Automatic Detection of Wheel Alignment Through Sensors

Shubham Spehia[1], Navdeep Prasher[2]
[1]*M.Tech Scholar, ME Department, Bahra University, Waknaghat, Himachal Pradesh,*
[2]*Asstt. Professor, ECE Department, Bahra University, Waknaghat, Himachal Pradesh.*

***Abstract*—**This paper represents the new method of front wheel alignment for all four wheel vehicles. In this method, wheel alignment on its toe is considered. Toe is the symmetric angle that each wheel makes with the longitudinal axis of the vehicle, as a function of static geometry, and kinematic and complaint effects. This can be contrasted with steer, which is the anti-symmetric angle and both wheels point to the left or right in parallel. With the help of ultrasonic sensors it will simply check the alignment of the wheel that the alignment is out or in. This advanced process is tested on the four wheel vehicle.

Keywords*—Wheel Alignment; Toe; Camber; Caster; Need of Wheel Alignment;Arduino;Ultrasonic.*

I. Introduction

Wheel alignment, sometimes referred to as breaking or tracking, is part of standard automobile maintenance that consists of adjusting the angles of the wheels so that they are set to the car maker's specification. The purpose of these adjustments is to reduce tire wear, and to ensure that vehicle travel is straight and true (without "pulling" to one side). Alignment angles can also be altered beyond the maker's specifications to obtain a specific handling characteristic. Motorsport and off-road applications may call for angles to be adjusted well beyond "normal" for a variety of reasons. All new vehicles leave the factory with their alignment checked and adjusted. Usually the technician paints the heads of the adjustment hardware to show it has been set, also to show if it has moved later on. It is advisable to do the alignment of the car after the first 5000 km, since all the suspension gets set. Failure to do this may result in the camber and toe specifications drifting outside the manufacturer's limit. This may lead to vehicle pulling and tire wear. Initially consumers may not notice these defects but after usage of some days or running some kilometers it can cause uneven tire wear and a pull/drifting to the left or right. Tire wear leads to frequent replacement of tires thus adding to running cost for the consumer. Vehicle pulling causes irritation and/or fatigue while driving the car. Under normal driving conditions many vehicles can go 50 000 km+ before they need a new set of tires, which is a good interval to have the alignment checked as well. Any severe driving incidents, or changed suspension components would also warrant a check. The typical alignment on an economy sedan takes about an hour under ideal circumstances. A utility or performance vehicle may require additional labour. When fasteners and hardware are rusted/seized, extra time may be required and/or parts may need to be replaced. A good start is to consult your local licensed automotive technician. In the same fashion that you will wear out your shoes if you walk only on the inside or outside edge, so your tires may become worn if not within allowed specifications. Many performance vehicles sacrifice tire life for driving performance. As the tire will bounce, it is the first spring that your car rides on, affecting and potentially shortening the life of all other components. Braking distance, ride quality, and even fuel economy are all affected by the correct inflation and rotation of tires. A major improvement in fuel savings would result if everyone correctly inflated their tires. If your vehicle squeals while turning corners on dry pavement, it is probably time to have your alignment checked (or slow down). Changing rims and tires will normally not affect the alignment but will affect secondary angles. Consult your local licensed automotive technician. The primary angles are the basic angle alignment of the wheels relative to each other and to the car body. These adjustments are the camber, caster and toe. On some cars, not all of these can be adjusted on every wheel.

A. Toe

Toe measures the difference between the front of the tires and the back of the tires. This is determined by checking if the fronts of the tires are closer together than the rear of the tires your tires are toed in. This means your vehicle is going down road like a crab. If the toe isn't corrected you can expect the tires to wear quickly. Toe measures the difference between the front of the tires and the back of the tires. This is determined by checking if the fronts of the tires are closer together than the rear of the tires your tires are toed in. This means your vehicle is going down road like a crab. If the toe isn't corrected you can expect the tires to wear quickly. Toe is a measurement that determines how much the front and/or rear wheels are turned in or out from a straight-ahead position.

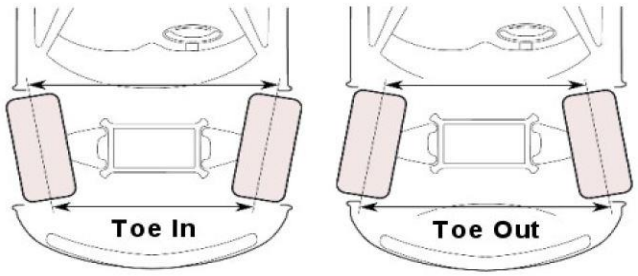


Figure 1.1: Toe Measurement.

The amount of toe, whether it's toe-in or toe-out, is expressed as the difference between the track widths as they are measured at the leading and trailing edges of the tires. Toe is expressed in degrees or fractions of an inch, and while your

wheels should be pointed directly ahead as you are travelling straight forward, there are some benefits to toeing depending on the type of vehicle that you drive. The purpose of toe is to ensure that all four wheels roll parallel to one another. Toe-in also provides increased stability because it discourages turning. If your vehicle has the proper amount of toe you should experience ideal straight line stability, corner entry, and very little tire wear.

B. Camber

Camber is the measurement that looks at how much a tire is leaning in or out. A camber problem will cause wear to the inside or outside edge of the tire. Camber is the angle of the wheel relative to the vertical of the vehicle, and depending on the tilt, is either considered positive camber or negative camber. When the top of the tires tilt away from the centre of the vehicle you have positive camber, and when the top of the tires are tilted inward you have negative camber. One isn't better than the other, but varying camber angles have different effects on your vehicle. When your wheels are tilted outward, the vehicle has improved stability.

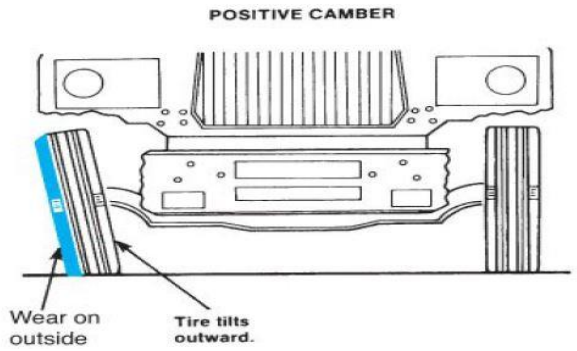


Figure 1.2: Positive Camber.

High performance vehicles that require better cornering tend to use negative camber, because it gives the driver more control in this regard.

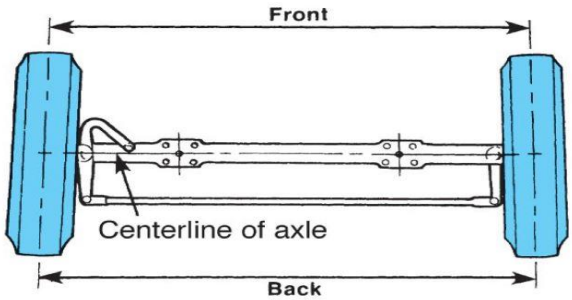


Figure 1.3: Negative Camber.

C. Caster

Caster measures the relationship of the wheels to one another. Most vehicles today require a four wheel alignment. To have your vehicle properly aligned you need to find a shop that has the proper equipment and a qualified technician to perform the service. Caster is the angle that identifies the forward or backward slope of a line that is drawn through the upper and lower steering pivot points. It does not affect tire wear, but caster does have an influence on the directional control of the steering. Caster angle settings allow manufacturers to balance steering effort, high speed stability, and front end cornering effectiveness.

Figure 1.4: Positive and Negative Caster.

If the line slopes towards the rear of the vehicle, then you have positive caster. The down side to positive caster is if the vehicle does not have power steering. In this case steering effort will be increased. Positive caster is primarily beneficial to the vehicle as it increases the lean of the tire when the vehicle is cornering, while returning it to an upright position when driving straight ahead. If the line slopes towards the front of the vehicle then the caster is negative. Negative caster will allow you to steer less around turns, but may cause you to drift if you are driving straight forward.

II. Wheel Alignment Need

When people talk about a car's alignment, they're talking about making sure the wheels all point in exactly the same direction.

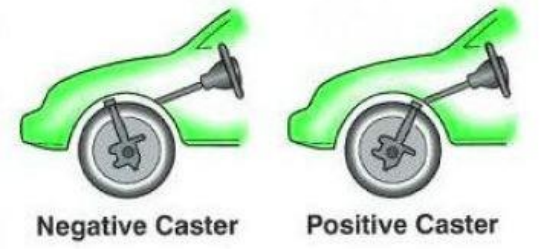


Figure 1.5: Wheel Alignment.

If a wheel gets knocked out of alignment just a little, you'll still be able to drive but your car won't handle well and you'll wear through tires and other parts more quickly than you should. Most drivers don't realize they need an alignment until their mechanic tells them. Once you know what to look for, though, the signs of an out-of-alignment vehicle are obvious.

III. Related Work

To begin a task, the initial step is to concentrate on the exploration papers of the required field that have been performed past by different specialists, to know the level of headway. For this work, paper identified with execution examination of proposed method used to detect wheel alignment is proper or not are picked and concentrated on.

Table 1: Related Work Wheel Alignment Detection.

S/No.	*Authors*	*Proposed Approaches*
[1]	**Miyahara et. al. (2018)**	Four-wheel steering (4WS) vehicles have superior characteristics in motion performance to two wheel ones by controlling the yaw motion and the sideslip angle.
[2]	**Sarode et. al. (2017)**	The technique for wheel arrangement of substantial business vehicle. Specifically subject of fix and take out the tire wear of vehicle and adjusted the vehicle legitimately. The correct wheel arrangement led on hard core vehicle with the assistance of electronic wheel arrangement machine.
[3]	**Patil et. al. (2016)**	The wheel arrangement innovation progresses consistently with the presentation of new makes and models of vehicles, motors, transmissions/transaxles, directing and electronic suspensions. Two wheel arrangements are rapidly getting to be out of date and four wheel arrangements are quickly being joined on huge numbers of the new models. This work focuses on the parameters like caster point, camber edge, toe in and toe out edges.
[4]	**Xiaolan (2015)**	Four-wheel arrangement is an essential parameter in plan of vehicle structure, specifically influences the driving execution of a vehicle. In perspective of the present vehicle four-wheel arrangement and vehicle application utilizing case, in this paper it presents a sort of inquiry configuration example of the four-wheel arrangement data stockpiling dependent on the Hadoop system , to enhance the nature of four-wheel situating upkeep, particularly can assume a positive job to enhance street wellbeing.
[5]	**Vinayak (2014)**	A novel method for dynamic alignment control using infrared light depth imagery to enable automated wheel loading operation for the trim and final automotive assembly line. A key requirement for automated wheel loading is to track the motion of the wheel hub and simultaneously identify the spatial positions and angular orientations of its alignment feature in real-time on a moving vehicle body.
[6]	**Rocco et al (2013)**	Wheel Alignment, consisting of properly checking the wheel characteristic angles against vehicle manufacturer's specifications, is a crucial task in the automotive field since it prevents irregular tyre wear and affects vehicle handling and safety. In recent years, systems based on Machine Vision have been widely studied in order to automatically detect wheels' characteristic angles.
[7]	**Carlos et al (2012)**	To calculate the sensibility of a Computer Vision measurement system is presented in this paper. The specific mensuration done is for car wheel inclination. It will be shown that an equipment using cameras and no other clamp or accessory attached to the wheels to help the procedure to obtain angles from the steering suspension alignment by means of the wheel's images is a viable idea, but not, nowadays technologically realizable.
[8]	**Wenhao et al (2011)**	To measure the vehicle four-wheel alignment parameters according to the theory of machine vision. A new method of obtaining the direction vector of wheel axle was proposed, and the datum pane was established to optimize the mathematical model of four-wheel alignment parameters measurement. The experiments show that this system can gives good performance with sharp image acquisition, high ellipse detection accuracy, and high speed of alignment parameter calculation.
[9]	**Zhang Lei et al (2010)**	new method for front wheel alignment parameters design of mine truck is afforded. In the design, tire wear and handling performance are considered. The candle-suspension and unite steering mechanism is adopted in the truck. The response surface method is applied by the second-order approximation model between alignment parameters and optimization objective. The controlled factors are included in inclination angle, caster, camber, toe-in, and the uncontrolled factors are included in the steering trapezoid arm length and the bottom angle of steering trapezoid.

IV. Proposed Method

The proposed method used to distinguish the deformity alignment of wheel utilizing electronic sensors. There are following steps as follow as:

Step 1: Design hardware for wheel alignment

Step 2: With the help of hardware firstly check the left wheel alignment

Step 3: Detect the minimum mean and maximum mean of left wheel

Step 4: With the help of hardware secondly check the right wheel alignment

Step 5: Electronic hardware detect the alignment of wheel with red and green signals. toolbar.

In view of the writing audit, wheel arrangement is most extreme out from toe. Camber and caster are likewise in charge of the excursion of the wheel arrangement yet camber and caster are manufactory absconded or wheel meet with the more awful mishap. Than we might suspect we understand that greatest wheel arrangement is out from the toe so we need to take a shot at toe. We realize toe is straightforwardly interconnected with directing wheel. We likewise realize center point interfaces with toe and toe associates with guiding haggle is additionally associates with edge of the vehicle is if the wheel internal way than we turn the toe outward way and if the wheel has the outward heading than we pivot the toe internal way.

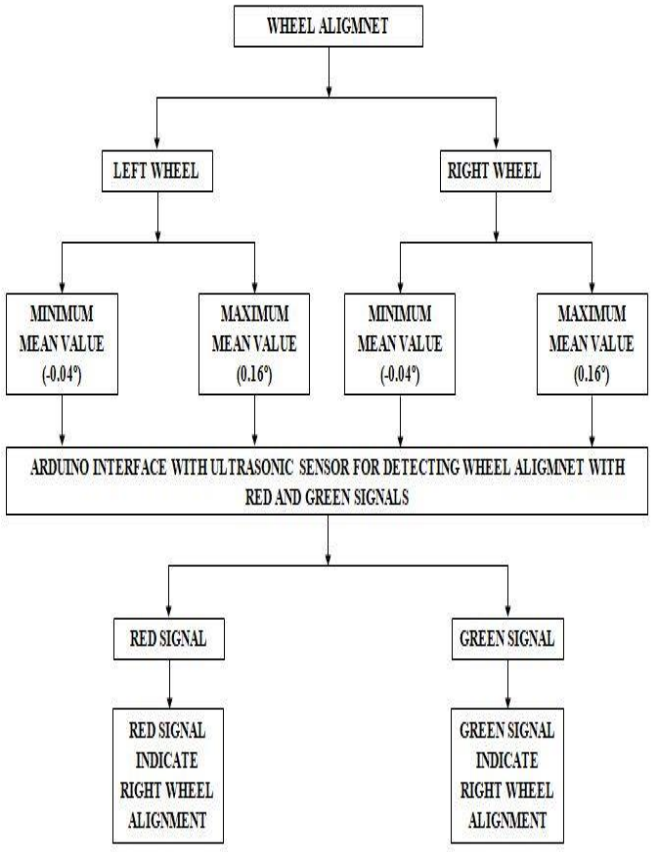


Figure 1.6: Flow Diagram of Work.

So we have a need of sensor which can identify the arrangement of wheel is out or alright and we settle a small scale controller contribute the sensor. This miniaturized scale controller chip contains the mean of the information of 12 to 14 vehicle wheel arrangement information. This mean estimation of the information is a check to detect the wheel is adjusted or not. All the procedure and mean information appear in the fig. all things consider.

On the off chance that the edge of wheel not coordinate with the point which is placed in sensor than sensor shows a flag which is as red light and if the edge of wheel coordinate with the edge which is placed in sensor than the sensor demonstrates a flag which is in type of green light. This new imaginative strategy is exceptionally useful to check mishap which is occurred by lopsided arrangement of haggle accommodating for check the mileage of the one side of tire. Figure 1.7 shows the circuit diagram of arduino interface with ultrasonic sensor for detecting the wheel alignment. Following components are required which is shown below in circuit diagram as follow:

1) Arduino Uno (Atmega 328P)

2) Ultrasonic Sensor

3) Power Supply

4) Buzzer

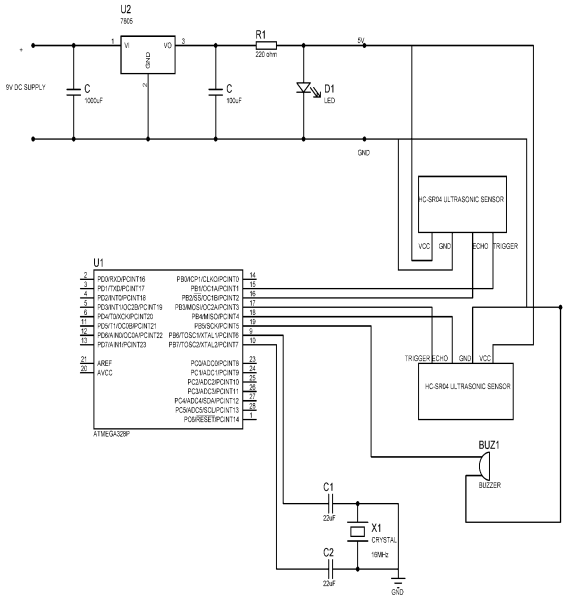
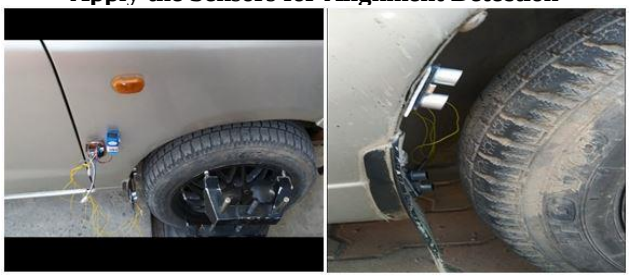


Figure 1.7: Circuit Diagram of Work.

V. Simulated Results

In this section, the proposed hardware is evaluated via computer simulation using Arduino IDE. All simulation results are obtained on the basis of proposed method for automatic detection of wheel alignment using ultrasonic sensors which is based on distance are picked and concentrated on. Figure 1.8 shows the target for detection of wheel alignment using sensors.

Apply the Sensors for Alignment Detection



When Alignment is OUT

When Alignment is IN

Figure 1.8: Target for Detection of Wheel Alignment.

VI. Conclusion

In this section, the proposed automatic detection of wheel alignment using ultrasonic sensors is an important task in computer vision field. Wheel alignment is the measurement of the position of the wheels compared to specifications that the vehicle manufacturers recommend. Each vehicle has specific wheel alignment settings. If any alignment measurement falls outside the specified range, uneven tire wear can result, vehicle handling may be affected and fuel economy can be diminished. The presented wheel alignment system used to perform the real time system. These systems also present how the proposed system is better than existing system. In this system the ultrasonic sensors are used for wheel alignment, it has advantages cost effective, superior than existing system, less time consuming. This system can be implemented for almost all types of four wheelers where the wheel alignment is necessary, and also find all types of misalignment by using only ultrasonic sensors.

References

[1] K. Miyahara ; H. Fujimoto ; Y. Hori, "Rear Steer Actuator-Less Four-Wheel Steering System for Four-Wheel Driving Electric Vehicles", published in IECON 2018 - 44th Annual Conference of the IEEE Industrial Electronics Society. 21-23 Oct 2018.

[2] Salave N. N, and Sarode L. N, "Experimental study on wheel alignment of TATA motors heavy commercial vehicle", International journal of latest engineering and applications, 2017, Vol. 02, PP. 64-70.

[3] Young, J. S., Hsu Y. H., and Chuang C.Y., "Camber angle inspection for vehicle wheel alignment", Institute of Vehicle Engineering, National Changhua University of Education, 2017, PP. 1-12

[4] Shweta G. Barhe and Balaji G. Gawalwad, "Measurement of Wheel Alignment using IR Sensor", published in International Journal of Engineering Technology, Management and Applied Sciences, February 2016, Volume 4, Issue 2, ISSN 2349-4476, pp 158-161.

[5] Patil, A. K., and Kadlag V. L, "Design of Wheel Alignment Measuring System Using Infrared Transmitions", published in International Journal Of Technical Research And Applications, 2016, Vol.4, PP.4-6.

[6] Feifei J., and Xiaolan X., "Design of four wheel alignment information storage and query", International conference on applied science and engineering innovation, 2015 PP. 978-982

[7] Chatur S., "Computer based wireless automobile wheel alignment system using accelerometer",Department of Electronics Engineering, K .J. Somaiya College of Engineering, Mumbai University,Maharashtra, India, (2015) , PP. 62-69

[8] Baek, D., Cho,S., and Bang, H., (2014) "Wheel alignment inspection by 3D point cloud monitoring", Journal of mechanical science and technology, 28(4):1465-1471 • April 2014.

[9] De Souza, R.T.Guedes, da costa, de Araujo, J.F.; de MacedoE.C.T. A system for dynamic contact resistance with arduino platform on MV and HV circuit breaker instrumentation and measurement Technology conference proceedings,2014 IEEE International.

[10] Vinayak A Prabhua, Ashutosh Tiwaria, Windo Hutabarata, John Throwera, and Christopher Turnera, "Dynamic alignment control using depth imagery for automated wheel assembly" , 8th International Conference on Digital Enterprise Technology - DET 2014.

[11] Akshay Padegaonkar, Madhura Brahme, Mohit Bangale, Alex Noel Joseph Raj, "Implementation of Machine Vision System for Finding Defects in Wheel Alignment" , IJCAT International Journal of Computing and Technology, Volume 1, Issue 7, August 2014.

[12] Rocco Furferi1, Lapo Governi1, Yary Volpe1 and Monica Carfagni1, "Design and Assessment of a Machine Vision System for Automatic Vehicle Wheel Alignment" , Department of Mechanics and Industrial Technologies, University of Firenze, Italy, Received 2 Jul 2012; Accepted 18 Jan 2013.

[13] Carlos Roberto Mingoto Junior ; Paulo Roberto Gardel Kurka, "Guidelines to Specify a Camera for Computer Vision Measurement of Vehicle Suspension Alignment Angles Based on the Desired Sensibility", published in 2012 Symposium on Photonics and Optoelectronics, 21-23 May 2012.

[14] LI Wenhao1, GAO Yan1, ZHANG Rong2, "Research on the Machine Vision System for Vehicle Four-wheel Alignment Parameters", Proceedings of the 30th Chinese Control Conference July 22-24, 2011, Yantai, China.

[15] Meng Qingguo, Zhang Lei, Dong En'guo, "Research on Front Wheel Alignment Parameters Based on Response Surface Model", 2010 International Conference on System Science, Engineering Design and Manufacturing Informatization.