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Suspension Geometry Measuring

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Abstract. This paper describes the instrumentation and analysis of the Vehicle suspension's electrical signals. It will measure the Vehicle suspensions' Vertical Displacement, Track Change, Camber Angle, Caster Angle Steer Angle and convert physical quantity into electrical signals in a various vehicle load change. With using electrical signals for computer control, the electrical controlled vehicle has brought great convenience, great safety and thoughtful kindness vehicle system in our daily life. It will measure the Vehicle suspensions' Vertical Displacement, Track Change, Camber Angle, Caster Angle Steer Angle and convert physical quantity into electrical signals in a various vehicle load change. The function of a suspension system in an automobile is to improve ride comfort and stability. Advances in electronic control technology, applied to the automobile, can improve those functions. The results show that the photocell can convert the electrical signals of suspension for peripheral communications link between the vehicle driving and the electronic control unit (ECU) employed for processing**.**

1. Introduction

Double-wishbone and Macpherson suspension are used widely [1,2,3]. However computer control in active suspension is less seen due to signals convert from suspensions' geometry changed is difficult. With photocell used, the measuring of two suspensions' Vertical Displacement, Track Change, Camber Angle, Caster Angle and produce electrical signals in a various vehicle load change can be used in real time such as active suspension control and steering control in real time [4,5]. Photocell (semiconductor) will be used to produce electrical signals in a various vehicle load change. After absorbing light, it will produce the different photo-voltage due to the energy represented by the absorbed photons is converted into heat within the semiconductor. These hole-electron pairs will recombine in a time dictated by the bulk lifetime and surface recombination velocity of the semiconductor. If a local electric field is present within the semiconductor it can be used to separate the constituent parts (holes and electrons) of the hole-electron pairs. Once separated, the collected charge carriers (holes and electrons) produce a space charge that results in a voltage across the semiconductor. Photocells made from amorphous materials are less expensive to construct per unit area than single crystal photocells. It will follow the Cosine Law ($V(\psi) = V(vertical) * \cos\psi$) to produce the various volts in various position [6,7,8].

2. Theory and Experimental Design

Two designed tester rigs are used including Double-wishbone and Macpherson suspension. The test bench consists of one hydraulic actuator for vertical force generation to be the vehicle load changed [3,4]. The caster/camber gauge was attached the wheel hub for the neutral position of the suspension adjusting. The photocells are attached on wheel center cap to received designed lightness at the constant distance light source to produce the various angles with various volts. As a light beam travels outward from most light sources, the beam spreads to cover a larger area. Distance greatly weakens illumination from such source. The same amount of light will cover a larger area if the surface it reaches is moved farther away. It follows the inverse-square law. If the distance from the source is doubled, the amount of light falling on a given area is reduced to one fourth (the inverse of two squared). As can be seen in figure 1, at the constant distance to measure angle change with various volts, it will follow the Cosine Law ($V(\psi) = V(\text{vertical}) * \cos\psi$) to produce the various volts in various position. With two photocells to measure, one photocell (photocell A) was attached on the wheel hubs for measuring angle. The measuring surface of photocell (A) faced forward to the light. Another (photocell B) was attached beside for the reference of the light which was from ambient surroundings. The volts of photocell (A) were deducted from the volts of photocell (B) to obtain the real angle change. To measure the volts of angle changing, a piece of metal (length about 65 cm) was set vertically to hub surface. The light was tied at the metal vertically to the measuring photocell [7]. The light was following the wheel hub to change the steering angle, caster angle and vertical distance. As the camber angle changing, with it gravity weight to keep the distance (between light and photocell) was vertical. Then the real voltage of camber angle change can be figured out. We used the same method to measure the voltage of caster angle change.

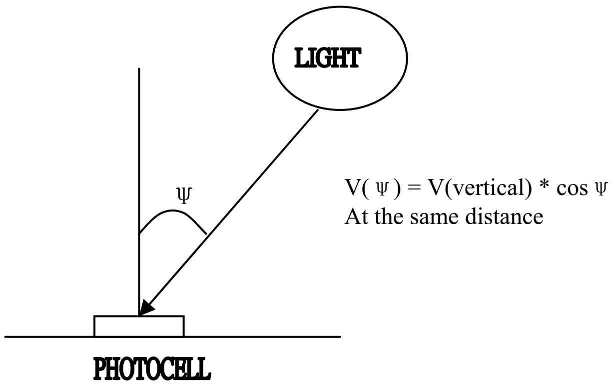

Figure 1. Measurement of photocell with various angle light project.

3. Results & Discussion

The figure 2 shows that the volts convert from Double-wishbone of camber angle change is relative Cosine Law to produce the various volts in various load changed. At the constant distance to measure angle changed with various volts, it produces the maximum voltage in vertical position and light reach the photocell in shortest distance. So as the "0 degrees of camber", producing the maximum volts is 0.067 and as showing in figure 3 the "0" degrees of caster", the maximum volts is 0.102. The same as can be seen from figure 4 and figure 5, the volts of camber angle change, at the "0 degrees of camber", producing the maximum volts is 0.062 and volts of caster angle change the maximum volts is 0.098. The parameters should take bump movement up and down in company with camber/caster angle to verify voltage changed. Those can be record as data source, as vehicle driving then electrical signal from suspension can compare and control to improve ride comfort and stability. The results show the relation of linear between volts and angle changed providing good basic for computer used.

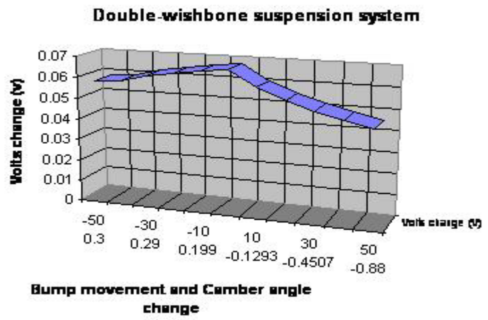

Figure 2. Double-wishbone volts with bump movement and camber angle changed.

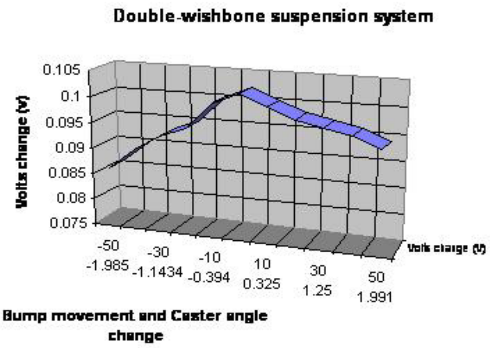

Figure 3. Double-wishbone volts with bump movement and caster angle changed.

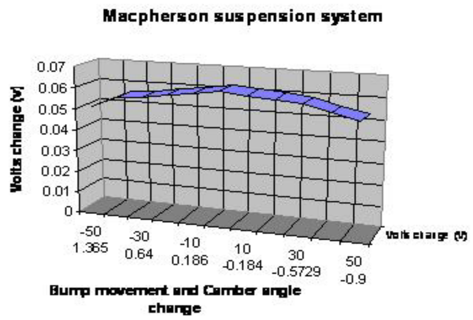

Figure 4. Macpherson volts with bump movement and camber angle changed.

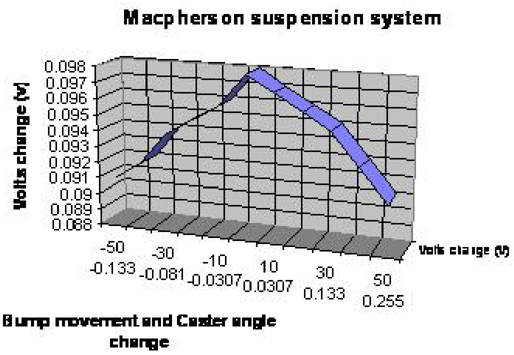

Figure 5. Macpherson volts with bump movement and caster angle changed.

4. Conclusion

The function of a suspension system in an automobile is to improve ride comfort and stability. An important consideration in suspension design is how to obtain both improved ride comfort and stability, since they are normally in conflict and getting geometry measuring signal in real time is difficult.

Advances in electronic control technology, applied to the automobile, can solve this conflict. Using photocell to measure vehicle suspension wheel angle, it is a new idea to convert the optical information with angle changes. It is a delight in the area of vehicle sensor development. The results show the relation between load changed and electrical signal is near linear. It provides good basic for electronic control unit to control ride comfort and stability in real time.

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