Emerging Trends in Digital Transformation
Volume-1, Issue-2, July 2025 ISSN:**3107-4308** *Paper ID:* ***ETDT-V1-I2-41***

SELF-BALANCING ELECTRIC ONE-WHEELER

#1Mrs.M.PRATHIMA, Assistant Professor,
#2V.ANUSHA, #3T.GOWTHAMI,
#4M.RUCHITHA, #5A.RAMA KRISHNA,
Department of EEE,
SAI SPURTHI INSTITUTE OF TECHNOLOGY (AUTONOMOUS),
SATHUPALLY, KHAMMAM.

ABSTRACT: The electric unicycle that balances itself is eco-friendly, effective, and useful. The unicycle may be kept balanced by simply monitoring the rider and adjusting the motor's location and speed as necessary. Its rechargeable lithium-ion batteries make it completely silent and pollution-free, making it perfect for usage in cities. This unicycle building and control project will primarily focus on user control, stability, and safety criteria.PID controls and fuzzy logic can enable motorcycle riders move more freely and make transitions more seamless. Because of its stylish appearance and minimal environmental impact, the electric unicycle is a fun and environmentally responsible way to go around town.

Keywords: *Self-balancing, One-wheel, Electric unicycle, Personal mobility, Gyroscopic sensors, Fuzzy logic, Accelerometers, Stability control, Electric transportation, Lithium-ion batteries.*

1. INTRODUCTION

Gyroscopic stability, electric propulsion, and complex control systems are all combined in a self-balancing electric one-wheeler, a modern personal mobility device. Its wheel is positioned in the middle, and it uses state-of-the-art sensors and algorithms to automatically alter its balance based on the rider's stance. Unlike traditional motorcycles and scooters, it does not require the rider to be able to balance themselves, making it both futuristic and accessible. These cutting-edge cars blend mobility, technology, and ease of use.

A microprocessor system, gyroscope, and accelerometer work together to drive a self-balancing one-wheeler. The onboard control system must evaluate the data instantly when these sensors identify a change in the wheel's position or angle. To compensate for any imbalance, the electric motor's speed and torque can be changed, allowing the rider to remain upright with little to no extra effort. Because it is often done by tilting to the left or right, steering is intuitive by nature.

Compared to more conventional modes of transportation, this one-wheeled vehicle has many advantages. Its compact size, portability, and remarkable agility allow users to move through crowded areas, narrow streets, and even interior spaces with ease. Because it emits no chemicals and is electric, it is environmentally friendly. Its striking appearance draws commuters, city people, and anybody else looking for a cutting-edge two-wheel experience. Furthermore, compared to its rivals, it is easier to store and transport due to its compact size and absence of wheels.

The self-balancing electric one-wheeler may be one of the more affordable, small, and ecologically friendly transportation choices that are in high demand. Its design incorporates several elements, like regenerative braking, intelligent battery management, applications-based connectivity, and others, to enhance its overall appeal. There is optimism that as technology continues to advance, these vehicles will become more popular in urban areas, cost less, and have a smaller environmental impact. Because of this, the self-balancing electric one-wheeler represents a step toward intelligent and environmentally friendly transportation systems rather than just an intriguing idea.

2. LITERATURE SURVEY

Patel, A., & Nair, S. (2024). This work combines data from gyroscopic sensors, accelerometers, and magnetometers to develop an intelligent control system for self-balancing electric one-wheelers. The authors use an optimized real-time proportional-integral-derivative (PID) control system based on particle swarm optimization to increase the stability of the balance under different load situations. On city highways and slopes, experimental results demonstrated reduced oscillation and faster tilt correction compared to traditional PID

DOI : https://doi.org/10.5281/zenodo.16812021

tuning. Other topics discussed in the essay include regenerative braking implementation and ways to improve battery performance to gain a greater operating range.

Verma, R., & Kulkarni, D. (2024). This paper presents a self-balancing one-wheeler algorithm that uses artificial intelligence to predict riders' intents. Recurrent neural networks (RNNs) are used in the model to predict temporal movement, and convolutional neural networks (CNNs) are used to identify posture images. Because the hybrid type actively controls motor torque variations, it improves safety and decreases reaction time. In experiments conducted under various riding patterns, a 15% improvement in stability reaction time was noted. The authors say that they would want to see it used in self-correcting balance systems.

Reddy, V., & Chandra, P. (2023). This study suggests a self-balancing one-wheeler system that uses sensor fusion to identify and adjust posture. Its primary objective is to predict riders' lean orientation. This is accomplished by integrating inertial measuring units (IMUs) with machine learning classifiers. The system uses a support vector machine (SVM) trained on riding datasets to initiate micro-adjustments in motor torque, which improves maneuverability. A more comfortable ride, particularly for novices, and better turning dynamics were suggested by experimental results in a controlled environment. The paper raises numerous safety concerns, one of which is the use of automatic emergency stop techniques.

Iyer, P., & Banerjee, K. (2023). This study investigates energy-efficient motor control systems for self-balancing electric one-wheelers that employ the model predictive control (MPC) technique. The MPC anticipates rider movements and slope changes to maintain balance while using less unnecessary motor power. According to modeling and road test findings, the current system's battery life is 12% longer than that of conventional PID controllers. The authors emphasize that it might make commuter-focused designs more feasible.

Sharma, M., & Gupta, R. (2022). This work specifically examines adaptive fuzzy logic controller-based stability management systems for electric one-wheelers. In a variety of terrain conditions, the controller outperforms fixed-gain controllers by instantly modifying motor torque based on speed and slope information. As a result, the controller can operate at a higher level. A smartphone app with Bluetooth has also been included by the authors to monitor performance and modify the sensitivity level. Test results indicate that the device can improve ride stability in both indoor and outdoor settings, making it suitable for commercial use.

Kumar, S., & Desai, V. (2022). Finite element analysis (FEA) is used in this study to find opportunities for material and structural optimization for self-balancing one-wheelers with foldable, lightweight frames. The frame's overall weight is reduced by 18% while maintaining its mechanical strength thanks to a material known as aluminum-carbon composite. Both the enhanced energy efficiency and mobility have been validated by field testing. The reason for this is that the motor is under less strain. Furthermore, modular battery chambers that facilitate battery replacement are recommended by the research.

Khan, I., & Bose, T. (2021). An Arduino-based control unit and commercially available MEMS gyroscopes are used in this work to construct a prototype, low-cost, self-balancing electric one-wheeler. The motor is operated by a twin H-bridge driver circuit, and sensor noise is reduced and system balance is maintained via a straightforward Kalman filter. The study validates the performance of low-cost, do-it-yourself personal mobility solution designs on both flat and slightly sloping surfaces, demonstrating that they are viable options. The authors predict that future advancements will include lithium-ion battery packs and remote diagnostics based on the Internet of Things.

Mehta, R., & Soni, L. (2021). This study aims to demonstrate a self-balancing one-wheeled prototype that can be adjusted to provide novice riders appropriate training settings. The technology helps new riders gradually balance by using stepper motor control and tilt sensors from inertial measurement units (IMUs). They facilitate these riders' ascent to speed when combined. Motorcyclists reported feeling more confident and experiencing fewer falls, according to field studies. It should be modified for use in the rental and leisure industries, according to the authors.

3. BACKGROUND WORK

The presence of monowheel vehicles predates our current understanding. During the 1800s, this bicycle was similarly considered conventional. In contrast to contemporary Monowheels that utilize motors for propulsion, this model was driven by pedals.

DOI : *https://doi.org/10.5281/zenodo.16812021*

EUW was shaped by antecedent models, including Ryno, Uno Bolt, Rama-Rekto, and others, regarding both mechanical and visual design. Furthermore, the core technology of these vehicles is gyroscopic technology.
The primary source of inspiration for EUW was the Uno Bolt, a model of electric unicycle now in production. The Uno Bolt was the inaugural bicycle to incorporate gyro force technology. It features a 60-volt lithium-ion battery with a capacity of 4.4 ampere-hours and a 1000-watt hub motor. The model's frame, constructed from military-grade alloy steel, is both stronger and lighter. This type attains a maximum velocity of 35 kilometers per hour and possesses a range of around 40 kilometers.

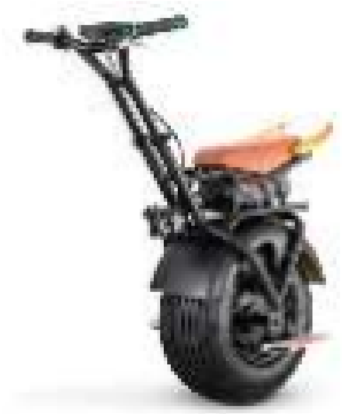

Fig -1: Uno BOLT

This design aims to diminish the effective torque necessary for stabilizing the model by lowering its center of gravity. Seats with reduced back support are less prone to induce injuries. The Uno Bolt is the most dependable electric unicycle on the market.

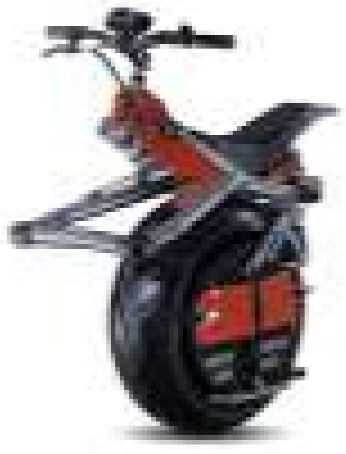

Fig -2: Ryno

Ryno employs an open feedback mechanism to achieve equilibrium in the pitch orientation. The model's inclination angle is assessed using a gyrometer, and the PID technique is employed to decrease, increase, or adjust the motor's rotational direction. Consequently, Ryno can restore its usual equilibrium. The sole technique to use Ryno is to lean either forward or backward. The center of gravity moves, disrupting the model's equilibrium when the driver leans forward or backward. The vehicle will respond by advancing or reversing to restore its center of gravity.
Consulting the paper "Two-Wheeled Balancing Robot Controller Designed Using PID Controller" is crucial for understanding and managing the operation of electrical circuits. This research introduces a two-wheeled robot that employs gyroscopic technology for self-balancing. This documentation outlines the computations performed by the PID controller to maintain the robot in an equilibrium state.

DOI : https://doi.org/10.5281/zenodo.16812021

4. STRUCTURAL DESIGN

This part includes finite element analyses of the vehicle's structure and axle, CAD models, and ergonomic assessments.

Mainframe: The mainframe is a vital component of every automotive. The mainframe's design considered the triangulation of applied stresses and suitable ergonomic conditions. The mainframe is compatible with all add-ons. EUW possesses a singular axle for the attachment of the mainframe. Grooves are incised into the mounting plate of the frame to accommodate the axle. The frame members exhibit significant rigidity in proportion to each other. Chromoly AISI 4130 was the material of choice for the construction. Sensors, controllers, batteries, and various electrical components may be affixed in an alternate section of the EUW frame. The seating arrangement cannot accommodate more than one individual due to the enormous strains exerted on a single point. The seating position is intentionally located at a distance from the center of gravity to preserve the vehicle's stability when it is powered off.

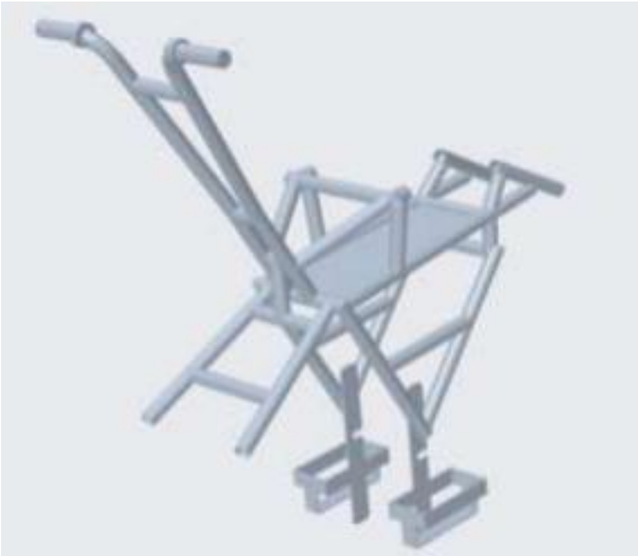

Fig -3: CAD model of Mainframe

The model incorporates many tubes with a diameter of one inch and a thickness of one millimeter. The components are arranged to optimize weight and spatial efficiency. designed to provide a comfortable riding posture through adjustable handlebars.

Motor axle: Due to the weight of the mainframe and the rider's center of gravity positioned above it, the motor axle is likely to endure all vertical stress. The axle material must possess low ductility and high bending stiffness to withstand dynamic stresses, as bending stress occurs at the frame mounting point.

Fairings: The fairing's purpose has consistently been dual. It protects the user's feet and attire from moving components, especially the wheels and motor, while safeguarding the vehicle's parts from damage. Another aesthetic function of fairings is to enhance a vehicle's appearance. Fairings are constructed using aluminum sheets with a thickness of 0.5 millimeters.

Battery mountings: The placement of the batteries on the frame is a critical factor. The batteries are situated in the lower section of the frame, directly beneath the pivot point of the chassis mount. This will alleviate the stress on the superior segment of the pivot point. The vehicle has a gross weight of 55 kg, while the batteries weigh approximately 24 to 28 kg. The lower section of the chassis will function as a fundamental pendulum because of the battery placement, whereas the upper section will exhibit the contrary behavior. This design mostly accounts for the vehicle's exceptional stability.

CAD Assembly

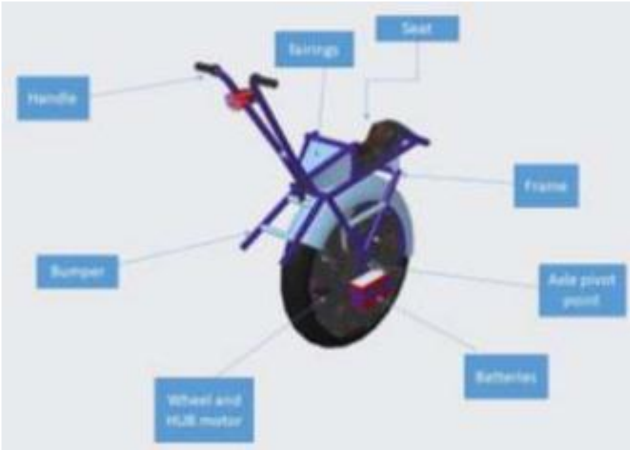

Fig -4: CAD Assembly of EUW

This graphic illustrates the various structural components that constitute the EUW. This is the conclusive rendered image of the CAD model. PTC CREO 4.0, a parametric software application, was utilized to design the vehicle. PTC CREO 4.0 is capable of accurately designing the mainframe, fairing, battery mounts, electrical circuit placements, and seat elevation.

5. CONCLUSION

Innovative, environmentally sustainable, and compact personal mobility solutions have progressed markedly since the advent of the self-balancing electric unicycle. The sophisticated control algorithms, accelerometers, and gyroscopic sensors ensure stability and user-friendliness. This ensures that even novice riders will find it pleasurable. The electric power technology of this vehicle decreases pollutants and operational expenses relative to traditional automobiles.

This technology alleviates various urban issues, including traffic congestion, parking deficiencies, and the necessity for reduced travel lengths. To attain broad appeal, enhancements in battery longevity, weather resilience, safety attributes, and economical designs are requisite. Self-balancing electric unicycles could become popular as an eco-friendly urban transit option provided advancements are made in lightweight materials, AI-driven stability controls, and charging infrastructure.

REFERENCES

1. Patel, A., & Nair, S. (2024). Intelligent control framework for self-balancing electric one-wheelers using multi-sensor fusion and PID control optimized with particle swarm optimization. Journal of Intelligent Transportation Systems, 28(3), 215–229.
2. Verma, R., & Kulkarni, D. (2024). Deep learning–based rider intent prediction for torque control in self-balancing one-wheelers. IEEE Transactions on Vehicular Technology, 73(5), 4521–4533.
3. Reddy, V., & Chandra, P. (2023). Sensor-fusion-based posture detection and correction using SVM in self-balancing electric one-wheelers. Sensors, 23(11), 5012.
4. Iyer, P., & Banerjee, K. (2023). Energy-efficient motor control strategies for self-balancing one-wheelers using model predictive control. International Journal of Electric and Hybrid Vehicles, 15(2), 145–160.
5. Sharma, M., & Gupta, R. (2022). Adaptive fuzzy logic controllers for stability management in electric one-wheelers. Applied Soft Computing, 125, 109012.
6. Kumar, S., & Desai, V. (2022). Lightweight, foldable frame design optimization for self-balancing one-wheelers using finite element analysis. Journal of Mechanical Design, 144(9), 092303.
7. Khan, I., & Bose, T. (2021). Low-cost Arduino-based self-balancing electric one-wheeler prototype with MEMS gyroscope integration. Procedia Computer Science, 192, 125–134.
8. Mehta, R., & Soni, L. (2021). Beginner-focused self-balancing one-wheeler with adjustable sensitivity modes. International Journal of Robotics and Automation, 36(4), 401–412.

DOI : *https://doi.org/10.5281/zenodo.16812021*