International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 11 Issue: 2
DOI: https://doi.org/10.17762/ijritcc.v11i2.6138
***Article Received**: 21 December 2022 **Revised**: 18 January 2023 **Accepted**: 28 January 2023*

Analysis of Unmanned Four-Wheeled Bot with AI Evaluation Feedback Linearization Method

[1] Chandrashekhar Kumar, [2]T. Muthumanickam
[1] Research Scholar,
Department of Electronics and Communication Engineering,
Vinayaka Mission's Research Foundation -Deemed to be University,
Salem, India
srichandrang@gmail.com
[2]Professor & Head,
Department of Electronics and Communication Engineering,
Vinayaka Mission's Kirupananda Variyar Engineering College,
Vinayaka Mission's Research Foundation -Deemed to be University,
Salem, India

Abstract
In this research paperwork, thereis the design and implementation of aBot with the ability to work in four directions of movement forward, backward, left, and right using aself-governingstability system. The bot's resultingbe in command of objective is to follow a path at the required speed, while its primary control purpose is to maintain equilibrium whenever the balance position is unstable owing to a change in the center of gravity. We report our surveys into the concertevaluation of a highly linear four-wheeledmatchingmachine using a PID regulator and a PI-PD regulator. Here I have added advantages with the AI evaluation feedback linearization technique to detect and process with auto error time solutions. The key benefits include cogency in the actual application; switchdevice, enhanced performance, and capacity to overcome uncertainties. Simulated and experimental findings are used to compare and support a performance evaluation of the system. Numerous automatic systems for detecting traffic accidents have been developed by researchers. These techniques frequently make use of many applications such as smartphones, infrared sensors, and mobile applications.All of these techniques fall short when it comes to the instinctiverecognition of traffic accidents. The sifters used in smartphones may make it difficult to detect low-speed collisions. The suggested system does not specify the threshold distances at which an IR sensor will react. It is suggested to use a revolutionary method based on ultrasonic sensors.Using an ultrasonic sensor to identify accidents allows for the ability to do so not only in different street contexts but also in industrial settings, busy intersections, and weather circumstances like clouds, fog weather, rain, and heavy traffic.

***Keywords:** Artificial Intelligence, Ultrasonic Sensor, PID Controller, PI-PD Controller, Balance Bot, Wireless sensor network.*

I. Introduction

In this paperwork,we show how to createahybrid unmanned, four-wheeled car using an AI PI-PD Controlled system that can balance itself both when it is moving and while it is still. The inverted pendulum theory is put into practice by the self-balancing robot [1]. We employed a pyramidal tower structure to achieve significant structural stability. This structure is on four wheels, independently controlling the stepper motors to maintain balance while moving by input from the user. And Artificial intelligence techniquesare used to send the command automatically using an ultrasonic sensor to receive the signal. There are a few automatic approaches for detecting traffic accidents that have been developed and published by researchers. The use of a smartphone for accident detection is suggested in [2]. However, there are several filters employed in smartphones to prevent false alarms if an accident is detected using a mobile device. Therefore, the likelihood of detection is lower for minor collisions like sideswipes. In [3], the system added advantages to using Location and positioning for communication, respectively, and an IR sensor for accident detection. The sensor relies on the infrared radiation that every item emits [4]. To demonstrate how an IR sensor detects an accident, neither experimental observations nor the installation of the sensor in the system is provided. What is the value that will cause it to trigger?when the bot is moving similarly to a close another bot, how will it prevent a false alarm? The use of airbag systems for accident detection is suggested in [5], however since these systems are only designed for automobiles and not for bicycles or bike riders, they cannot render medical aid in the event of a collision involving two bike riders. A system should, however, be universal for all cars. It is suggested in [6] to use a mobile application to detect accidents, although different smartphone models have processors with varying processing speeds. Therefore, it's possible that not all smartphone models will handle the application well. A revolutionary concept is accident detection utilizing an ultrasonic sensor with a feedback linear method. The authors of [7] have previously outlined the system's concept.Various

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 11 Issue: 2
DOI: https://doi.org/10.17762/ijritcc.v11i2.6138
***Article Received**: 21 December 2022 **Revised**: 18 January 2023 **Accepted**: 28 January 2023*

ultrasonic sensors have been unifiedinto the proposed system to sensecoincidences. The remoteness is restrained using asupersonicdevice. The gap between making the wave process and getting returned to the sense place will be calculated as the remoteness. [8]. The ability to detect crossing points, in an underpass or a route is provided by accident detection employing ultrasonic sensors, and it also has the potential to function well under diverse environmental circumstances, such as rain. This is because an ultrasonic sensor works on the principle of sound wave propagation. So, the sensor can detect waves in different weather conditions like all forms of gases, solid and liquid forms as well. [9].as anoutcome, it is possible to detect rush-hour trafficcoincidences in tunnels or during cloudyweather. An ultrasonic sensor is a desirable alternative for automatic accident detection because of this feature.

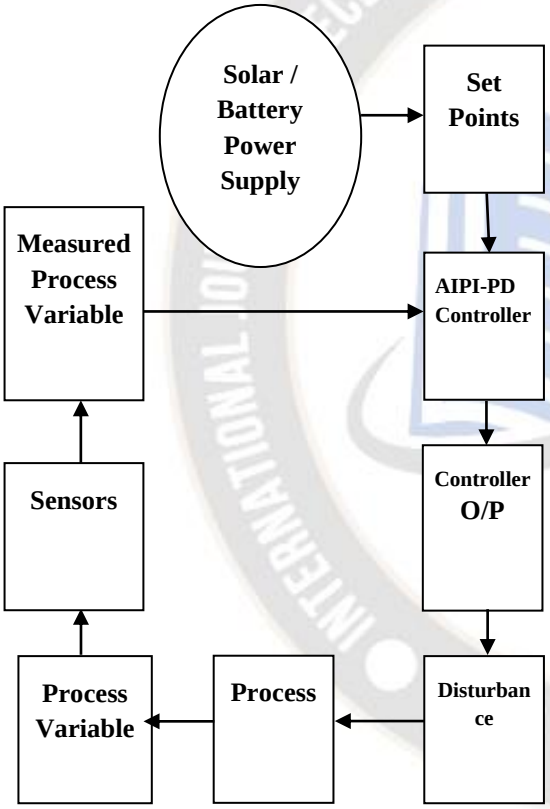

Fig.1.Block diagram of Bot with Ultrasonic sensors

II. Design of the AI Four-WheelBot

The bot's goal is to balance itself while vertical on four wheels and hold things starved ofplummeting them. Since triangle constructions are thought to be the most stable among other shapes, a pyramidal tower structure is used to achieve stability. The supported items placed on top and the center of mass will be in the middle area, allowing the lower part of the robot to move effortlessly while the upper part remains stable. Individual motors must individually drive each set of wheels.

A. Measurements

The model robot weighs about 8.6 kg and stands 10 cm tall.

There are three platforms in it:

- Top: Solar Glass Panel, 15 cm long by 10 centimeters wide;
- middle: plastic layer, 20cm long; width of 10 cm
- Bottom: Metal layer,20 cm long, 10 cm wide.

B. Components employed

Metal: Cares the stepper motors' heavyweight, preventing any needless or exaggerated bends.

The different onboard electronics are supported by wood.

Plastic material: - which also serves as an insulator.

Solar-panel glass: - which is glass with the semiconductor material of the top layer, will guarantee that the center of mass is balanced and in addition, gives the power supply to the power source system.

III. Hardware

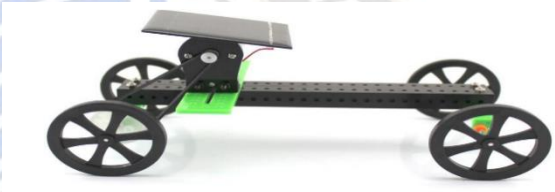

Fig. 2. Model structure of a car with modules

Step resolutions 2,4,8,16,32,64 come in a variety of kinds. With adjustable current control, we can use a potentiometer to make the variable output have different levels of current output;this allows us to achieve higher step rates by using voltages other than the stepper motor's rated voltage. Under-voltage lockout is built into the motors, so they don't run if the voltage applied to them is less than the threshold, and crossover-current protection is enabled alongside the motors. When the temperature inside the motors exceeds a certain threshold, the motors shut down, a process known as over-temperature thermal shutdown. Short-to-ground and shorted-load protections are provided for the motors.

C. Controls:

The wheels are made of high-quality silicone. This has the surety of the greatest possible grip and is very adherent. The wheels have a 10 CM diameter and a 2 CM thickness.

D. Control Board:

i). Arduino Leonardo:

This board is based on the ATmega32u4 microprocessor and has 20 digital I/O pins (12 analog inputs and 7 PWM outputs). A 30 MHz crystal oscillator powers it.

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 11 Issue: 2
DOI: https://doi.org/10.17762/ijritcc.v11i2.6138
***Article Received**: 21 December 2022 **Revised**: 18 January 2023 **Accepted**: 28 January 2023*

ii). Brain Shield:

This covered the installation and integration of all of the project's various components, such as the push button, and sensor port;we have the stepper motor for measuring outputs, servo outputs, I^2C communications, and an ESP8266 Wi-Fi module.

iii) AI PI-PD Controller:

Artificial Intelligence is a newly gained technology in the PI-PD process to enhance error resolution. Once data is stored and it will offer the feedback data to process and again reconfirm with a set of needed tasks and send to the controlled output and error finding device which is the next step for the disturbance removal if added there.

E. Sensors

The feeler that can be employed is an InventSense MPU-6050 device that has a gyroscope and an accelerometer incorporated into a single chip process using AI technology. Here is given with ultrasonics with AI image detection for accuracy of data set will perform better. Accuracy and precision are ensured by the existence of 32-bit A/Drenovation technology for each control. Because of this, it quickly catches these single x, y, and z channels. The sensor's connection to the Arduino board takes place over the I^2C bus.

F. Power Circuit

NiMH batteries are used to provide the Bot with power. Later, we switched to 3S LiPo batteries to maintain a constant voltage and enable longer workdays.

IV. Dynamics and control of systems

The PID controller was the control algorithm utilized to keep the four-wheeled robot self-balanced. [10] The transfer function of the main partsiscomparative, fundamental, and imitative (PID) controller can be written as illustrated in equation (1):

Cr + Cc +Ci/s …… (I)

Where, Cr - relative coefficient

Ci - imitative coefficient, and

Cc- Coherence coefficient.

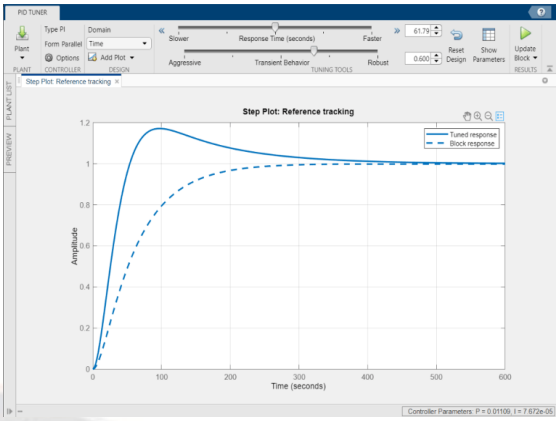

Fig. 3. Tuned Steps response graph plotted

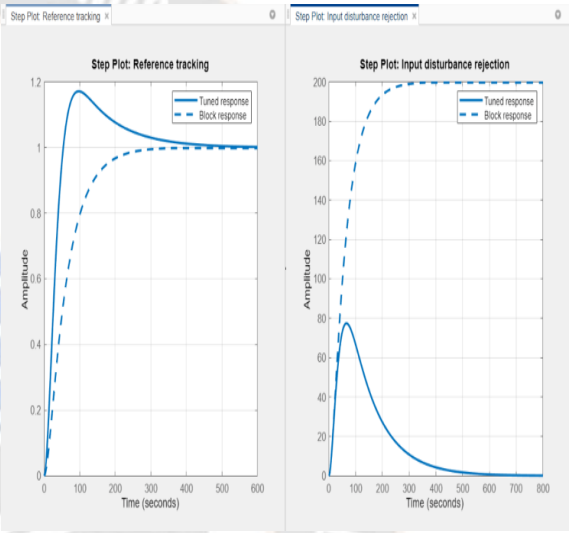

Fig. 4. Disturbance rejection output graph plotted.

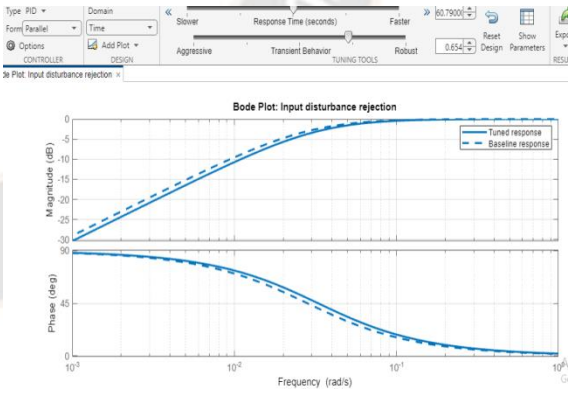

Fig. 5. PID Disturbance rejection input graph plotted

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 11 Issue: 2
DOI: https://doi.org/10.17762/ijritcc.v11i2.6138
***Article Received**: 21 December 2022 **Revised**: 18 January 2023 **Accepted**: 28 January 2023*

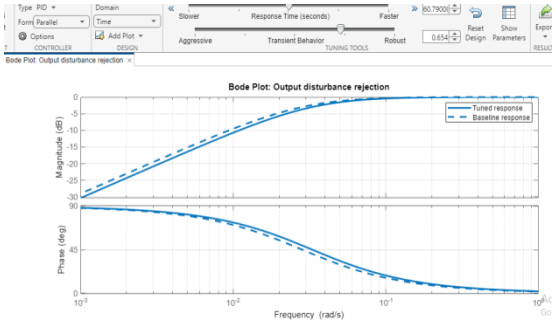

Fig. 6. PID Disturbance rejection output graph plotted

V. Model of the system for Collision Detection

Even though the suggested approach is suitable for detecting a traffic accident. However, the suggested approach of 10 meters has significant drawbacks. For this reason, an ultrasonic feeler module can only detect sound waves that are reflected up to 15°, positioning the sensor module is also important for getting good results.

VI. Performance Results

The receiving sound wave's frequency after it has hit and been reflected by an object, together with the car's speed and temperature. The Doppler's Effect theory forms simulations. The Doppler is a revolution in influence frequency caused by an observer moving about its source. It is known that the propagation of sound waves must be interrupted while a bot is driving down the road and emitting sound waves, which is why this component must be simulated. As a result, the disruption caused by the production of sound waves has an impact on the outcomes. The performance assists in adjusting the sensor output to the vehicle's motion. The first shows what happens when a source—a collision car—moves toward a stationary sensor-mounted observer.

The following is the effective frequency formula:

$$fe= \frac{v}{v-vs} f(II),$$

$$fe= \frac{v+vo}{v} f(III)$$

where, fe=Effective frequency,

f=Ultrasonic sensor frequency,

V=Sound velocity, and Vs=Sourcevelocity.Vo=Velocity of observer

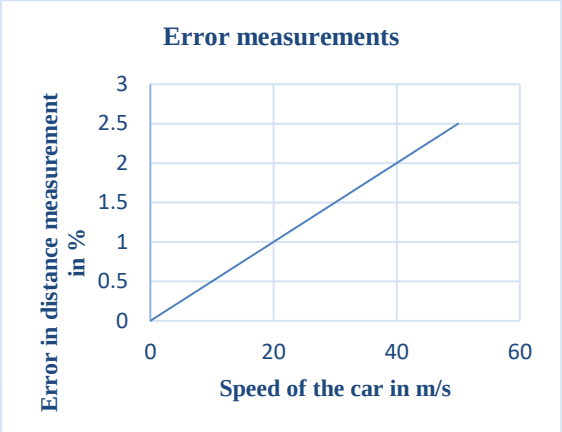

Fig 5. Temperature VSspeed of sound.

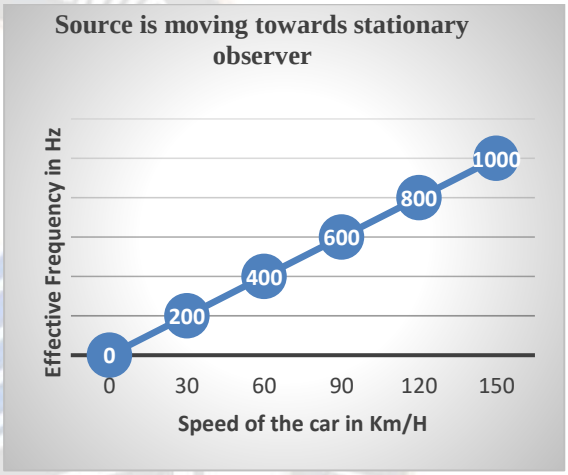

Fig.6. When hitting the car, the observer ultrasonic sensor placed

The second simulation shows an observer traveling toward a stationary source while the sensor is mounted on the observer (colliding car).Vs = 30 square0$\sqrt{T}$, Where T is in temperature.

The distance that an ultrasonic sensor has measured can be affected by the speed of a car (the observer). This performance is essential since an ultrasonic sensor won't deliver the appropriate results if the predicted distance is not exact. The output of the sensor can be appropriately adjusted by this numerical data set value. The following calculation is given in [11] for the percentage inaccuracy in distance estimation caused by the sound wave's speed (observer):

Distance error in percentage=$\frac{1}{2} * (\frac{Vc}{Vs})^2$*100.(IV)

VII. Conclusion

In this research paperwork, we are using AI feedback linear technique using Ultrasonic sensors.Control theory is used to create PI-PD controllers, which guarantee the system's efficiency and speed. As a consequence of the results, we can conclude that the PI-PD control algorithm successfully

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 11 Issue: 2
DOI: https://doi.org/10.17762/ijritcc.v11i2.6138
***Article Received**: 21 December 2022 **Revised**: 18 January 2023 **Accepted**: 28 January 2023*

achieves self-balance control of the four-wheeled robot and can prevent the robot from falling, while also offering good dynamic performance using an ultrasonic sensor for accident detection is a wise decision because it works by reflecting sound waves., which can travel through all types of materials and are less affected by the environment and other variables like the color of the colliding objects. Advanced gained work is done with complete data set using AI and machine learning methodsit can be applied for the normal vehicle with heavy vehicles as well and additional work can be done with GPS based for long-distance road traffic control and multi balance method for heavy vehicles for upcoming in my research work.

References

[1] R. Fierro, F. Lewis, and A. Lowe, “Hybrid control for a class of underactuated mechanical systems,” IEEE Transactions on Systems, Man and Cybernetics, Part A: Systems and Humans, vol. 29, no. 6, pp. 649–4, Nov 1999.

[2] K. Xu and X.-D. Duan, “Comparative study of control methods of a single-rotational inverted pendulum,” in Proceedings of the First International Conference on Machine Learning and Cybernetics, vol. 2, 2002, pp. 776–8.

[3] F. Grasser, A. D’Arrigo, S. Colombi, and A. C. Rufer, “JOE: A mobile, inverted pendulum,” IEEE Transactions on Industrial Electronics, vol. 49, no. 1, pp. 107–14, 2002.

[4] R. C. Ooi, “Balancing a two-wheeled autonomous bot,” Final Year Thesis, The University of Western Australia, School of Mechanical Engineering, 2003.

[5] N. M. A. Ghani, F. Naim, and P. Y. Tan, “Two wheels balancing bot with line following capability,” World Academy of Science, Engineering and Technology, vol. 55, pp. 634–8, 2011.

[6] G. M. T. Nguyen, H. N. Duong, and H. P. Ngyuen, “A PID backstepping controller for two-wheeled self-balancing bot,” in Proceedings for the 2010 IFOST, 2010.

[7] K.-H. Su and Y.-Y. Chen, “Balance control for two-wheeled bot via neural-fuzzy technique,” in SICE Annual Conference 2010, Proceedings of, Aug. 2010, pp. 2838 –2842.

[8] O. Ozen, E. Sariyildiz, H. Yu, K. Ogawa, K. Ohnishi, A. Sabanovic, "Practical PID controller tuning for motion control", Mechatronics (ICM) 2015 IEEE International Conference on, pp. 240-245, 2015.

[9] Campari, Kannur. "SELF BALANCING ROBOT." (2015).

[10] T. S. Cleatus, S. Hedge, P. Harshitha and S. Jaswanth, "Unmanned two-wheeled bot using feedback linearization," 2017 International Conference on Intelligent Computing and Control Systems (ICICCS), 2017, pp. 1059-1062, DOI: 10.1109/ICCONS.2017.8250629.

[11] Juang, Hau-Shiue, and Kai-Yew Lurr. "Design and control of a two-wheel self-balancing bot using the Arduino microcontroller board. “Control and Automation (ICCA), 2013 10th IEEE International Conference onIEEE, 2013.

[12] U. Khalil, A. Nasir, S. M. Khan, T. Javid, S. A. Raza and A. Siddiqui, "Automatic Road Accident Detection Using Ultrasonic Sensor," 2018 IEEE 21st International Multi-Topic Conference (INMIC), 2018, pp. 206-212, DOI: 10.1109/INMIC.2018.8595541.

[13] NUSRAT TAN "Computation of Stabilizing PI-PD Controllers,"175, Springer (2009)

[14] V. Praveena, A. R. Sankar, S. Jeyabalaji, and V. Srivatsan, “Efficient accident detection and rescue system using ABEONA algorithm,” International Journal of Emerging Trends and Technology in Computer Science, vol. 3, no. 5, pp. 222–225, 2014.

[15] B. Fernandes, V. Gomes, J. Ferreira, and A. Oliveira, “Mobile application for automatic accident detection and multimodal alert,” in 81st Vehicular Technology Conference (VTC Spring),. IEEE, 2015, pp. 1–5.

[16] U. Khalil, T. Javid, and A. Nasir, “Automatic Road accident detection techniques: A brief survey,” in International Symposium on Wireless Systems and Networks (ISWSN). IEEE, 2017, pp. 1–6.

[17] Ultrasonic Distance Sensor, “How an ultrasonic distance sensor works,” Last accessed on 20 July 2018.

[18] J. Walker, R. Resnick, and D. Halliday, Fundamentals of Physics. Wiley, 2008.

[19] Sparkfun, “UltrasonicSensorHC-SR04,” Last accessed on 20 July 2018.

[20] E. McCune, Practical digital wireless signals. Cambridge University Press, 2010.

[21] Carullo A. and M. Parvis, “An ultrasonic sensor for distance measurement in automotive applications,” IEEE Sensors Journal, vol. 1, no. 2, p. 143, 2001.

[22] World Health Organization, “Road Traffic Injuries,” Last accessed on 20 July 2018.

[23] World Health Rankings, “Health Profile: Pakistan,” Last accessed on 20 July 2018.

[24] A.M. Khan and A. Tehreem, “Causes of road accidents in Pakistan,” Journal of Asian Development Studies, vol. 1, no. 1, pp. 22–29, 2012.

[25] J. White, C. Thompson, H. Turner, B. Dougherty, and D. C. Schmidt, “Wreckwatch: Automatic traffic accident detection and notification with smartphones,” Mobile Networks and Applications, vol. 16, no. 3, pp. 285–303, 2011.

[26] S. K. Poornesh, T.V. Harsha, “Automatic vehicle accident detection and messaging system using GPS and GSM modems,” International Journal of Scientific & Engineering Research, vol. 4, pp. 1937-1940,2013

[27] R. Mariappan, L. Manjunath, G. Ramachandran, M. Porkodi and T. Sheela, "Super Artificial Intelligence Medical Care Systems with IoT Wireless Sensor," *2022 IEEE International Conference on Distributed Computing and Electrical Circuits and Electronics (ICDCECE)*, Ballari, India, 2022, pp. 1-4, doi: 10.1109/ICDCECE53908.2022.9792895.

.