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Design and Development of AKEA: A 360-degree rotating vehicle

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Abstract

The design of a 360-degree rotating vehicle has been proposed as a solution to the problems encountered in traditional wheel vehicles. This paper highlights the benefits of such a design, the proposed models for implementing the design, and the design of a 360-degree rotating vehicle known as AKEA. Traditional wheel vehicles are faced with numerous problems such as parking and u-turn. The 360-degree rotating vehicle design eliminates these problems as it can take turns without moving the vehicle, and no extra space is required to turn the vehicle. The proposed models for implementing the design of the 360-degree rotating vehicle include lifting plates, chain sprockets, chain or belt drives, and quad-steering mechanisms. These models have several shortcomings, including complexity in design, unrealistic features and increased turning radius. The AKEA design, however, incorporates sustainable and recycled materials, and the result of the design process was a vehicle that performed various features. These features include side-ways movement, 360-degree rotation, and mobile phone operation. AKEA is connected to the mobile phone via Bluetooth, having a range of 100 meters. However, to improve the design further, sensors for self-driving and WiFi connectivity for a broader range of connectivity were proposed. In conclusion, the design of a 360-degree rotating vehicle is necessary to reduce and eliminate problems encountered in traditional wheel vehicles. Although several models have been proposed, the AKEA design performs various features and can be implemented in modern cars and trucks. Improving the design by incorporating sensors and WiFi connectivity will improve the responsiveness of the mobile application and ensure wider range connectivity.

Keywords: 360-Degree Rotating Vehicle; Zero Turning Radius; Bluetooth Connectivity**.**

1 Introduction

360° rotating vehicle moves in all directions and this design provides better comfort and also saves time [1]. Normal wheel vehicles face lots of problems like parking, u-turn and much more. So, the design of a 360° rotating vehicle is needed to reduce and eliminate problems in the industry as well as common life of people.

The vehicle can take a turn without moving the vehicle, no extra space is required to turn the vehicle. In this system, each of the four wheels is given drives with motors, so it can rotate 360°.

The vehicle will be controlled by an RF remote. Consequently, we can utilize this vehicle from various perspectives like to transport things, overwhelming bags and furthermore in heavy-duty vehicles like tractors which will help in rush hour gridlock and spare time.

As it is likewise a battery-operated vehicle, no fuel is required. Consequently, it is affordable to the earth this will likewise diminish the expense of the vehicle. Zero degrees turning radius of a vehicle suggests the vehicle pivoting

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around a hub going through the focal point of gravity of the vehicle, for example, the vehicle turning at a similar spot where it is standing. No additional room is required to turn the vehicle.

2 Literature review

Several models were proposed earlier in different research for the 360-degree rotation operation of a vehicle and some of them include a lifting plate to be placed at the bottom centre of the vehicle, to lift up the vehicle and then rotate, which is quite inappropriate and unrealistic. Also, some of the proposed models were introduced to be operated by chain sprocket, chain or belt drive along with dc motors, which were quite complex in design and construction as well as not suitable for real-life application. Quad-steering mechanism of three several phases was introduced to reduce the turning radius of the vehicle, which also provides complicity in the design of the vehicle.

Again, using hydraulic hoses, connecting rods and toggle disks was proposed earlier to be introduced to make a connection between the front and rear wheel steering rack to implement a centrally and radially adjustable zero-turning 4-wheel steering system. Also, a modified mechanical steering system was proposed for a vehicle in replacement of a normal conventional steering system which is realistic, but more complicated in construction than the proposed electrical model. In replacement of all these models, the proposed model of electrical vehicle is simple in construction and much easier and more realistic to operate as a daily life vehicle as neither lifting plate nor chain drive is required for it.

Previously, Honda had four-wheel steering as an option in their 1987–2000 Prelude and Honda Ascot Innova models (1992–1996). Mazda also offered four-wheel steering on the 626 and MX6 in 1988. General Motors offered Delphi's Quadra steer in their consumer Silverado/Sierra and Suburban/Yukon. However, only 16,500 vehicles have been sold with this system since its introduction in 2002 through 2004. Due to this low demand, GM discontinued the technology at the end of the 2005 model year.[2] Nissan/Infiniti offer several versions of their HICAS system as standard or as an option in much of their line-up[5]. A new "Active Drive" system is introduced on the 2008 version of the Renault Laguna line. It was designed as one of several measures to increase security and stability. The Active Drive should lower the effects of under steer and decrease the chances of spinning by diverting part of the G-forces generated in a turn from the front to the rear tires. At low speeds, the turning circle can be tightened so parking and manoeuvring are easier.

3 Material and Methods

The basic frame is produced in accordance with the measurements. The frame is a 24mm x 14mm material used to hold all the components together. The four servo motors are mounted at the four corners of the frame and held together with screws and glue for extra reinforcement, the TT dc motor is attached to the rotating part of the servo motor, each servo motor having one dc motor to itself this will aid the forward and backward movement and also the rotation of the wheel, which is attached to the shaft of the dc motor. The configuration includes an installed Arduino Uno R3 board. Relay boards are installed in the same location. The Arduino IDE is used to interface with the Arduino Uno R3 board to program it. The motor is subsequently connected to the interfaced electronic setup in order to control it. To connect to the battery, all connections have been done. This completes the assembly of the setup. All of the circuits and motors are now powered on. The Arduino board sends signals to any potential pairing devices. To connect to the board and show the web page with the remote control features, a mobile device is typically utilized. The loading region is where the cargo is loaded. The motor starts to work using battery power. The Arduino uno R3 board manages the motor's operation. Two different key sets are available for operating the motor.

The device's forward and reverse movement is managed by the Dc motors with the motor driver circuit board. This is accomplished by adjusting the motors' power supply via the relay board. Positive supply is used to propel anything forward, and polarity reversal is to move something backwards. The setup's directions are controlled by the second set of motor drivers. The servo motor and the Dc motor securing the front and back wheels together for rotation regulate the setup's 360° rotation. This is done using the same logic as before. These procedures make it relatively easy to transport the burden from one place to another. The movement of the setup is more simpler than with typical systems because the wheels may rotate 360 degrees. The movement of the device is controlled by a mobile device, reducing the need for human intervention in its operation. This dramatically reduces human error that happens carelessly or while unconscious. In addition, there is a significant reduction in the cost of moving resources and the wasteful use of labour. The unit's operating time is extended by this system. Since it takes humans a while to become fatigued from heavy lifting, The device may fit into all available spots with the least amount of room needed because of its tiny form. In this situation, a small operation space is necessary.

3.1 Dc Motor

The TT dc motor is used in the design of the 360° rotating vehicle, connected to the servo motor, which makes it easy to run the codes for when connecting it with the Arduino uno R3. Four(4) of this Dc motor is used and it is what aids the rotation of the wheels in the 360° form. This is a 48 mm square length motor with an output D-shaft of 5mm and a section that is flattened by 0.5mm.

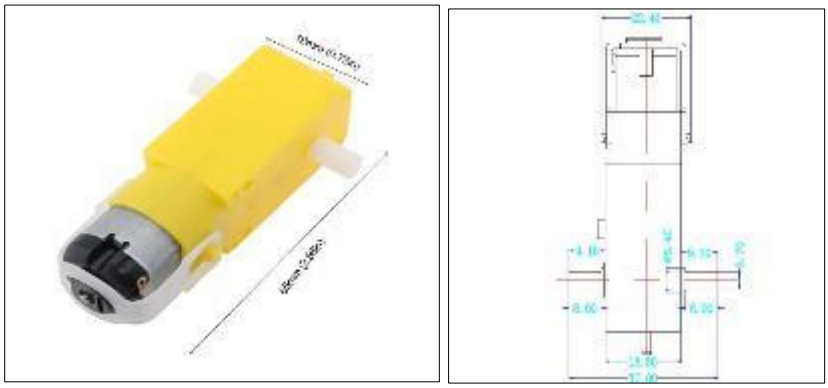

Figure 1 Schematic diagram of the Dc motor

The power of the Dc motor

Power transmitted by the Dc motor, $P = \frac{2\pi NT}{60}$

Torque of motor, $T = 68.6mm$

Speed of motor, $N = 115rpm$

Therefore; $P = \frac{2\times3.142\times115\times68.6}{60}$

Power of Dc motor $P = 0.83KW$

3.2 Servo Motor

An actuator that provides for exact control of linear or angular position, acceleration, and velocity is a servo motor. It comprises a motor connected to a position feedback sensor. It also needs a rather complex controller, frequently a special module created just for use with servomotors. A servomotor, often known as a servo motor, is a simple electric motor that is managed by servo mechanism[13]. If a motor is used as a controlled device and is connected to a servomechanism, it is referred to as a DC Servo Motor. The controlled motor is referred to as an AC Servo Motor if AC drives it.

The servo motor is an important part of the design as it aids the motion of the wheels, each of the wheels is connected to a servo motor which rotates the wheels both in clockwise and counterclockwise movement.

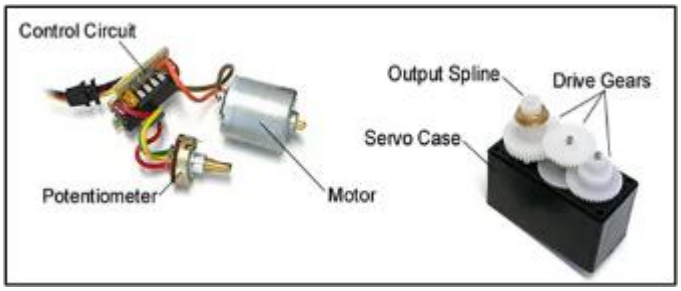

Figure 2 The gut of a servo motor and its assembly

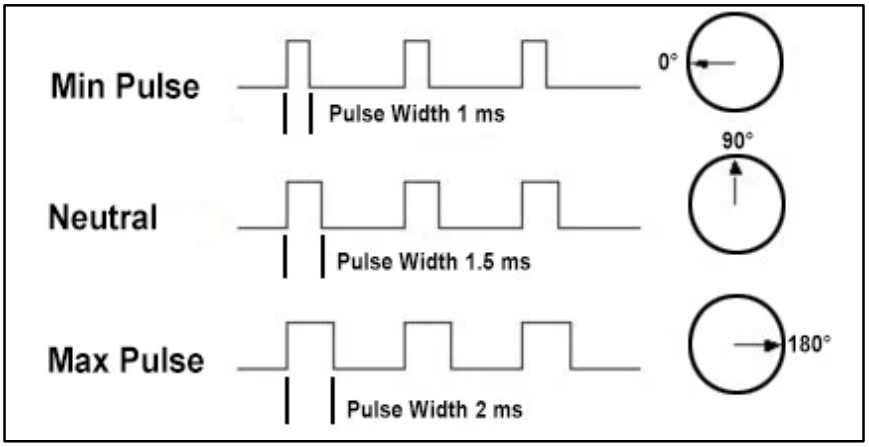

Figure 3 Variable pulse width control servo position

(ii) the power of the Servo motor

Power transmitted by the stepper motor to the belt, $P = \frac{2\pi NT}{60}$

Torque of motor, T = 3.4 kg.cm; 346.7 N.mm

Speed of motor, N = 628.2rpm

Therefore; $P = \frac{2\times3.142\times628.2\times346.7}{60}$

Power of stepper motor, **P = 22.81 KW**

3.3 Arduino Uno R3

The Arduino uno R3 is used to operate the vehicle wireless through Bluetooth or Wi-Fi, The whole electrical components are wired around the Arduino uno which serves as the heart of the design. This system was chosen because of its popularity and ability to run on many devices since this innovation will be worked on in the future. The most well-known and often utilized development board is the Arduino Uno. An ATMega328P microcontroller powers it. It is the most often used option in the community since it is affordable, simple to learn how to use, and has a selection of prefabricated modules that make it simpler to construct this prototype. It has 14 digital I/O ports, including SPI, I2C, and UART standard communication ports, as well as 6 8-bit PWM pins, 6 10-bit analogue inputs, and 6 digital I/O pins. The Arduino is the control unit.

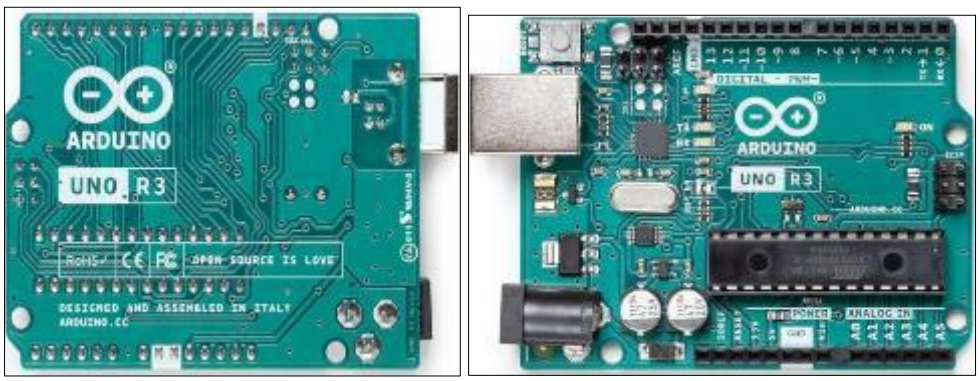

Figure 4 Arduino panel

3.4 Bluetooth Module

The Bluetooth module is used in the design of the 360° rotating vehicle and this is a very important component in the design as it helps in controlling the vehicle wirelessly. The Bluetooth module is an electrical component that enables

wireless communication between devices. It is a compact electronic circuit with a Bluetooth radio that enables communication with other Bluetooth-enabled gadgets, including computers, smartphones, tablets, and other gadgets. Low power consumption, short-range communication, and the capacity to create safe and dependable connections between devices are some of Bluetooth modules' major characteristics. A variety of communication protocols, including the Serial Port Profile (SPP) and the Low Energy (LE) protocol, are commonly supported by them. The Bluetooth module has a range of 100m

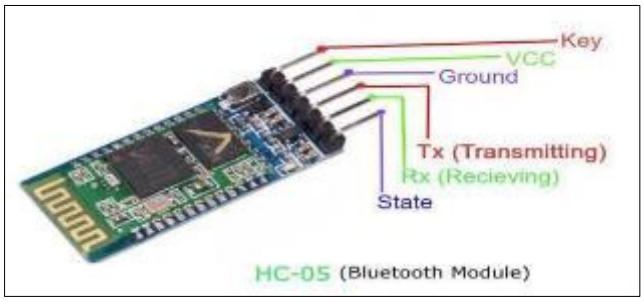

Figure 5 labelled Bluetooth module

3.5 Wheels

The wheels are used to provide stance and support to the vehicle. The vehicle is supported with 4 wheels on each side of the frame and each of the wheels is connected to a servo motor. An axle bearing is positioned through a circular hole that has been bored out of a circular block of hard, durable material to form a wheel. The wheel rotates when a moment is applied to the wheel's axis by gravity or torque. When a vehicle is being propelled forward, the wheel is employed to deliver rotational motion and torque to the machine because of friction between the road and the wheel's friction material.

Figure 6 Rubber wheel

3.6 DC Motor Driver

This is used to regulate the direction and speed of a DC motor. Robotics, automation, and electric vehicles are just a few of the applications where DC motors are frequently employed [7]. To obtain the required speed and direction, the motor's input voltage must be regulated because a DC motor requires a DC voltage to function.

A microcontroller, power MOSFETs, and a motor control circuit are the standard components of a DC motor driver. Receiving input signals and producing the necessary control signals to drive the MOSFETs are the responsibilities of the microcontroller. The MOSFETs function as switches that may be used to control the voltage and current provided to the motor as well as turn it on or off.

Servo motors, brushless DC motors, brushed DC motors, and other types of DC motors can all be controlled by DC motor drivers. The needs of the motor, such as the voltage and current rating and the type of motor, should be met by the driver's specifications.

DC motor drivers come in a variety of forms, including H-bridge drivers, L298N motor drivers, L293D motor drivers, and TB6612FNG motor drivers. The motor's parameters, as well as the required speed and torque, determine the driver to use[12].

A DC motor driver, in general, is an essential part of the design and development of AKEA in regulating the speed and direction of a DC motor and it allows for accurate and effective control over the motor's behavior.

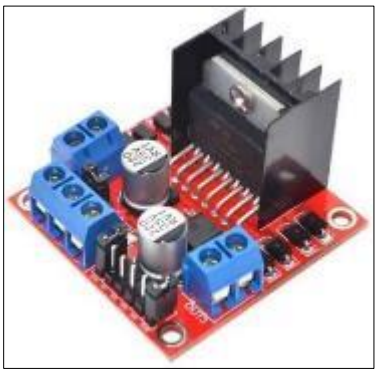

Figure 7 Dc motor driver

3.7 Charging Management Circuitry

The electronic circuits and parts used to control how a battery or battery pack is charged are referred to as charging management circuitry[7]. This includes parts like voltage regulators, current limiters, and charge controllers.

The battery is safeguarded from overcharging, overheating, and other potential risks by the charging management circuitry, which also works to ensure that the battery is charged safely and effectively. This is crucial for lithium-ion batteries in particular since they are vulnerable to thermal runaway if not charged properly.

In most cases, the charging management circuitry consists of sensors to keep track of the battery's temperature and voltage as well as microcontrollers to handle the charging procedure depending on this information. To make sure that the battery is charged at the appropriate rate, the micro-controller will change the charging current and voltage at the optimal rate without causing damage to Battery balancing, which helps to guarantee that all of the cells in a multi-cell battery pack are charged to the same level, is another feature that some charging management circuits contain. By doing this, you can protect the battery pack from damage caused by overcharging or undercharging and increase its longevity.

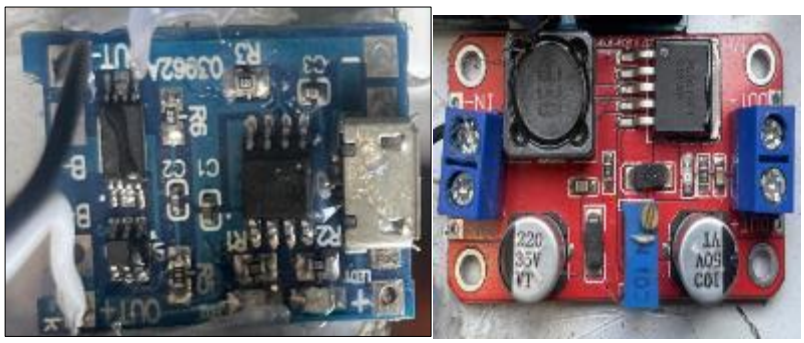

Figure 8 Charging booster and charging station

3.8 Power Switch

An electrical device known as a power switch is used to turn on or off the flow of electricity to a device or circuit[14]. To control the flow of electricity, a mechanical switch that can be toggled between the "on" and "off" states is usually used. The power switch, which is often found at the back of the vehicle, is used to turn the vehicle on and off.

3.9 Cad Model

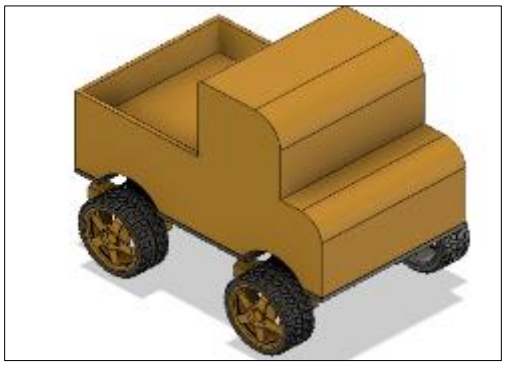

Figure 9 Sideview CAD model of AKEA

3.10 Mode of Operation

The AKEA special mini vehicle would require sophisticated mechanical engineering and control technologies to enable the vehicle to travel and rotate in any direction. AKEA can be driven using a mobile phone with a customized application that is used for the controls of the vile. With a long 100m blue-tooth range.

A driver would need to be trained in the particular controls and conversant with the distinctive features and capabilities of the vehicle in order to operate AKEA

Table 1 Controls and command operation

Buttons	**Operations**
	To Reset
	To turn 45˚clockwise
	To turn 45˚ anti-clockwise
	All four wheels align at 90˚
Start	Each wheel turns 45˚ clockwise and anti-clockwise
Start + Select	It rotate at a point having Zero turning radius
	Moves forward
	Moves backwards
	Moves to the left
	Moves to the right

Figure 10 AKEA controller app interface

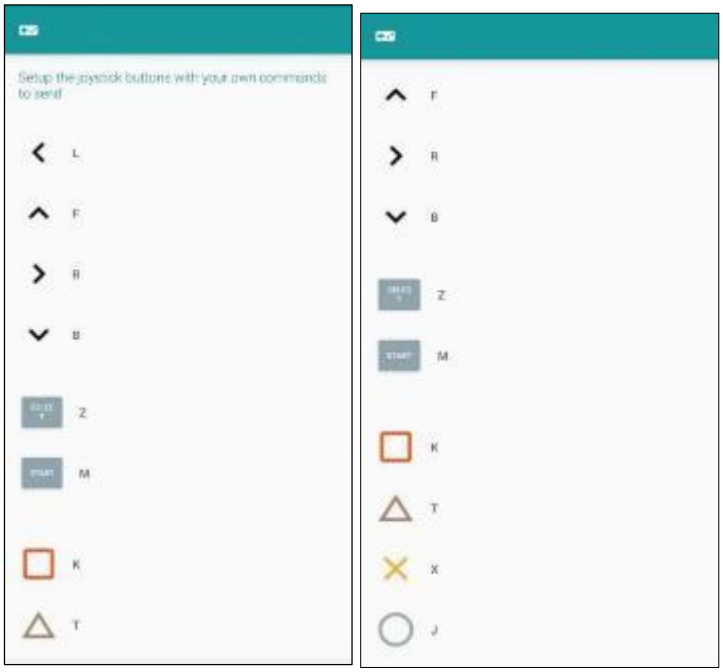

Figure 11 AKEA command prompt

4 Results

The new innovative eco-friendly 360-degree rotating vehicle is an advanced type of machine that rotates at 360 degrees at a particular place. It is an operated system we have given motion to using TT dc motor and servo motor. It is controlled by a mobile device. The system is fixed with pairs of wheels that are connected to help the rotation and movement.

The frame/base was first constructed using the white Formica board then the dc stepper motor was joined using a 4min glue and the stepper motor is connected to the dc motor which is linked to the wheels. Every wheel has its own controller or motor and it has a kind of functionality that would automate it in a particular direction and what we just have to do is turn the wheel.

The idea of a vehicle that rotates 360 degrees has the ability to completely alter how we perceive mobility and transportation. Drivers of such a vehicle might be able to move in any direction, making it simpler to maneuver in confined places and congested streets. This could be especially helpful in cities where transportation congestion is a big issue. Furthermore, the flexibility to rotate in any direction could increase safety by giving drivers more control and visibility.

Nevertheless, creating a vehicle that rotates 360 degrees comes with a number of difficulties. The engineering needed to create such a vehicle is one of the major obstacles. It would take a lot of research to make a full 360-degree rotation possible with current technology. The safety concerns of such a vehicle would also need to be carefully considered, especially in scenarios involving high speeds or heavy traffic.

Despite these difficulties, the concept of a 360-degree rotating vehicle is still an exciting one that has the potential to significantly influence the way we travel in the future. It will be interesting to see how this idea develops as technology advances and whether it ends up being a workable answer to the world's transportation problems.

The device is powered by a 4000mh battery that can last up to one hour with a 15-minute charge.

5 Conclusion

Finally, the idea of a 360-degree rotating vehicle opens up a variety of fascinating options for mobility and transportation. Vehicles might negotiate confined spaces and congested metropolitan areas more effectively if they could rotate in any direction. This would also increase safety features because it would allow for better visibility and mobility.

There are, however, a number of key obstacles and constraints to take into account. Such a vehicle would require tremendous technical and design resources, and the technology to allow a full 360-degree rotation is still in its infancy. The safety concerns of such a vehicle would also need to be carefully considered, especially in scenarios involving high speeds or heavy traffic.

Despite these difficulties, the concept of a 360-degree spinning car is still an exciting one that has the potential to completely change how we move and travel. It will be interesting to see how this idea develops and whether it turns out to be a workable solution for the transportation demands of the future as technology continues to grow.

Recommendation

An improved camera system can be used for remote surveillance and exploration, so improving its camera system could enhance its functionality and usefulness in these applications.

A modular design could make it easier to customize and upgrade AKEA with different components and features, allowing users to adapt it to different applications and environments.

Employ constants rather than hard-coding pin numbers: It is preferable to utilize constants rather than pin numbers directly in the code. This makes changing the pins later on easy since the code won't need to be altered.

Overall, there are several ways that AKEA could be improved to enhance its performance, functionality, and versatility, making it an even more innovative and useful device.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to disclosed.

Reference

[1] Arun, S., Abhishek, K. & Rajiv, C., 2014. Study of 4-Wheel Steering Systems to Reduce Turning Radius and Increase Stability. *International Conference of Advance Research and Innovation,* p. 7.

[2] Sudip, K., 2016. DESIGN OF 360-DEGREE ROTATING CAR. IJARIIE, 2(5), p. 5.

[3] Oviya, R., Sasitharan, L., Kathiravan, S. & Sreeman, C., 2019. FABRICATION OF 360-DEGREE ROTATING WHEEL IN ELECTRIC VEHICLE. International Journal of Innovative Research in Advanced Engineering, 6(3), p. 5.

[4] Jaishnu, M., Shubhankar, M., Mudit, C. & Dr. Jaswinder, S., 2015. 360° Rotating Vehicle to Overcome the Problem of Parking Space. International Journal of Research in Mechanical Engineering & Technology, 5(2), p. 4.

[5] Yogendra, K. et al., 2022. 360-DEGREE ROTATING WHEEL VEHICLE USING A LIFTING PLATE. International Research Journal of Engineering and Technology, 9(4), p. 5.

[6] Mahbubur, R. T., 2021. Control of A 360 Degree Rotating Vehicle with Arduino and Bluetooth Module.

[7] Sarvind, K. et al., 2020. 360-DEGREE WHEEL ROTATION VEHICLES. International Journal of Creative Research Thoughts, 8(6), p. 6.

[8] V, M. & Dr B James, P. R., 2017. Fabrication of Electrical Steering Mechanism. International Journal for Research in Applied Science & Engineering Technology, 5(10), p. 18.

[9] Baljit, S. B., Gupta, P., Pawar, A. & Javed, M., 2017. Development of 360-degree Rotating Vehicle. *International Journal for Innovative Research in Science & Technology,* 3(11), p. 4.

[10] Arunkumar, S. M., Chandan, K. S., Yubaraj, G. M. & Jahangeer, A. B., 2017. 360 Degree Wheel Rotation Vehicle. International Journal of Latest Engineering Research and Applications, 2(5), p. 7.

[11] Bobade, S. et al., 2017. Design & Fabrication of Mechanised Car with the Hel of Internal Gear to Obtain Zero Degree Rotation and Straight Line Stability. S.l GRD Journals- Global Research and Development Journal for Engineering.

[12] Dr. P, M. A., A, S., S, S. K. & P, Y., 2019. Design and Fabrication of 360 Degree Rotating Vehicle. International Journal for Research in Applied Science & Engineering Technology, 7(2), p. 5.

[13] Khan, N. M. & Vatsal, S., 2018. Design, Analysis and Fabrication of an Effective steering system. International Journal for Research in Applied Science & Engineering Technology, 6(5), p. 14.

[14] P Suresh, K., Swapnilm, J. & N Prasanthi, K., 2019. Design and Fabrication of Four-Wheel Steering. International Journal of Innovative Technology and Exploring Engineering, 8(10), p. 7.

[15] Shirsath, S. et al., 2016. ZERO TURN VEHICLE. International Research Journal of Engineering and Technology, 3(2), p. 5.

[16] NNPC, Public Relation 2022.