IoT Driven Parking System: Integrating 4WD, 4WS and Parking Sensors for Electric Four Wheelers Enhanced Maneuverability

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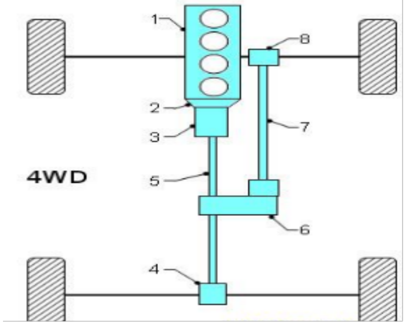
Abstract – Innovative automotive technologies like 4-Wheel Drive, 4-Wheel Steering, and Electric Power Steering systems can greatly enhance a vehicle's performance, stability, and handling. These technologies are commonly found in high-end vehicles due to their ability to improve traction, maneuverability, and steering accuracy. A sophisticated system utilizing a combination of advanced sensors, electronic controls, and mechanical components would enable each wheel to turn independently of the others. Such a system could provide even better handling, stability, and traction in challenging driving situations. The integration of independent wheel turning mechanisms, 4-Wheel Drive, 4Wheel Steering, and Electric Power Steering has the potential to transform the automotive industry, offering enhanced safety and efficiency in addition to providing an enjoyable driving experience, making it more appealing to drivers.

Keywords – IoT, 4WD, Wheelers, Power, EPS.

I. INTRODUCTION

The driving experience has significantly improved due to the integration of advanced steering, driving, and braking systems in modern vehicles. Despite the integration of advanced steering, driving, and braking systems in modern vehicles, challenges persist in achieving precise navigation and collision avoidance, especially in crowded urban environments with limited parking space. The integration of advanced steering, driving, and braking systems with parking sensors revolutionizes the parking experience. [3]By combining Four-Wheel Steering (4WS), Four-Wheel Drive (4WD), Electric Power Steering (EPS), and independent-wheel steering and driving systems, drivers gain unprecedented control and maneuverability. Parking sensors using ultrasonic or radar technology detect obstacles, enabling greater precision and collision avoidance. Incorporating 4WS enhances maneuverability, while Electric Power Steering ensures responsive steering adjustments. 4WD improves traction and stability, particularly in challenging parking conditions. Independent wheel steering and driving systems enable precise control in tight spaces, ideal for navigating urban environments. Overall, this integration empowers drivers with precise steering, acceleration, and braking, allowing them to effortlessly navigate even the tightest parking spots.

II. 4 WHEEL DRIVE SYSTEM (4WD)



1) Internal Combustion engine,
2) Clutch / Torque converter,
3) Gearbox,
4) Rear Differential,
5) Rear Propeller (longitudinal) Shaft,
6) Transfer Case [with central differential and gear reductor (optional)],
7) Front Propeller (longitudinal) shaft,
8) Front Differential

Fig 1. 4 Wheel Drive System [2].

It is a type of drivetrain system that powers a vehicle's four wheels at once. The 4 Wheel drive system distributes torque to all four wheels, providing improved traction and stability on challenging terrains such as mud, snow, or sand.There are various types of 4 Wheel drive system available., including full-time 4 Wheel drive, part-time 4 Wheel drive, and automatic 4 Wheel drive [1]. Full-time 4 Wheel drive provides constant power to all four wheels, while part-time 4 Wheel drive only powers the rear wheels during normal driving conditions and engages the front wheels when extra traction is required. The automatic 4 Wheel drive system combines the two, sensing the need for additional traction and automatically engaging the front wheels. Off-road vehicles frequently use 4 Wheel drive to navigate through challenging terrains.**Fig 1** shows 4 Wheel Drive System.

III. 4 WHEEL STEERING (4 WS)

Four-Wheel Steering (4WS) is a system which enables a vehicle's four wheels to turn in opposite directions.This system enables the rear wheels to turn opposite to the front wheels that enhance high-speed agility, stability, and control. Mechanical and electronic 4 Wheel steering are the two subtypes available. Electronic 4 Wheel steering systems use sensors and electronic controls to adjust the steering angle of the rear wheels, while mechanical 4 Wheel steering systems use a mechanical linkage to connect the steering of the front and rear wheels. 4 Wheel steering systems offer several advantages, including a smaller turning curve, improved stability during high-speed maneuvers, better handling on uneven terrain, and increased safety during emergency situations.**Fig 2** shows 4 Wheel steering system.

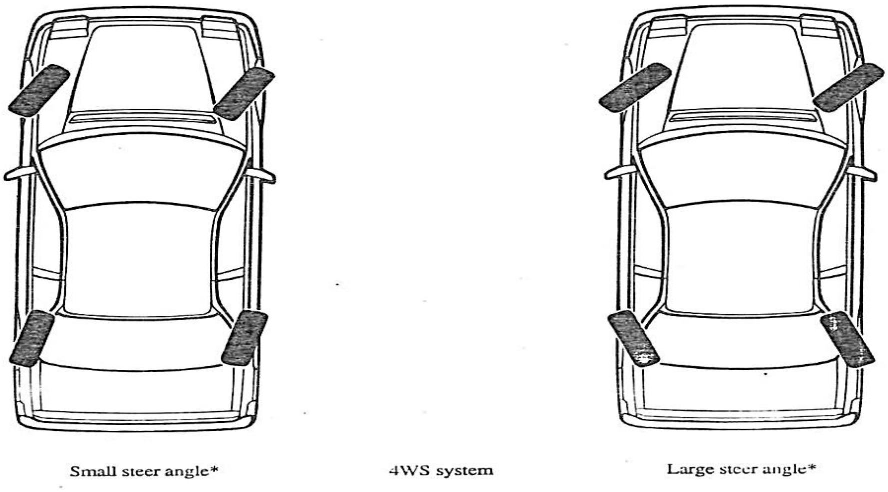


Fig 2. 4 Wheel Steering System [4].

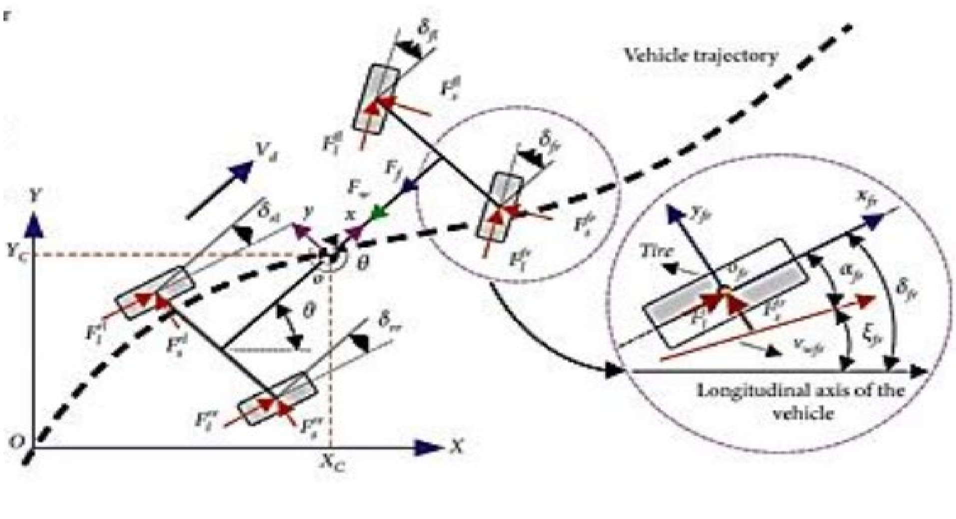


Fig 3. Motion Control of a 4 Wheel Steering4 Wheel Drive Path.

The combination of four-wheel steering (4 Wheel steering) and four-wheel drive (4 Wheel drive) systems can significantly improve a vehicle's handling and stability on various terrains. With the addition of 4 Wheel steering to a vehicle, the direction of rotation for the rear wheels can be different or the same as the front wheels, reducing the turning radius and improving stability [5, 6]. 4 Wheel drive distributes power to all four wheels, providing better traction and grip on uneven or slippery surfaces. A control system manages the vehicle's motion, using sensors such as wheel speed sensors, steering angle sensors, and vehicle speed sensors to optimize motion. For example, when the vehicle is traveling at high speed on a straight road, the rear wheels may turn slightly in the same direction as the front wheels to enhance stability and reduce the risk of over steer. During turns, the control system adjusts the steering angle of the rear wheels to reduce the turning radius, making the vehicle more agile and easier to control [7]. Additionally, power distribution to each wheel can be adjusted to provide maximum traction and grip on different terrains, such as mud, snow, or gravel. The integration of 4 Wheel steering and 4 Wheel drive improves a vehicle's stability, handling, and traction, making it ideal for various applications, such as off-road driving, sport driving, or emergency response.[19]**Fig 3** shows Motion Control of a 4 Wheel steering4 Wheel drive path.

IV. ELECTRIC POWER STEERING

Electric power steering (Electric Power Steering) is a standard and advanced technology used in highly automated driving [8]. It is also referred to as motor-driven power steering and it assists the driver by using an electric motor. The motor is typically located on the steering rack or steering column, and an electronic control unit (ECU) will receive inputs from various sensors like the steering angle sensor, vehicle speed sensor, and torque sensor. The ECU adjusts the level of assistance provided by the motor based on these inputs. Electric Power Steering eliminates several components of hydraulic power steering systems, such as the pump, hoses, fluid, drive belt, and pulley. Consequently, electric power steering systems are generally more compact and lightweight than hydraulic power steering systems [9-11].**Fig 4** shows Electric power steering.

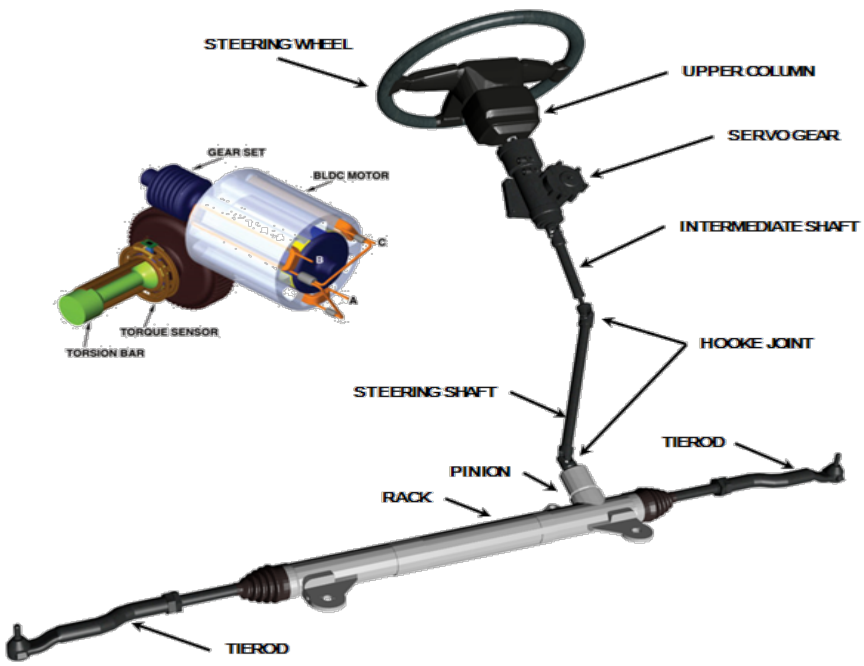


Fig 4. ElectricPower Steering.

V. MATERIALS AND METHOD

The development of a fully autonomous vehicle can be realized by combining multiple systems, such as independent steering and drive for all wheels, which encompass Four-Wheel Steering (4WS) and Four-Wheel Drive (4WD). This integration involves equipping each wheel with its dedicated motor or actuator, allowing for individual control and management. Furthermore, a separate steering system for each wheel empowers the vehicle to execute intricate maneuvers with precision. To attain autonomy, an onboard computer system plays a crucial role, comprising an extensive network of sensors, cameras, and sophisticated algorithms. These components work in harmony to navigate and drive the vehicle without the need for human intervention. The computer system receives crucial input from an array of sensors, including cameras, radar, and lidar, which enables it to regulate the speed, direction, and trajectory of each wheel. However, the construction of such a comprehensive all-wheel onboard computer system, integrating independent drive and steering systems, presents a formidable challenge that must be overcome.

Some key components needed to build such a system

Sensors

Fig 5 shows Sensors.Sensors are needed to detect various parameters such as [12,13] wheel speed, vehicle orientation, acceleration, and others that affect the vehicle's performance, including ultrasonic sensors, cameras, and LIDAR sensors.**Fig 6** shows Wheel Speed Sensor.

Sensors

- Wheel speed sensors
- Accelerometers
- Inertial measurement units (IMUs)
- GPS sensors

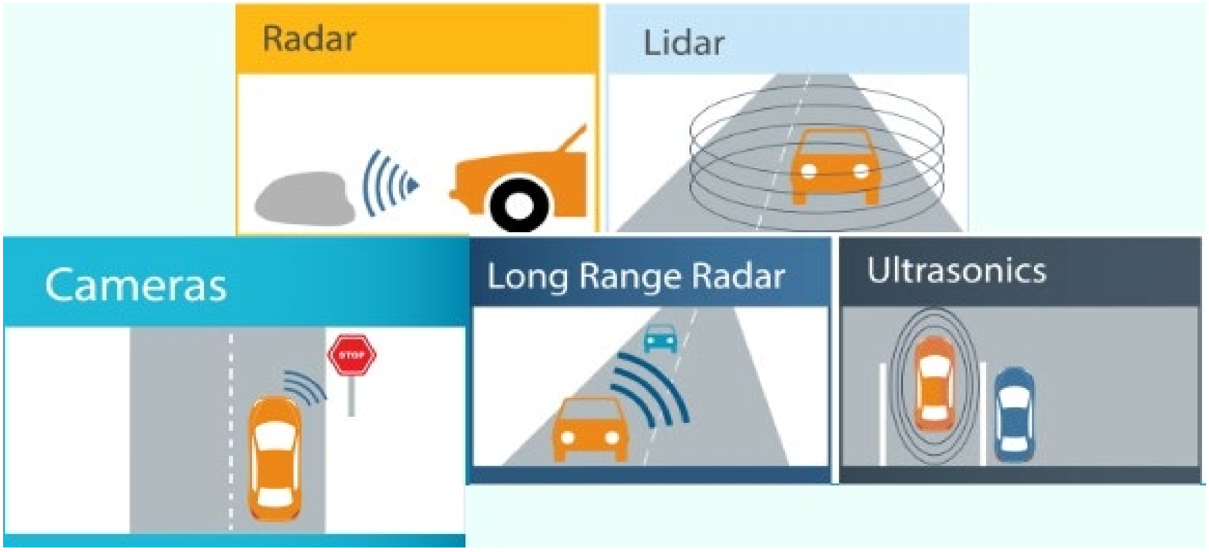


Fig 5. Sensors.

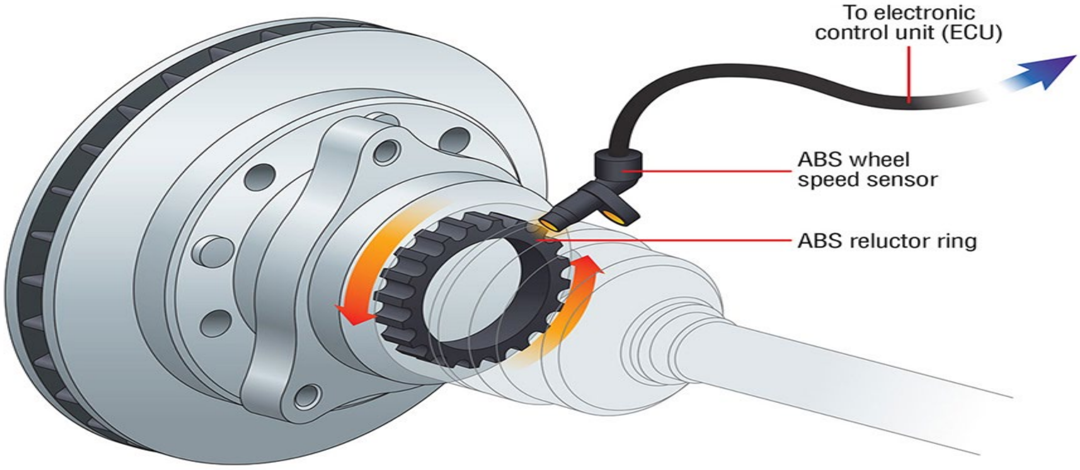


Fig 6. Wheel Speed Sensor.

Control systems

Advanced control systems are necessary to manage the complex interactions between the various components and ensure that they work together effectively [14]. This includes algorithms that govern steering, driving, and braking, as well as communication protocols that allow the different systems to communicate with each other [18]. Some of the Controls are,

- Advanced control algorithms for steering, driving, and braking systems
- Communication protocols for the various systems to communicate with each other

- User interface software to provide feedback to the driver

Actuators

Actuators are needed to physically control the various systems, including motors that control the wheels, steering mechanisms that control the angle of the wheels, and braking systems that control the vehicle's speed. [15-17]**Fig 7** shows Electric motors to control all wheels.

Actuators:

1.

Fig 7. Electric motors to control all wheels.

2. Servo motors to control the steering mechanism
3. Hydraulic or electric braking systems to control the vehicle's speed

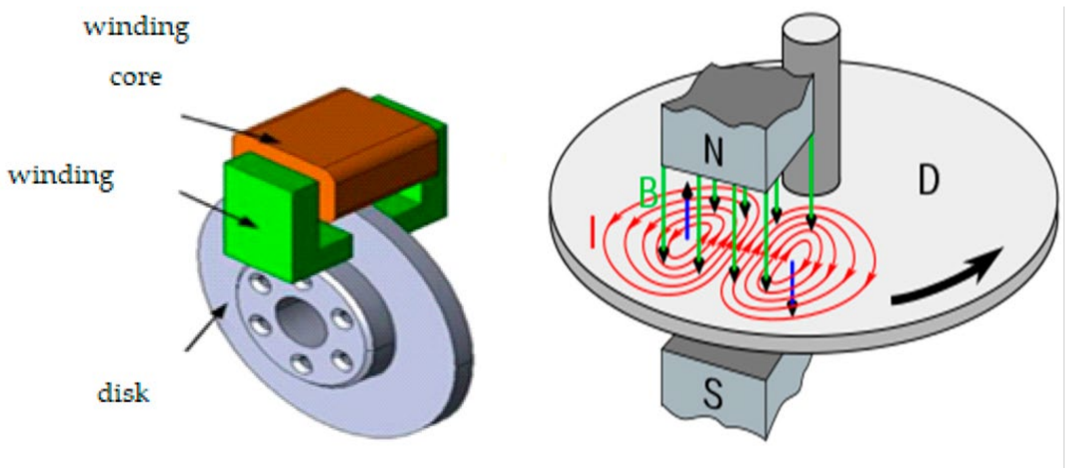


Fig 8. Hydraulic or electric braking systems.

4. Electric power steering (Electric Power Steering) systems to provide precise and responsive steering

In addition to these basic components, more advanced systems might require additional sensors, controls, and actuators to achieve specific goals. For example, a system that uses machine learning algorithms to improve steering performance might require additional sensors to gather data, as well as more advanced controls and actuators to respond to that data in real time [19, 20]. **Fig 8**shows Hydraulic or electric braking systems.

Safety Mechanisms

Safety mechanisms are crucial components for vehicles equipped with independent driving and steering systems. These safety mechanisms include:

1) Collision avoidance systems will have cameras and radar sensors to identify obstructions in the path of the vehicle and alert the driver or take corrective action to prevent a collision.
2) Emergency braking systems will be used in emergency situations such as when a pedestrian suddenly stepping into the road or a vehicle cuts in front of the autonomous vehicle, these systems has automatic brakes to avoid a collision.
3) For Lane departure warning systems, cameras and other sensors are used to monitor the car's lane position and warn the driver or take corrective action if the vehicle drifts out of its lane.
4) Fail-safe mechanisms are designed to detect faults or malfunctions in the vehicle's system and take corrective action to prevent accidents. For example, if a sensor fails, the system may switch to a backup sensor or bring the vehicle to a safe stop.
5) Redundant system are to ensure the safety and reliability of the autonomous vehicle's system, redundant systems such as backup sensors or power systems can be employed to ensure the vehicle can still operate safely in the event of a failure.

Software

Software is needed to manage the complex interactions between the various components and systems, as well as to provide user interfaces and feedback to s

- CAD: Computer-aided design (CAD) software,
- Simulation software,
- Programming languages: Programming languages such as C++, Python, or MATLAB can be used to develop the various software components needed to manage the vehicle's systems and components.

Manufacturing Equipment

Specialized manufacturing equipment is needed to produce the various components and systems, including specialized machining equipment, 3D printers, and other tools.

VI. CONCLUSION& RESULT

In conclusion, By the integration of parking sensors that relay signals based on object detection enables precise control of wheel turning, offering drivers enhanced maneuverability when parking in densely populated urban settings with restricted space. The incorporation of Four-Wheel Steering (4WS), Four-Wheel Drive (4WD), and Electric Power Steering (EPS) systems further amplifies accuracy, control, and traction, facilitating seamless navigation through tight parking spaces and challenging conditions, particularly in urban environments.

Table 1. Results Comparison Table for Integration of Systems in Fully Autonomous Vehicles

Aspect	Results
Integration of systems	Successful integration of independent steering and drive systems, including Four-Wheel Steering (4WS) and Four-Wheel Drive (4WD)
Maneuverability	Significantly enhanced maneuverability achieved through individual control and management of each wheel
Precision in maneuvers	Empowered vehicle execution of precise and intricate maneuvers through the implementation of separate steering systems for each wheel
Autonomy achieved	Onboard computer system, consisting of sensors, cameras, and algorithms, enables autonomous navigation and driving without human intervention
Sensor input processing	Efficient processing of inputs from diverse sensors, such as cameras, radar, and lidar, for precise regulation of each wheel's speed, direction, and trajectory
Technological challenge	Construction of a comprehensive all-wheel onboard computer system that seamlessly integrates independent drive and steering systems remains a formidable challenge requiring dedicated efforts to overcome
Software management	Construction of a comprehensive all-wheel onboard computer system that seamlessly integrates independent drive and steering systems remains a formidable challenge requiring dedicated efforts to overcome

The comparison table highlights the remarkable progress in the development of fully autonomous vehicles. The integration of independent steering and drive systems, such as Four-Wheel Steering (4WS) and Four-Wheel Drive (4WD), has revolutionized maneuverability. The onboard computer system, coupled with sensors and algorithms, enables autonomous navigation and control. Efficient processing of inputs from cameras, radar, and lidar ensures precise regulation of each wheel's speed, direction, and trajectory. However, constructing a comprehensive all-wheel onboard computer system remains a formidable challenge. Nonetheless, the advantages of fully autonomous vehicles, including enhanced precision, control, and traction, hold immense potential for addressing parking challenges and improving safety and efficiency in urban environments.**Table 1**Results Comparison Table for Integration of Systems in Fully Autonomous Vehicles

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