

Detection of tyre wear using Colour Coding

Praful Darekar¹, Akash Saste², Shubham Bhandarkar³, Nikita Kadam⁴, B. R. Patil⁵

^{1,2,3,4}Student, Department of Mechanical Engineering, MITAOE, Alandi, Pune, India

⁵Assistant Professor, Mechanical Engineering, MITAOE, Alandi, Pune, India

ABSTRACT - The primary aim of the project is to design, develop and implement colour coding in tyre which helps to achieve low cost detection of tyre wear. This system deals with the tyre wear detection by using visualization method in this system we will add the color coding to the tyre which will be helpful in detecting the tyre wear in simple way. This system is easy to implement and don't need extra components in the system to detect the tyre wear. Despite the advancements in technology there is no such system which indicates us with our naked eyes that the tyre has been wearied out & using it further may be at risk of accidents. Also the nature of current procedure that requires repeated look at the tire for the indication to change it. In addition, it would offer the opportunity to reduce or eliminate human exposure to difficult and hazardous situations, which would solve most of the problems connected with safety when many activities occur at the same time. These factors motivate the development of this colour coding.

Key Words: Colour Coding, Tread thickness.

1. INTRODUCTION

The motto of the project is to drive out the problems faced with use on tyre while travelling, so as to ease the tyre change time & reduce accidents for the welfare of the society.

Now a day's tyre wear may cause damage to the vehicle which leads to accident due to sudden catching fire. It is need for maintenance to tire for that purpose we can implement different type of systems in the vehicle like electronics or by visualization inspection. Also the material being used for manufacturing of tyre plays a important role in this. The Indian subcontinent has bright sunny days most of the year around and summer as such is the safest time of the year for driving. Just for caution, drivers should be careful in areas which gets summer rains as the oil build up can mix with water to make for a slippery surface. To ensure the tyre's contact with the road remains rigid as much as possible, summer tyres generally have a simple block-shape tread pattern. This helps to ensure optimum grip types of tyres ensuring the friction between the tyre and the road surface is maximized at all times.

2. LITERTURE REVIEW

Kati Kõrbe Kaarea, Kristjan Kuhib and Ott Koppela [1]

This paper tells us about the various factors of road which contribute towards the wearing of tyres. This also gives us

the knowledge about pavements being effective in tire wear & what effects does movement of tire has on the road condition & its life.

Ryosuke Matsuzaki and Akira Todoroki [2]

In this paper discusses key technologies of intelligent tires focusing on which monitor their pressure, deformation, wheel loading, friction, or tread wear, are expected to improve the reliability of tires and tire control systems. However, in installing sensors in a tire, many problems have to be considered, such as compatibility of the sensors with tire rubber, wireless transmission, and battery installations. sensors and wireless data transmission. Intelligent automobile tires.

Sung-Hyun Baek, and Jong-Wook Jang[3]

In this paper, the researchers have designed a tire surface check system with laser sensors in order to check the normal wear and abnormal wear of tires. Unlike the existing methods, this system uses laser sensors to determine current abnormal wear state objectively and also check the degree of tire wear simultaneously. Thus, the users can be provided with more accurate service than before.

3. SYSTEM DESCRIPTION

3.1. DIFFERENT TYPES OF TYRES

In this system we would be embedding colourful layers of tyre on tyres wire mesh so that the strength of the tyre is not hampered. This can be done in moulding plants & if initiated from starting it could be done in tire manufacturing industries. Only the tread of the tire will be coloured & the thickness for safe tread can be decided on each manufacturers choice but it is generally 3mm for 8mm tread. This would turn out to be revolution in tire manufacturing if this system is implemented.

Some important points to be studied before implementing the colour coding are the properties of tyre & Type of contruction.

1) Cross ply or bias ply

Tyres where the fabric cords run from one bead to another at an angle with respect to the center line of the tyre are called cross ply or bias ply tyres.

2) Radial tyres

Radial tyres don't have belts that cross over each other like cross ply tyres do. Here, parallel plies radiate from one bead to another. They are softer and offer a more comfortable ride. As the ride is soft the sidewalls are weak and there is no directional stability, and so stiff belts of steel or fabric run around the circumference of the tyre between the plies and the tread.

a) Tube

Tube tyres have an inner tube in between the rim and the tyre. It's this tube which has the air filled in it. When the tyre is punctured, it's the tube which loses air immediately and the tyre goes flat. This tube is doughnut-shaped and made of rubber. It has a valve which protrudes through a hole in the rim. To repair a punctured tube, it has to be taken off from the tyre and rim completely. If a nail punctures the tyre tread, then the tube could have multiple punctures as the tube gets deflated and rotates within the tyre.

b) Tubeless

Tubeless tyres work by sealing the spoke well of the rim, either with a specially designed rim and spokes, or with a butyl/plastic strip. The valve is either a separate item sealed with an 'O' ring or part of the rim strip. The tyre is also air tight, this can be done either by adding rubber to the tyre material, or more commonly by coating the inside of the casing with Butyl rubber. Tubeless tyres deflate slowly rather than suffering from a blowout, which for some drivers improves the safety and reliability of the tyres.

- Marking/Ratings - Low to High profile tyres

The main thing of your concern when choosing a tire is how much grip it has to automobile and the road. High profile tires have a longer contact path between the road and your car, as with low profile tire they have a shorter contact path between the road and your car. How this does and what does this mean for you and your car you are travelling in.

"Low profile" describes an especially short sidewall height, or aspect ratio, on a tire. That's the amount of rubber between the outside edge of the wheel or rim, and the road. Shorter sidewalls provide crisper handling and positive feedback to the steering wheel, but also give a rougher ride because of less cushioning between the rim and the road, which sends each bump and road imperfection directly to the suspension. Many people also like the looks of low-profile tires.

Tyres have a code system etched into their sidewall, which allows you to understand their technical capabilities.

This code provides information on the tyre's construction (e.g. radial), its size, its load-carrying capacity and its speed rating.

For example, the code on a common fitment for Indian cars is: 205/65R15 95H.



Fig - 1: Tyre Code

205 : indicates the nominal section width of the tyre in millimeters (205mm).

65 : indicates its aspect ratio, a comparison of the tyre's section height with its section width (65 indicates the height is 65% of its width).

R : indicates radial ply construction.

15 : indicates the nominal diameter of the wheel rim (15 inches)

95H : is a symbol indicating the maximum load capacity and speed at which the tyre can be safely operated, subject to the tyre being in sound condition, correctly fitted, and with recommended inflation pressures (95 represents a maximum load of 690kg per tyre; H represents a maximum speed of 210km/h).

size: 205/55 R 16 91 V is made up of the following information:

Width:- The width is measured in millimeters, and is measured from end to end of the tyre including the sidewall but excluding any raised lettering or rim protectors. In the size written above and the image the 205 represents the width.

Height / profile:- The aspect ratio is the height of the tyre, in this case the height is 112.75mm so those of you that are good with your maths will know that 55 % of 205 is 112.75mm. Another way to understand this is that the profile / height is basically a percentage of the width of the tyre.

Rim diameter:-The words say it all how wide your rims are is basically the rim size in this case its 16 inch

Load rating:- This is where most people get confused, but help is at hand. The load index is a numerical code that represents the maximum load a tyre can carry. In this scenario the load rating is 91 which mean this it has a carrying capacity of 615kg. All tyres do not carry the same load rating so for more information on please visit our load rating section.

Speed rating:-The speed rating of the tyre determines how fast the tyre can travel, in the above example the speed rating is V this means the speed limit is 149mph. In this example the R donates the radial size and is not a speed rating indicator.

3.2. Materials used for Manufacturing & it's properties.

Pneumatic tires are manufactured in about 450 tire factories around the world. Tire production starts with bulk raw materials such as rubber (60% -70% synthetic) carbon black, and chemicals and produces numerous specialized components that are assembled cured. Many kinds of rubber are used, the most common being styrene butadiene copolymer.

The materials of modern pneumatic tires can be divided into two groups, the cord that make up the ply and the elastomer which encases them.

Cords

The cords, which form the ply and bead and provide the tensile strength necessary to contain the inflation pressure, can be composed of steel, natural fibers such as cotton or silk, or synthetic fibers such as nylon or kelvar.

Elastomer

The elastomer which forms the tread and encases the cords to protect them from abrasion and hold them in place, is a key component of pneumatic tire design. It can be composed of various composites of rubber material – the most common being styrene butadiene copolymer – with other chemical compound such as silica and carbon black.

With over 1 billion tires manufactured worldwide annually, the tire industry is the major consumer of natural rubber. Tire factories start with bulk raw materials such as synthetic rubber (60% -70% of total rubber in the tire industry) carbon black, and chemicals and produce numerous specialized components that are assembled and cured. This article describes the components assembled to make a tire, the various materials used, the manufacturing processes and machinery, and the overall business model.

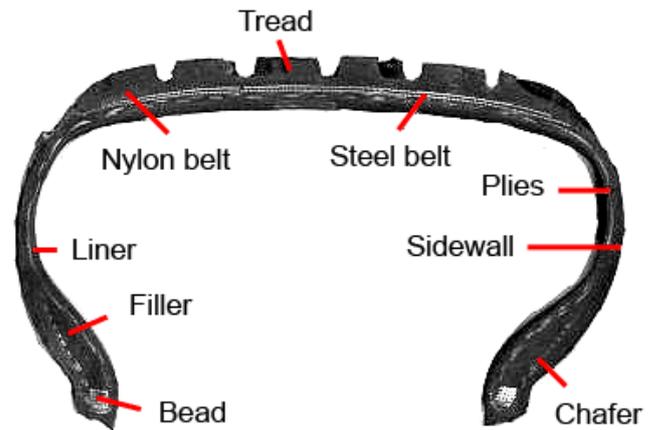


Fig- 2 : Internal structure of Tyre

The tire is an assembly of numerous components that are built up on a drum and then cured in a press under heat and pressure. Heat facilitates a polymerization reaction that crosslinks rubber monomers to create long elastic.

Materials

Natural rubber, or polyisoprene is the basic elastomer used in tyre making.

Properties of Rubber Used For Manufacturing of Tyres

The rubber materials selected by designers and technical buyers should meet all their application requirements. The inherent physical characteristics of elastomers can be modified through compounding. However, the knowledge of rubber's physical properties and their measurement is critical for compound selection.

The following are the physical properties of rubber:

Hardness

The chemical structure of the elastomers provides them with an inherent hardness that can be altered. The modified hardness is then measured in terms of of durometer (duro) on a Shore scale. Shore A is used for a soft to medium-hard rubber. Solid rubber, with a consistency of pencil erasers, has a hardness of 40 duro. By contrast, harder rubber, like that used in hockey pucks, has 90 duro hardness. Figure 1 shows rubber with different hardness.

Tensile Strength

Tensile strength is the amount of force needed to tear apart a rubber specimen until it breaks. It is also known as ultimate tensile strength, and is measured in terms of megapascals or pounds per square inch (psi) according to ASTM D412. The tensile strength is a key factor for designers and buyers as it signifies the point of failure resulting from the stretching of rubber.

Tensile Modulus

Tensile modulus is the stress or force required for producing a strain or an elongation percentage in a rubber sample. Although it sounds similar to tensile strength, the properties are different. Harder rubber usually has a higher tensile modulus, making it more resilient. It is also more resistant to extrusion, which is a process for manufacturing stock materials used in custom fabrication.

Elongation

Elongation is defined as the percentage increase, or strain, in the original length of a rubber sample with the application of a tensile force, or stress. Certain elastomers tend to stretch more compared to others. Natural rubber, for instance, can stretch up to 700% prior to reaching its ultimate elongation, which causes it to break. However, fluoro elastomers can only withstand 300% elongation.

Resilience

Resilience, also known as rebound, is the ability of rubber to return to its original size and shape following a temporary deformation, such as contact with a metal surface. Resilience is critical in dynamic seals that serve as a barrier between stationary and moving surfaces. It is necessary to take into account resilience for applications that require weather stripping between a door frame and a door.

Compression Set

Compression set is the extent to which an elastomer fails to return to its original thickness upon releasing a compressive load. Repeated compression of a rubber seal over time results in progressive stress relaxation. Compression set is the end result of a continuous decline in sealing force. Figure 2 shows the schematic of compression set.

Tear Resistance

Tear resistance is the resistance of an elastomer to the development of a cut or nick when tension is applied. This property, also called tear strength, is measured in kilonewtons per meter (kN/m) or pound force per inch (lbf/in). It has to be considered when selecting a compound for edge trim that will be in contact with sharp objects or rough metal edges.

Abrasion Resistance

Abrasion resistance is the resistance of rubber to abrasion by scraping or rubbing. Abrasion-resistant rubber is used in industrial applications including conveyor belts that move coal, and pumps that handle slurries. The measurement of material loss due to abrasion is carried out according to tests such as ASTM D394.

Specific Gravity

Specific gravity is the ratio of a material's weight to the weight of an equal volume of water at a particular temperature. This property enables the chemists to identify compounds. It is important for part designers and technical buyers to be aware that rubber with a low specific gravity provides more square inches per pound of stock. By contrast, those with a higher specific gravity have advantages in molding consistency.

3.3.Tread & Working Conditions

Tread depth is a vertical measurement between the top of the tread rubber to the bottom of the tyre's deepest grooves. A new car tyre begins life with approximately 8mm of tread. The minimum legal tread depth is 1.6mm, however most motoring organisations recommend changing at 2mm and the majority of tyre manufacturers recommend changing at 3mm.

As the tread depth reduces, the tyre's ability to remove water from the road surface reduces, increasing the risk of aquaplaning because the tyre is unable to transmit traction and braking forces to the road as effectively. Therefore the vehicle's stopping distance increases.

In the United States, tread depth is measured in 32nds of an inch. Because it is difficult to accurately measure tread depth with a ruler, tread depth is best measured with a tire tread depth gauge. When tires have neared the end of their life, a U.S. Lincoln penny can also be used to confirm the tire's tread depth. If Lincoln's entire head is visible, the tire is worn to approximately 2/32" and is considered legally worn out in most States.

Average new tires used on cars typically start with 10/32" to 11/32" of original tread depth. Dedicated winter / snow tires and light truck tires typically are deeper (for light truck tires, how much deeper depends on the tire's tread type, Highway Rib, Highway All-Season, Off-Road All-Terrain or Off-Road Maximum Traction).

As mentioned above, tires are legally "worn out" in most States when they reach 2/32" of remaining tread depth. For example, a typical tire that starts with 10/32" of original tread depth has only 8/32" of useable tread depth. Its useable tread depth is calculated by subtracting a worn out tire's 2/32" from the new tire's original depth of 10/32". The final 2/32" of a tire's tread depth isn't part of the equation when it comes to calculating tread depth percentages because the tire is already legally worn out with just 2/32" of remaining tread depth.

Useable tread depth is calculated by subtracting 2/32" from the tires' new tread depth. Then usable tread depth is compared to remaining tread depth in order to calculate tread wear percentages. For example, a tire that started with

10/32" of original tread depth and has worn off 4/32" (down to 6/32" of remaining tread depth) is 50% worn.

3.4 Factors Affecting tyre performance

[1] Inflation

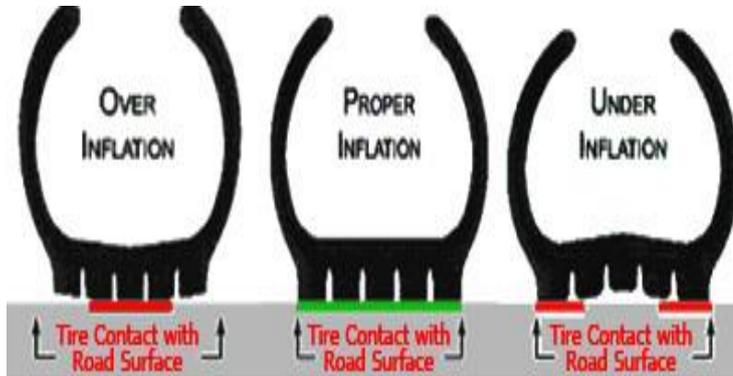


Fig -3 : Effect of inflation on tyre performance

The science and the technology that has gone into producing even the best quality of tyre will go waste if the tyres are not inflated to the recommended pressure – Pressure commensuration to the load carried. The best performance of tyres can only be achieved when the tyre is inflated to the designated pressure based on the load per tyre.

“Under inflation” or “Over inflation” on the tyre tend to impact tyre life, vehicle handling and safety. There are two factors with weight distribution of the vehicle. One is contact patch and other linked to the tyre wear. This result in heat buildup/tyre temperature and thus loss of tyre life, premature tyre removals, increased rolling resistance and fuel consumption.

“Under Inflation” is more common than Over inflation. Tyre users are not always conscious about maintaining or matching tyre pressure to the loads carried.

In pneumatic tyre the “Air carries the load”. The best tyre performance and lower tyre CPKM are obtained by maintaining correct tyre inflation pressure.

[2] Loads and Loading practices

It is important to remember that even one trip of the truck, with improper load distribution may cause irreversible damage to the tyres.

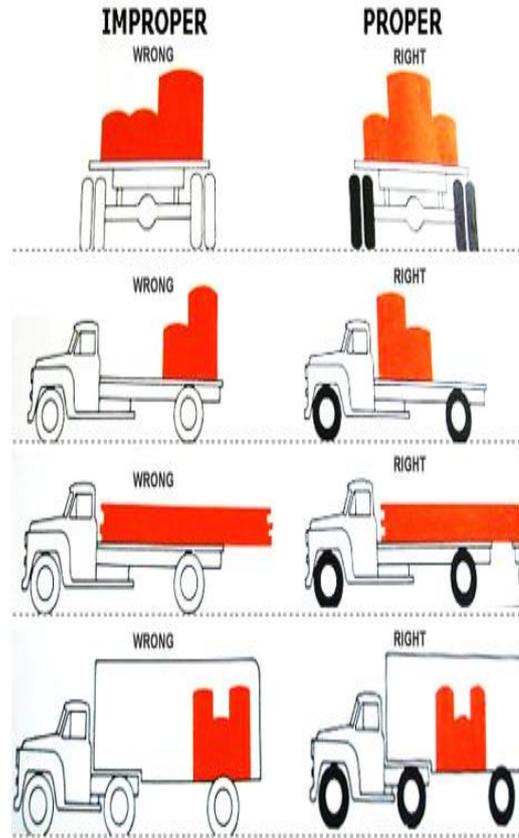


Fig-4 : Loading Diagram

[3] Speed

Excessive high speeds results in increased tyre running temperature. As the rubber gets heated up its modulus (stiffness) gets reduced. Rubber being a good nonconductor of heat the residual heat is retained causing increased tyre wear and separation of components.

[4] Wheel Alignment

A vehicle is said to be properly align when all the steering and suspension components and set as per the vehicle manufacturer and when the tyre wheel assembly are running straight and true. Proper alignment is necessary for perfect vehicle control, uniform and even tyre wear and safety. Recommended to get the vehicle alignment checked and corrected as per vehicle owner’s manual as soon as tyre are wearing unevenly or ride handling problems(vibrations, pulling to one side etc).

[5] Wheel Balancing

A wheel which is not properly balanced may setup vibrations which can affect steering control. Wheels, tyres and tubes are usually checked for balance before leaving factory. This balance is achieved by positioning weights on the wheel to counterbalance heavy spots on the tyre wheel assembly. Properly balanced tyres are important for driving comfort and long tyre life.

Tyres should be balanced when they are mounted on the wheels for the first time or when they are removed for repair or periodically as per vehicle manufacturer's recommendations.

[6] Road Conditions

Vehicle /tyre operating conditions which significantly influence tyre life both in terms of new tyre life and structural durability.

- Rough/abrasive road surface
- Paved road
- Straight road
- Broken up roads
- Hilly windings roads
- Unmade country roads
- Driving habits

Careful driving habits will ensure optimum tyre life, unavoidable damages besides avoiding serious road accidents.

[7] Seasonal Effects

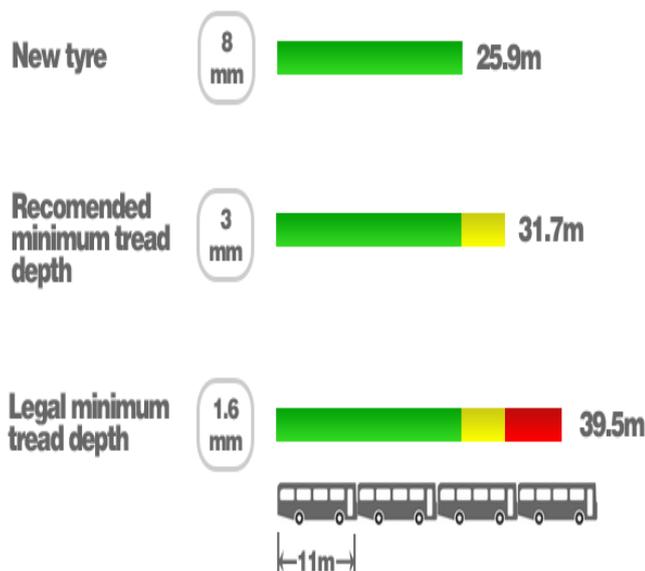
Climatic and whether conditions in our country varies widely from region to region. Dry and extremely hot during summer, extreme cold during winter and rains during monsoon. This variation in climatic conditions influence tyre life in terms of mileage and structural durability.

[8] Breaking Distance

The breaking distance diagram is shown below.

Fig

Braking Distance Diagram



4. CAD MODEL



Fig 5 : Normal view of Tyre

This is the Normal view of the tyre we use, & now the following images will show how using colour coding it will be easy for us to detect the tyre wear.

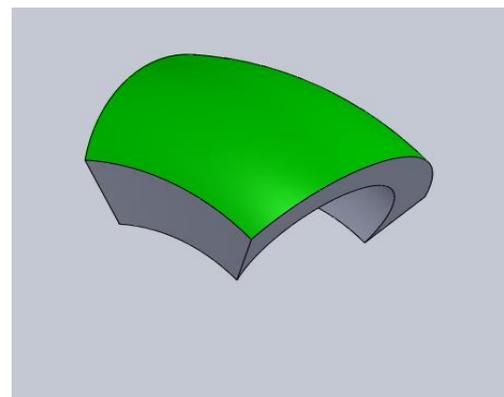


Fig 6 : Green Colour layer

The Tread depth of the given figure is 8mm as it is in normal tyres.

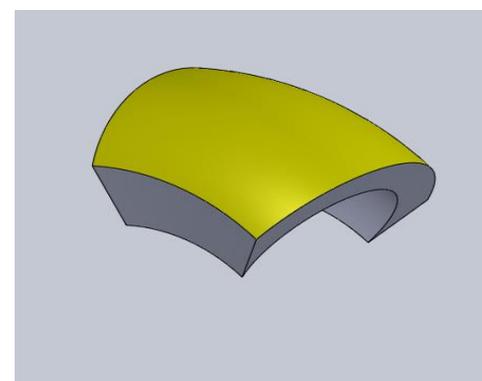
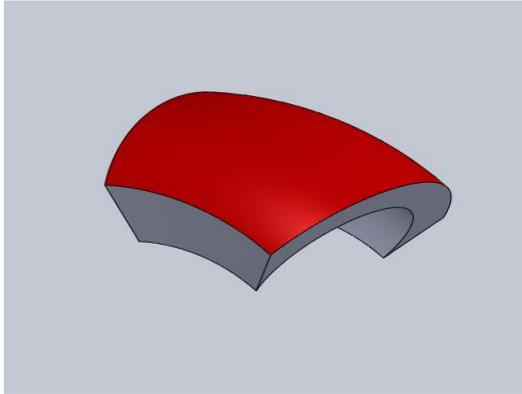


Fig 7 : Yellow Coloured Layer

This is the view of tyre when it has gone through moderate wear. This colour indication will be shown after wear of 5mm till 2mm.



[4] Mechanical Properties of Industrial Tyre Rubber Compounds

Fig 8 : Red Coloured layer indicating tire change

This is the view of tire when its should be changed as 2mm depth of tread is not safe to use the tire. But the final call of changing tire or not will be taken by the user.

5. ADVANTAGES

- 1.Less system cost.
- 2.No need for maintenance.
- 3.Ease for visual inspection in tyre wear .
- 4.Safety Assurance.

6. APPLICATIONS

- 1.This is not the separate system we have to implement in the vehicle body. We have to just insert the color coding while manufacturing the tire.
2. So we can use this concept in tire of any kind of vehicle.

7. CONCLUSION

- ▶ The system eliminates the hazards caused due to unchanged tyres & reduces the % of accidents due caused due to worn out tyres.
- ▶ The system is cost effective, reduces work force for human workers, reduces time consumption.

8. REFERENCES:

- [1]Tire and pavement wear interaction monitoring for road performance indicators, Kati Kõrbe Kaarea, Kristjan Kuhib and Ott Koppela, Estonian Journal of Engineering, 2012
- [2]Wireless Monitoring of Automobile Tires for Intelligent Tires,Ryosuke Matsuzaki ,and Akira Todoroki, Sensors 2008
- [3]Design of Tire Surface Check System with the Laser Sensor Sung-Hyun Baek, and Jong-Wook Jang, International Journal of Control