicates with the car to ensure it is safe to start driving, indicating that the charging process is complete.



# Charging



- ▶ Automated Charging Initiation: Charging can start automatically through methods like Plug & Charge or Smart Charging. These methods are often defined in charging standards, such as ISO 15118.
- ▶ Integration with Fleet Management: Robotic charging systems can be integrated with fleet management software. This integration allows operators to see the system's status, diagnose errors remotely, and support the resolution of issues.



# Research Aspects In Charging the EV Using Robotics Applications

- ▶ In these robotic systems, computer vision stands as the core guiding principle. This advanced technology enables their robots to skillfully navigate the plug toward the socket.
- ▶ Today, highly sophisticated vision solutions can extract 3-D information with a single camera, providing the robot with the necessary data to reliably direct the plug into the socket.
- ▶ The computer vision algorithms, based on deep learning, have been trained to function effectively in adverse weather conditions such as rain, snow, fog, and bright sunlight.



# Research Aspects In Charging the EV Using Robotics Applications

With the integration of LED lighting, the system operates seamlessly day and night.



Deep-learning-algorithm-based vision identifies vehicle inlet orientation even in tough weather.



Constant optimization through heavy reliability testing in automated test set-ups.



When deployed to customers, continuous performance optimization is powered by Artificial Intelligence (AI)

# Few Models Of Robotic Charging For EVs

**Some examples of robotic charging systems include:**

- Auto Charging Robot (ACR): Automatically recognizes the charging port of an EV, inserts the charger, and disconnects when charging is complete.
- Autev robots: Can bring EV charging to any parking spot in a garage.
- EVAR Parky: Navigate to your car while avoiding pedestrians and other vehicles.
- NaaS Technology: Can automatically locate charging ports on EVs and recharge them.
- Ziggy: Can come to the car instead of the driver parking by the EV charger.



# Autev Robotic Charging

The background image shows a robotic arm with a gripper mechanism positioned over the charging port of a white electric vehicle. The scene is dimly lit, emphasizing the mechanical components of the robot and the sleek lines of the car.

- ▶ Autev robots are designed to bring EV charging to any parking spot in a garage.
- ▶ These robots have the capability to navigate parking areas and reach individual parking spots where EVs are located.
- ▶ Once the robot arrives at a parking spot, the user can plug the EV's charging cable into the vehicle's charging port, and the robot takes care of the charging process.

# Autev Robotic Charging



This technology enables EV owners to conveniently charge their vehicles without the need for fixed charging stations, making it a flexible and efficient solution for EV charging in various parking environments.

- ▶ Autev robots are advanced robotic systems that are reshaping the landscape of EV charging.
- ▶ The adaptability and convenience of Autev robots in providing EV charging solutions.
- ▶ Their unique ability to bring EV charging to any parking spot within a garage.

A wireframe illustration of a robot, possibly an Autev robot, is shown on the left side of the slide. It is composed of a network of black dots connected by thin grey lines, forming a skeletal structure of a vehicle. Above the robot, there is a smaller, more abstract network of dots and lines, suggesting a navigation or communication system. The background of the slide is dark blue with geometric, triangular patterns in lighter shades of blue.

# How Autev Robots Work

- Autev robots navigate parking areas to reach individual EVs, allowing users to plug their vehicle's charging cable into the robot, streamlining the charging process.

## Key Points:

- **Navigation Capabilities:** Autev robots autonomously navigate parking areas, avoiding obstacles to reach parked EVs.
- **User-Friendly Process:** Simple user interaction, where users plug their EV's charging cable into the robot without any additional effort.
- **Eliminating Fixed Charging Stations:** Autev robots remove the dependence on fixed charging infrastructure.



# Conclusion

- ▶ Robotics are at the forefront of revolutionizing EV charging, paving the way for a future where EV charging is both highly accessible and exceptionally efficient.
- ▶ These robots offer unprecedented convenience, adapting to any parking spot in a garage and eliminating the need for fixed charging stations.
- ▶ Their adaptability and flexibility empower EV owners to charge their vehicles wherever they park.
- ▶ Autev robots also hold the potential to reduce congestion at traditional charging stations, greatly enhancing the overall EV charging experience.
- ▶ As pioneers in this field, Autev robots are reshaping the future of EV charging, setting new standards for accessibility and efficiency.



# Future Aspects of Car Servicing: Electric Cars Recharging Stations

Robot charging offers numerous benefits, such as enhanced accessibility and adaptability for EV owners.

## Key Points

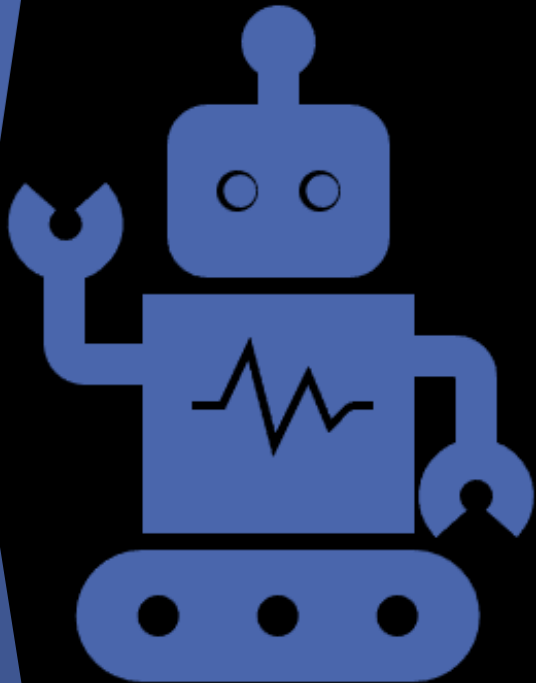
**Convenience and Accessibility:** Convenience and accessibility of EV charging in any garage spot, reducing the need for users to search for specific charging stations.

**Flexibility and Adaptability:** Adaptability of Autev robots in diverse parking environments, offering EV owners the freedom to charge their vehicles wherever they park

**Reducing Congestion:** Potential for Autev robots to reduce congestion at traditional charging stations, improving the overall EV charging experience.

# References

1. Rayhan, A. (2023). Artificial intelligence in robotics: From automation to autonomous systems.
2. Mastoi, M. S., Zhuang, S., Munir, H. M., Haris, M., Hassan, M., Usman, M., ... & Ro, J. S. (2022). An in-depth analysis of electric vehicle charging station infrastructure, policy implications, and future trends. *Energy Reports*, 8, 11504-11529.
3. Ahmed, M., Zheng, Y., Amine, A., Fathiannasab, H., & Chen, Z. (2021). The role of artificial intelligence in the mass adoption of electric vehicles. *Joule*, 5(9), 2296-2322.
4. Duan, A., Batzianoulis, I., Camoriano, R., Rosasco, L., Pucci, D., & Billard, A. (2023). A structured prediction approach for robot imitation learning. *The International Journal of Robotics Research*, 02783649231204656.
5. Ben-Ari, M., Mondada, F., Ben-Ari, M., & Mondada, F. (2018). Robots and their applications. *Elements of robotics*, 1-20.
6. Singh, B., Sellappan, N., & Kumaradhas, P. (2013). Evolution of industrial robots and their applications. *International Journal of emerging technology and advanced engineering*, 3(5), 763-768.
7. Rubio, F., Valero, F., & Llopis-Albert, C. (2019). A review of mobile robots: Concepts, methods, theoretical framework, and applications. *International Journal of Advanced Robotic Systems*, 16(2), 1729881419839596.
8. Jiang, Y., Yang, C., Na, J., Li, G., Li, Y., & Zhong, J. (2017). A brief review of neural networks based learning and control and their applications for robots. *Complexity*, 2017.
9. Zhang, T., & Mo, H. (2021). Reinforcement learning for robot research: A comprehensive review and open issues. *International Journal of Advanced Robotic Systems*, 18(3), 17298814211007305.
10. Fahimi, F. (2009). *Autonomous robots*. Boston, MA, USA:: Springer.



Question?



THANK YOU

