Introduction of the Tire Pressure Detection/Adjustment System

Shu-Lung Wang、Win-Xian Liao*、Szu-Cheng Peng

Department of Mechanical Engineering Nanya Institute Technology,

Chung- Li, Taiwan 320, R.O.C

Abstract

In modern vehicles, mechatronic systems are increasingly used. To improve reliability, safety and economy, an early recognition of tire pressure detection is becoming increasingly important. In this paper, we describe the tire pressure detection/adjustment system that we designed is able to solve the problem which current single monitoring mode fails to deal with the actual control of the pressure. The design of this system will provide four modes accordingly: 1.the senor and adjustment of vehicle loading capacity (to coordinate with restarting after a stop or midway change of loading); 2.Low-speed (normal) running; 3.Bumpy road running; 4.High-speed running. When the vehicle is running, ECU will decide on the above modes and make an adjustment on the tire pressure for maximum safety.

Keywords：Tire pressure detection system；ECU microcomputer control

行車胎壓調整控制系統簡介

王士榮、廖文賢、彭思程

南亞技術學院 機械工程系

摘要

車用電子系統運用在現代汽車中越來越多，為促進可靠性、安全和經濟，早期胎壓檢測系統已逐漸變得更為重要。本研究之行車胎壓調整控制系統，是目前可有效解決單一行車胎壓監測模式中無法實際控制輪胎壓力之缺點。此系統具有以下四種設計模式:1.車輛負載時之感應調整(包含停止再起動或中途負載增減配合) 2.低速(正常)中行駛 3.顛簸路面上行駛 4.行車中以高速行駛而運用ECU判斷上述模式，且即時調整以最安全的胎壓使用。

關鍵詞：胎壓偵測系統；ECU微電腦控制

*Email：wzl@nanya.edu.tw； Fax:03-436-5226 ；Tel：03-4361070 ext 5121

1. Introduction

Since the development of automobile industry for hundred years ago, we have witnessed the continuous improvements on its science and technology. These great developments include the comfort, manipulation, humanization, intellectualization, and computerization. The large variety of basic and optional equipments for automobile is even a feast for the eyes. However, safety-related inventions and equipments seem not sufficient. In view of this, we have devoted to a design that enhances safety in vehicles. At present, the monitoring of tire pressure is an important concern of the automobile industry. More and more vehicle manufacturers had included the tire pressure real time monitoring system as one of the basic equipments. The US government has even passed the law. This explains the importance of tire pressure monitoring. The system that we designed aims at this matter. The 2000 TREAD Act which requires automakers to gradually provide tire pressure monitoring systems for vehicles sold in the US will correct this problem for new vehicles[1]. The TREAD Act will also reduce energy use because it demands that manufactures install a tire pressure monitoring system (TPMS) in the future automobiles[2].The German Umweltbundesamt reports a 30% reduction in a tire's rolling resistance can reduce a vehicles fuel consumption from 2% to 6%, depending on driving conditions and other factors (Friedrich, 2002) [3].The National Center for Statistics and Analysis of the USA (NCSA) have conducted a comprehensive tire survey in February 2001 (Department of Transportation, Docket no. NHTSA2000-8572).The total of 11,530 vehicles have been inspected at gas stations selected randomly throughout the USA. The survey indicated that 30% of the drivers of passenger cars check the pressure in tires at least once a month, but about 7% do not check the pressure at all[4]. Under accelerating conditions, the tire/road noise represents the largest percentage of noise, after engine noise. Consequently, reduction of the tire/road noise is very important issue [5].Both the under-inflation and over-inflation of tires will affect car safety. The existing tire pressure monitoring systems provided by vehicle manufacturers have a data discriminating function only. Though they help drivers understand the real time tire pressure data, they are not able to change the actual tire pressure instantly. In case of massive leakage of tire pressure when the vehicle is running with a high speed, or in case of under-inflation of tires

which requires a pit stop during a long car journey, those systems will leave drivers in a helpless situation.

The Tire Pressure Adjustment System that we designed is able to solve the problem which current single monitoring mode fails to deal with the actual control of the pressure. The instant control of tire pressure is no doubt important, but it is also important to note that different running speeds, different road conditions and even different loading capacities (men, goods) require different tire pressures. Therefore, the design of this system will provide four modes accordingly:

（a）The senor and adjustment of vehicle loading capacity (to coordinate with restarting after a stop or midway change of loading);（b）Low-speed (normal) running;（c）Bumpy road running;（d） High-speed running.

When the vehicle is running, ECU will decide on the above modes and make an adjustment on the tire pressure for maximum safety. This case focuses on designing a full automatic system that has not only the monitoring function, but also the capability of adjustment control without additional power supply. It converts the existing kinetic energy and work together with ECU and other parts, accessories and the operation of a screw compressor to deal with various road conditions and contingencies so that safety, convenience, energy saving and driving comfort can be achieved.

This system presses signal of transmission the induction by the microwave technology and the RFID technology as the embryo Presses the driving in embryo the data to inform immediately ECU Again pressurizes after the ECU distinction, the decompression, accumulation of pressure of organization and the barometric pressure part the constant voltage three kind of controls condition actuation design (solenoid valve and so on..) Beautiful t gathers Achieved its system does moves the goal to achieve in the driving the entire automatic monitor and the control.

Tire pressure increasing and decreasing can reach the suitable tire pressure for driving. It also can detect the load on the vehicle and make necessary tire pressure adjustment automatically, For driving on the rocky road, the tire pressure also can be adjusted automatically to meet the safety standard(embryo presses standard value control)The basic four tires to press the standard control (to need to stop gasification).

2. Description of System Design Mechanism

（a）Construction Assembly

The drawing on the right is the assembly drawing of this design system (pneumatic components not included). At present, there are many types of transmission systems and suspension systems for vehicles on the market. Therefore, the construction of this design was also modified for the integration into different transmission systems and suspension system. Explanation on the Operation of Construction System When the vehicle is running, the turning force of the transmission shaft (Fig.2a) is utilized to drive the timing pulley (design as shown in the construction of Fig. 2b). The electromagnetic clutch (design as shown in the construction of Fig. 2b) actuates the screw compressor (Fig.2b) to compress the air and store it in the pressure accumulator (Fig.2c).The pressure limit of the accumulator must follow the control of the pneumatic device and ECU and give instructions to the electromagnetic clutch to stop the pressurization. The compressed air passes through the air outlet of the pressure accumulator and flows into the air inlet seat (Fig.2d), then into the transmission shaft (Fig.2a) and aluminum ring (Fig.2f), and finally gets into the tire for pressurization. In the meantime, the sensor inside the tire reports the pressure value to ECU. If the set point of the specific mode is satisfied, the construction will stop operation. It will restart operation when ECU determines another mode when the car is still running.

（b）The Components of Supercharger

This construction design（Fig.3） show integrates the timing pulley, timing belt, clutch, screw compressor into a single construction. Screw compressors, as shown in the diagram on the right, are common on the market. In view of this, the supercharger components of this design can be used together with a screw compressor.

（c）Air Inlet Seats

The air inlet seat, as shown（Fig.4）in the diagram on the right, is fixed on the transmission shaft. The parts with hard chrome electroplates on the two sides should match the transmission shaft. The groove in between the electroplating must also stick to the air inlet groove to form a loop for air inlet. The oil filling hole is used for lubricating the bearings and isolating the air, while an oil seal should be installed on the other side.

（d）Transmission Shaft

The diagram as shown（Fig.5）on the right is the display drawing of the front part of the transmission shaft. As shown in the diagram, the air inlet groove connects to the groove in between electroplates at the air inlet seat to form a loop of air inlet. Air flows into air inlet A, as shown in the below sectional view, and enters the wheel rim (aluminum ring).

PS: The connecting point for air inlet groove and air inlet seat should be on the inside of the universal joint

（e）Wheel Rim (Aluminum Ring)

In the（Fig.6）diagram, the air inlet A (in the middle of wheel ring) connects to the air outlet of the transmission shaft. The air flows from the air inlet B into the tire through the route as described in the sectional view.

3. Explanation of System Computer Mode

The design of this system will provide four modes （Fig.7）show accordingly:

（a）Normal Mode.

This mode emphasizes on examining the tire pressure instantly upon the start of the vehicle. Due to different loadings (the amount of passengers, goods or luggage etc), the weight of the vehicle changes and adjustments to the tire pressure must be made. Normally, for a 2000cc medium sized car with 195/60-15 tires, a tire pressure of 2.2-2.4 (kg/cm^2) for both the front and back wheels should be fine. But for cars that often carry many passengers or goods, the required pressure should be 0.1-0.2 above the normal value. Therefore, this mode can react to the above situations and make an adjustment according to the set standard values. The adjustment is completed once the vehicle is running. The tire pressure measured on this mode after the adjustment will become the new memorized value. The other three modes will make judgments based on this memorized value until a new memory is generated by a change of loading. In such case it will abandon the old memory and use the new memory.

（b）Low-Speed Mode

The set speed of this mode is 0~80(km/h). When the speed is between 0 and 80, the

tire pressure is the memorized value as examined by Mode 1 (Normal Mode). This tire pressure is also the safest value according to the current condition. If the condition does not satisfy the requirements for High-Speed Mode or Bumpy Mode, the tire pressure of this mode will be maintained.

（c）Bumpy Mode

If the vehicle is running on a bumpy road with a speed within the range of the Low-Speed Mode, the sensor will transmit the message to ECU. Meanwhile, the tire pressure will be adjusted accordingly. When the vehicle has passed the bumpy road, the tire pressure will resume to that of the Low-Speed Mode. Normally speaking (excluding other factors), when the normal tire pressure is 28~30（psi）, 30psi will be generally used. In a poor road condition where the traction of the road surface is not good, the tire pressure will be adjusted to 28psi to give a better traction, in order to extend tire life and maintain road safety. When the irregular area of thrust surface enlarges so to have the reduced pressure to whip safe (pressure of this pressure and the low speed travel not equally coordinates empirical datum standard value) (below hypothesis speed 40km and bumper sub to induce time frequency value enhancement)

（d）High-Speed Mode

The set speed for this mode is 80 km/h and above. When the driving speed exceeds 80km/h, it satisfies the condition for the High-Speed mode and the tire pressure will be adjusted instantly. Normally speaking (excluding other factors), when the normal tire pressure is 28~30（psi）, 30 psi will be generally used. In case of running on a super highway, the tire pressure can be adjusted to 32 pounds to avoid refraction of tire walls that may cause tire puncture. However, to avoid the adverse effect, the tires should not be over-inflated. We all know that the pressure inside the tires will increase when the weather becomes hot. So, the weather factor is also considered in the ECU judgment. In the extremely hot summertime, the tire pressure should also be increased appropriately in order to help the tires cool down. Due to global warming, (the extremely hot summer or high speed travel to pressurize in order to radiate, it will be gradually the few tires and the ground contact are become a major concern in the future.)

4. Conclusions

（a）If the tire pressure is insufficient, do not drive the vehicle or leave the vehicle in parking for a long period. The problem should be dealt with immediately because this will cause damage and deformation to the tire walls and tire surface. Above all, such damage and deformation are sometimes not easy to be observed by naked eyes, but these will create a serious crisis to road safety potentially. Even more, if the problems happen to one of the tires or one side of the vehicle, the balance of manipulation will be lost. Even if a slight insufficiency of tire pressure can at least cause an increase of abrasion to the tires. This design system will solve the above problem.

（b）An over-inflation of tires will decrease the ground contact area and cause rough performance, tire deformation and difficult tire tracking. Furthermore, the abrasion at the center of the tire will be larger than that at the two sides, which is an abnormal condition. Therefore, frequent inspection of tires should be carried out even if the car runs on ordinary roads. This design system will solve the above problem.

（c）An under-inflation of tires will cause make turning difficulty, meaning that the steering wheel will become very heavy. The engine requires more power to drive the tires. Therefore, insufficient tire pressure will cause fuel consumption because the ground contact area for the tires becomes larger. In addition, insufficient tire pressure will accelerate the aging of tires. When the tire pressure is insufficient, the two sides of the tire surface will be worn. This will create a potential danger as the tires could be punctured when the vehicle is running with a high speed. For these reasons, a proper maintenance on tire pressure ensures road safety. This design system will solve the above problem.

5. References

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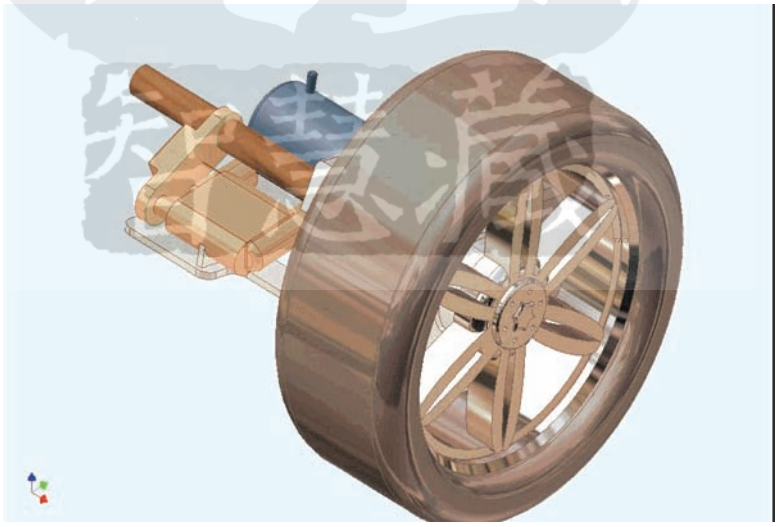

Fig.1 Assembly of design system diagram

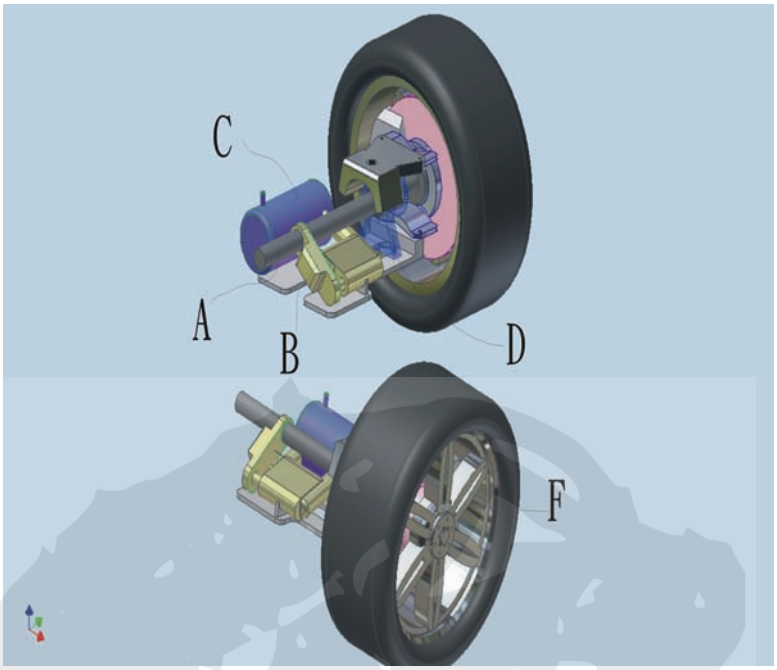

Fig.2 Construction assembly diagram

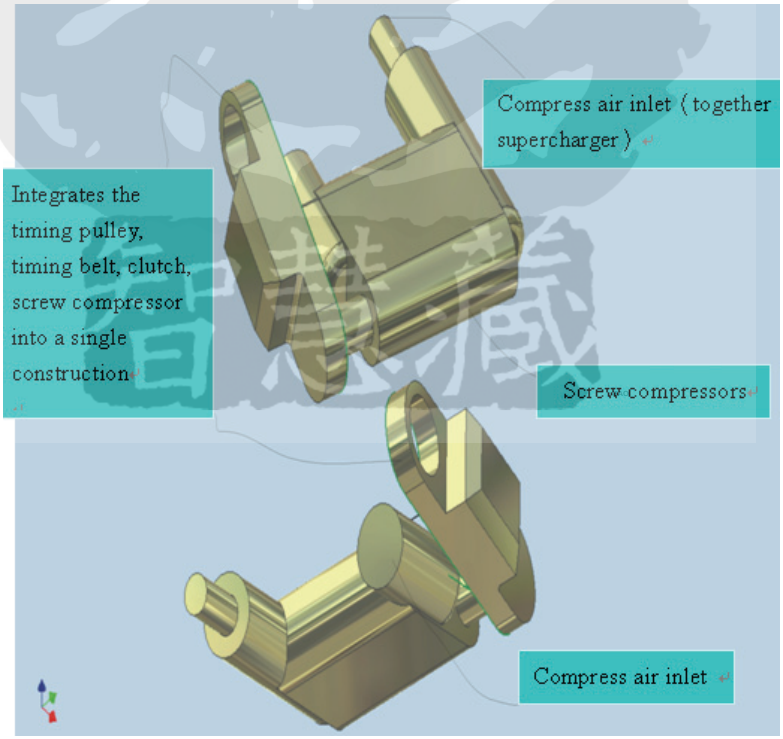

Fig.3 The Components of supercharger diagram

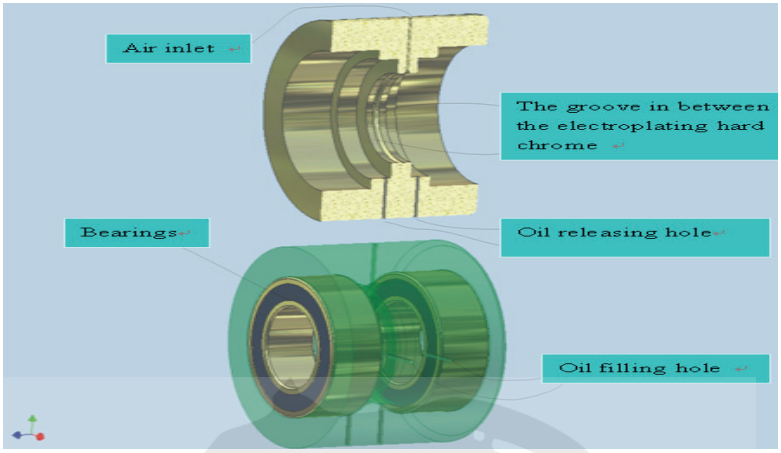

Fig.4 Air inlet seats diagram

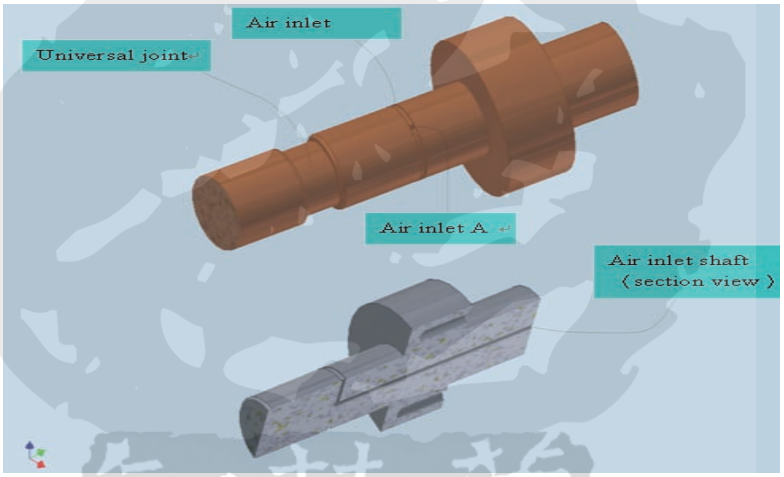

Fig.5 Part of the transmission shaft diagram

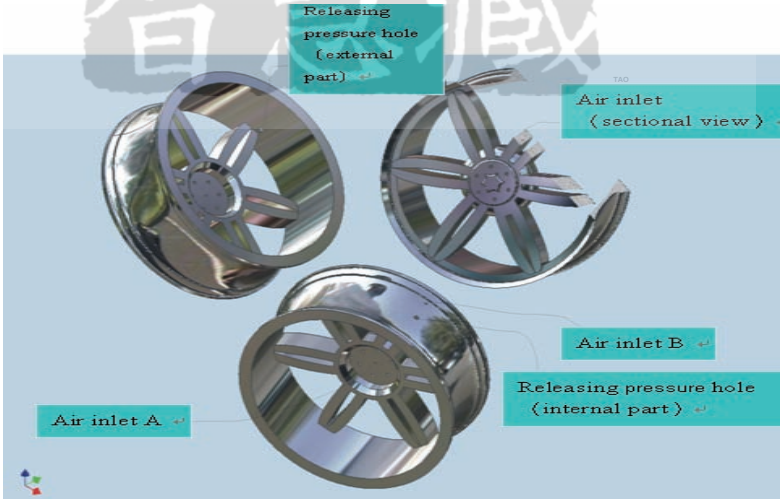

Fig.6 Wheel rim（the air inlet diagram）

The core of this system is an ECU microcomputer control. It monitors the digital signals from various sensors. After synchronous high-speed logic computing by ECU, the correct executing instructions such as the operation of supercharger, the operation of clutch, the setting of tire pressure and the pneumatic device are given to various executing components through synchronous high-speed delivery.

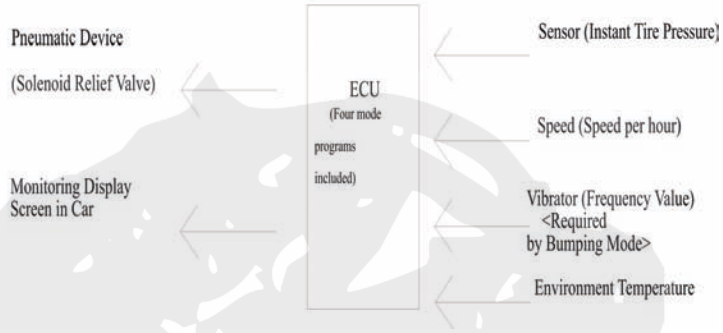

Fig.7 Explanation of system computer mode