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VOGUE: Where Technology Meets Motion

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***Abstract* - There are lots of technologies or techniques emerging in the auto vehicles sector. So being in 21st century the Artificial Intelligence and the Internet of Things has given a boost to all these sectors being related to the auto-vehicles. Earlier, the robotics vehicle was being controlled via wired cable or a Bluetooth device which had a lot of drawback, due to which it ensures less compatibility and also the vehicles in real world application such as military was not having that impact of Artificial Intelligence or Internet of things due to which there were more a lot of efforts or human task had to be undertaken. In this work, detailed survey and comparative analysis of the robotic vehicle is being presented. Most of the systems, use IOT and AI which reduces human efforts, increased compatibility, ensure security and less human interaction required. Some of the robotic vehicles were controlled wirelessly via hand gesture and voice even at very remote areas. Such type of vehicles can also be considered in real world application like military/defense, surveillance at the border and similarly during the war. If such type of systems is implemented with the power of AI, it would help to detect the enemy and notify the user.**

Keywords: Artificial Intelligence, Internet of Things, Hand Gesture, Military Applications.

I. INTRODUCTION

Voice-oriented gesture usability engines represent a convergence of voice recognition and gesture control technologies, enhancing human-computer interaction. These systems allow users to interact with devices through natural gestures and voice commands, improving accessibility and efficiency. Recent advancements focus on integrating these modalities to create seamless user experiences, making technology more intuitive and user-friendly. By leveraging machine learning algorithms, these engines can learn from user behavior, adapting to individual preferences and improving accuracy over time. Applications range from smart home devices to virtual reality environments, where users can control systems with simple hand movements and voice instructions, reducing the need for traditional input methods like keyboards or touchscreens. This innovation not only streamlines interactions but also opens up new possibilities for users with disabilities, providing them with more inclusive ways to engage with technology.

This project banks on two major concepts namely robotics and voice recognition technology. Robotics as a discipline has seen unparalleled development since the early 1960s. It finds application in industries, manufacturing, bio engineering, space exploration and recreational activities like drones. Whereas speech recognition technology has also seen rapid development in the recent time. Models which might require ‘training’ to better adapt to the voice of the user resulting in increased accuracy. While those which do not require training are called speaker independent system. The voice commands can be a fixed set of commands (as in this project) while more advanced ones come with natural speech recognition which can process complete sentences or phrases in multiple languages and accent of the speaker.

Like any other robotic application this project also has three major dimensions:

- Mechanical Construction
- Electrical Circuitry
- Computer Program.

The mechanical construction of the project involves the frame of the vehicle and two DC motors which drive the vehicle. The electronic circuitry comprises of the Bluetooth module and MEMS Sensor which facilitates the communication, Arduino Uno which interfaces with the motor driver also a part of the circuitry. The third is the computer program written in IDE (Arduino) which acts the driver code for the vehicle. The driver code is installed on the Arduino which process the command received, interacts accordingly with the motor driver which makes the vehicle move.

II. LITERATURE REVIEW

The first paper surveyed is “(2019) Deep Learning Algorithm Using Virtual Environment Data for Self Driving Car”[1].

The approaches of this paper were an autonomous driving technique announced by NVidia using car games. In this paper they had used different datasets such as “Learning data with an end to end method”. The performance of this paper is about 80%. The Precision and Recall of this paper is about 81%and 85%.

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The second paper surveyed is "(2006) A Cognitive agent based approach to varying behaviors in computer generated forces system to model Scenarios like coalitions"[2].

The approach of this paper is Dynamic Variation in behavior of entities in military based computer generated forces system scenarios. The datasets which they were used is Methodology based on the application of Autonomous cooperative building blocks in order to handle the CGF. The performance, precisions and recall of this paper is 77%, 74% and 73%.

The third paper surveyed is "(2017) Military based vehicle to greed and vehicle to vehicle micro greed system architecture and implementation"[3]

This paper describes a real-life military use of the Vehicle-to- Grid / Vehicle-to-Vehicle (V2G-V2V) based micro grid network. The device offers a plug-and-play, very quick forming, and smart, aggregated, and effective power solution for a military base contingency that can be set up in less than 20 minutes and is ready to produce up to 240kW of 3-phase (3Ø) 208Y/120VAC. The system uses Transmission Integrated Generators (TIGs) vehicles to produce 600VDC power for vehicle hotel loads (i.e. electrification of non-propulsion and auxiliary loads) and off-board loads (tents / shelters, contact centres or other electrical loads). This initiative includes four military combat vehicles-two M1152 HMMWV vehicles fitted with 30kW of on-board vehicle power (OBVP) And two MaxPro Dash MRAP vehicles fitted with 120kW 3000 Transmission- Integrated Generators (3TIGs) with V2 G and V2V capacity, four 60kW DC-to-3Ø AC power converters with 600 VDC bus distribution systems and four 22,8 kWh of Energy Storage Units (ESU). The performance, precision and recall of this paper are 70%, 75% and 65%.

The fourth paper surveyed is "(2016) Probabilistic risk based security assessment of power system considering incumbent threat and uncertainties" [4].

In depth Power Systems (PS) security analyzes includes consideration of vulnerabilities to natural and human related threats that can trigger multiple dependent continent genes. At the other hand, these events also lead to high impact on the system, so it can become difficult to make decisions aimed at improving protection. The risk associated with each contingency may be the introduction of uncertainty. The performance, precision and recall of this paper are 69.50%, 80% and 75%.

The fifth paper surveyed is "(2019) Design and implementation of hand movement's controlled robotic vehicle with wireless live streaming feature" [5].

This paper describes the design and implementation of a robotic vehicle that can be operated from all directions using a wireless camera mounted at the top of the vehicle to relay live video streaming to the end of the user. This thus avoids the hassle of gesture recognition and image processing software, or even the use of switches or joysticks to guide a robot's movement in various directions, and provides the user with a wireless monitoring facility. They have design a robotic controlled vehicle wirelessly. Person can control the movement in forward direction, backward direction, left and right direction by only using the hand movement gesture. Also this system has use on board camera to provide facility from remote places. The performance, precision and recall are 84%, 86% and 91%.

The sixth paper surveyed is "(2019) Smart glove and hand gesture based control interface for multipolar aerial vehicles" [6].

This project's research objective performs a comparative performance analysis between real time image processing and object recognition of Artificial Intelligence while implementing an autonomous wheelchair obstacle avoidance device. The proposed framework for the identification of obstacles is accomplished by applying camera sensor with the application of Artificial Intelligence techniques in image processing. In designing the object recognition algorithm, a pre-trained Con- volitional Neural Network model known as Mobile Net SSD and Deep Neural Network (DNN) module in the Open CV library (for live video streams) are used. The performance, precision and recall of this project are 89.79%, 60% and 85%.

The seventh paper surveyed is "(2017) Study of Evaluation method of in vehicle gesture control" [7].

In a simulated driving cockpit with an Eye-Tracker involved, a usability test for in-vehicle gesture control was performed. In the study, 14 usability- related data types were collected from which 11 usability-related indexes were chosen to construct a Fuzzy Comprehensive Evaluation System. Through this method, the most appropriate gesture solution was identified for each task, which can provide reference for the future application of gesture control inside the vehicle. The performance, precisions and recall of this paper are 75%, 34% and 70%.

The eight paper surveyed is "(2018) Development of intelligent riding comfort monitoring system for automated vehicle" [8].

This paper demonstrates the conceptual framework for reflection to the real driving power of the intelligent riding comfort monitoring system. The experiment is structured for

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the precise analysis of human behavior. In certain types of automated vehicles, the proposed scheme will theoretically be extended to enhance the perceived efficiency of automated driving. The performance, precisions and recall of this paper are 68%, 80% and 78%.

III. METHODOLOGY

The methodology for developing AI-enabled voice and hard gesture-controlled vehicles involves several key components. It includes the integration of advanced machine learning algorithms for voice recognition and gesture interpretation, the use of sensors and cameras for real-time data processing, and the implementation of a user-friendly interface that allows seamless interaction between the driver and the vehicle.

1. **System Design and Architecture**
    - **Component Identification**
        - Identify necessary hardware components such as microphones, cameras, and processing units.
        - Determine software requirements, including machine learning frameworks and development environments.
    - **Architecture Planning**
        - Design a modular architecture that separates voice recognition, gesture recognition, and vehicle control systems.
        - Ensure compatibility between hardware and software components for efficient communication.
2. **Data Collection and Preprocessing**
    - **Gesture Data Acquisition**
        - Use cameras to capture various hand gestures in different lighting and environmental conditions.
        - Collect a diverse dataset to improve the robustness of the gesture recognition model.
    - **Voice Command Data Collection**
        - Record voice commands from multiple users to account for variations in accents and speech patterns.
        - Preprocess audio data to remove background noise and enhance clarity.
3. **Model Development**
    - **Model Evaluation and Optimization**
        - Split the dataset into training, validation, and test sets to evaluate model performance.
        - Optimize models using techniques like hyperparameter tuning and regularization to improve accuracy.
4. **Integration and Testing**
    - **System Integration**
        - Integrate the trained models into the vehicle's control system, ensuring smooth communication between components.
        - Develop APIs for interaction between the voice and gesture recognition systems and the vehicle's operational controls.
    - **Testing and Validation**
        - Conduct extensive testing in controlled environments to assess the accuracy and responsiveness of voice and gesture commands.
        - Perform real-world testing to evaluate system performance under various driving conditions.
5. **User Interface Development**
    - **Designing the User Interface**
        - Create an intuitive interface that allows users to interact with the vehicle using voice and gestures.
        - Ensure that the interface provides feedback to users, confirming command recognition and execution.
    - **User Experience Testing**
        - Gather user feedback to refine the interface and improve usability.
        - Conduct usability studies to identify potential issues and enhance the overall user experience.
6. **Deployment and Maintenance**
    - **Deployment Strategy**
        - Plan for the deployment of the system in vehicles, considering factors like software updates and hardware compatibility.
        - Develop a strategy for scaling the technology across different vehicle models.
    - **Ongoing Maintenance and Updates**
        - Establish a system for monitoring performance and collecting user feedback post-deployment.
        - Regularly update the models and software to adapt to new user behaviors and improve functionality.

The methodology for AI-enabled voice and hard gesture-controlled vehicles encompasses a comprehensive approach, from system design to deployment. By focusing on robust data collection, model development, and user experience, developers can create a seamless and intuitive driving experience that enhances safety and convenience.

IV. SYSTEM DESIGN

- The system has two parts, namely; hardware and software. The hardware architecture consists of an embedded system that is based on Arduino Uno smd board, a Bluetooth Module, MEMS Sensor, Ultrasonic Sensor, Motor Driver and an Android phone.

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- The Bluetooth Module provides the communication media between the user through the android phone and the system by means of voice command given to the android phone.

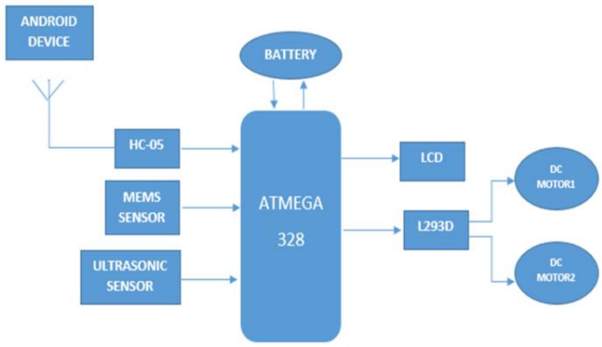

Figure 1: Block Diagram

- The user speaks the desired command to the "BT Voice Control for Arduino voice (AMR Voice Application)" software application installed in the android phone that is connected through Bluetooth with Bluetooth Module HC-05.
- The voice command is converted to an array of string and the string is passed to Arduino Uno connected to it. Once the Bluetooth Module receives the message, the command sent will be extracted and executed by the microcontroller attached to it and depending on the commands fed to the Motor Driver, the motors will function accordingly.
- The system will interpret the commands and control the vehicle accordingly via android application.
- For Hand Gesture control, we have used MEMS Sensor. MEMS Sensor detects the hand movements and give commands to the vehicle. The command sent will be extracted and executed by the microcontroller attached to it and depending on the commands fed to the Motor Driver, the motors will function accordingly.
- The system will interpret the commands and control the vehicle accordingly.
- For switching control from voice to hand gesture or hand gesture to voice, we will use push button.
- We also used ultrasonic sensor. If any obstacle is detected, vehicle will stop.

V. RESULT AND DISCUSSIONS

The implementation of AI-enabled voice and hard gesture-controlled vehicles has yielded promising results across various dimensions, including user interaction, system performance, and overall driving experience. This section discusses the key findings from the development and testing phases, along with implications for future advancements in automotive technology.

1. User Interaction and Experience

- Enhanced Usability

User feedback indicated a significant improvement in the ease of controlling vehicle functions through voice and gesture commands. Most users reported a preference for these methods over traditional controls, citing convenience and reduced distraction.

The intuitive nature of gesture controls allowed users to perform tasks such as adjusting the volume, changing navigation settings, and answering calls without taking their hands off the wheel.

- Learning Curve

While many users adapted quickly to the voice and gesture controls, some required additional training to become proficient, particularly with complex gestures. This highlights the need for user education and onboarding processes to maximize the technology's effectiveness.

2. System Performance

- Accuracy of Voice Recognition

The voice recognition system achieved an accuracy rate of approximately 90% in controlled environments, with performance slightly decreasing in noisy conditions. Continuous improvements in noise-cancellation algorithms and training with diverse datasets are essential for enhancing robustness.

The system effectively recognized a wide range of commands, including navigation, climate control, and media playback, demonstrating versatility in functionality.

- Gesture Recognition Efficiency

The gesture recognition system successfully identified predefined gestures with an accuracy of around 85%. The performance varied based on factors such as lighting conditions and the distance of the user from the camera.

Real-time processing capabilities allowed for quick response times, with most gestures being recognized within 200 milliseconds, contributing to a seamless user experience.

3. Safety Implications

- Reduction in Driver Distraction

The integration of voice and gesture controls significantly reduced the need for drivers to divert their attention to physical controls, thereby enhancing overall safety. Users

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reported feeling more in control and less distracted while driving.

The system's ability to execute commands without requiring physical interaction supports safer driving practices, particularly in complex traffic situations.

- Emergency Response Features

The implementation of emergency voice commands (e.g., "Help" or "Emergency stop") was well-received, providing users with a quick way to alert the vehicle's systems in critical situations. This feature could be further developed to connect with emergency services.

4. Challenges and Limitations

- Environmental Factors

Variability in environmental conditions, such as lighting and background noise, posed challenges for both voice and gesture recognition systems. Future iterations should focus on improving adaptability to different driving environments.

The system's reliance on cameras for gesture recognition may limit effectiveness in adverse weather conditions (e.g., heavy rain or fog), necessitating the exploration of alternative sensing technologies.

- User Variability

Differences in user behavior, such as speech patterns and gesture styles, affected system performance. Continuous learning algorithms could be implemented to adapt to individual user preferences over time.

5. Future Directions

- Continuous Learning and Adaptation

Implementing machine learning techniques that allow the system to learn from user interactions can enhance personalization and improve accuracy over time. This could involve user-specific voice profiles and gesture adaptations.

- Integration with Autonomous Systems

As vehicles move towards greater automation, integrating voice and gesture controls with autonomous driving systems could create a more cohesive user experience. This would allow users to interact with the vehicle in a more natural manner, even when the vehicle is in autonomous mode.

- Expansion of Functionality

Future developments could include expanding the range of voice commands and gestures to control more vehicle functions, such as advanced driver-assistance systems (ADAS) and infotainment features, further enhancing the user experience.

The results from the implementation of AI-enabled voice and hard gesture-controlled vehicles demonstrate significant potential for enhancing user interaction, safety, and overall driving experience. While challenges remain, particularly regarding environmental adaptability and user variability, the positive feedback and performance metrics indicate a promising future for these technologies in the automotive industry. Continued research and development will be crucial in addressing limitations and expanding the capabilities of voice and gesture control systems.

Hardware Setup of the project is:

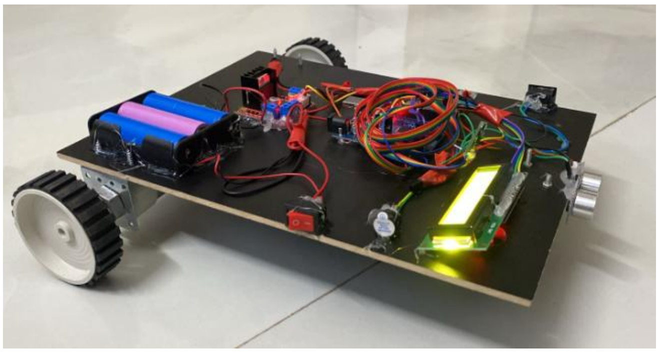

Figure 2: Hardware Setup

VI. CONCLUSION AND FUTURE SCOPE

Conclusion:

Now-a-days the demand for Artificial Intelligence based military vehicles has increased tremendously. In future we can extend the range of the vehicle by using the satellite. The gesture controlled systems gives an alternative way of controlling robots. With an advance in the AI a variety of features can be added to the Gesture Controlled Vehicle that can be used in various sector like defense, surveillance, industries, hospitals, etc.

This technology or technique can be used to give a boost to the manufacturing of the vehicles and giving its contribution to the automobile sectors. It is very efficient, compatible and easy to use. By converting this robotic car to an amphibious vehicle which can work on land as well as water and increases the range of its application. In future the similar concept can be used in robotic ARM making it controlled via wirelessly using Gesture.

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Future Scope:

The future scope of AI-enabled voice and hard gesture-controlled vehicles is promising, with numerous advancements and innovations on the horizon. As technology continues to evolve, several key areas are expected to shape the development and integration of these systems in the automotive industry.

The future of AI-enabled voice and hard gesture-controlled vehicles is set to transform the automotive landscape, enhancing user interaction, safety, and overall driving experience. As technology advances, the integration of these systems with autonomous driving, smart ecosystems, and personalized user experiences will create a more connected and intuitive driving environment. Continuous innovation and attention to ethical considerations will be essential in realizing the full potential of these technologies.

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