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A Neural Network theory based expert system – ICRT

Shieh-Shing Lin [a,*], Shih-Cheng Horng [b], Ch'i-Hsin Lin [c]

[a] Department of Electrical Engineering, St. John's University, 499, Sec. 4 Tam King Road, Tamsui, Taipei 25135, Taiwan
[b] Department of Computer Science and Information Engineering, Chaoyang University of Technology, Taichung, Taiwan
[c] Department of Electronics Engineering, Kao Yuan University, Kaoshiung, Taiwan

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ABSTRACT

In this paper, we focus on the frequent glitches of general family cars. Based on the Neural Network theory and combining with the Micro-chip processor technology, we design an expert system-"Integrated Cars Repairing Tools" (*ICRT*) and the size of the proposed *ICRT* is quite small and achieves the following attractive functions: (1) Portable Electric-jack, (2) Electric Tire-pressure-meter, (3) efficiently Pneumatic tire machine, (4) LCD type Sparing Battery, (5) trouble blinking sign and lighting device. Compare to the traditional single function tools – "Hand Jack", "Mechanic tire-pressure-meter", "Pressure-stat pneumatic tire machine", and "Hand-held glitch indicator", the proposed innovative expert system – *ICRT* has the following special features: the Portable Electric-jack can easily and rapidly lift cars, the Electric Tire-pressure-meter works precisely, the efficiently pneumatic tire machine works rapidly, the LCD type Sparing Battery with the capability to show the residual capacity of Power and can be used to start cars easily. We install the proposed *ICRT* in several different types of cars and make numerous simulations, the test results show that the *ICRT* is efficient for rejecting the frequent glitches of cars.

1. Introduction

Cars are one of the most important traffic tools for people in the real world. In this paper, we focus on the frequent glitches of the general cars; such as, the drivers cannot start cars or the pressure of the Tire is inefficiency for driving; in general, in the first case, probably, the Battery box of the car is leaking or out of order, the second, the Tire of the car is already broken or not working for a few days ago or yesterday. There could be the worse case happen about while the Tire of the car is broken during the driving. In general, while the Tire broken accident occurred, the drivers will call the Car Rescuing Center for help or use the Sparing Tire in car to replace the broken Tire by himself, since, almost it is true that there is a "Hand Jack" in every car. However, if the accident is occurred in midnight, sometimes it is hard to call some one to help the drivers, moreover, if the pressure of the Sparing Tire is inefficient for driving since it have been long time no used stayed in car, then it should have some more necessary device (such as the Pressure-stat output pneumatic tire machine) to inject the air and stabilize the pressure of the Tire. In addition, there still have many glitches of the family cars always trouble the drivers, such as; the car cannot be started in the morning (probably, the Battery box of the car is leaking or out of order); the pressure of the Tire is inefficient for driving, . . ., etc. Therefore, it is necessary for drivers to have *more than one or many* scatter car repairing devices in cars (such as, the Power bank, the Pneumatic tire machine, the "Hand Jack", . . ., etc.) to handle the unexpected accidents occurred during the driving. These devices always occupy some accommodations and are dispersed in the cars. Furthermore, the more unexpected things to bother the drivers are that the Tire is leaking air or broken while encountered some stringer stone during the driving, especially, for the female driver. About the research of the car repairing equipments for solving the problem of the inefficiency of the pressure of the Tire, the traditional device-the Pressure-stat output pneumatic tire machine is used to inject the air into the Tire with slowly speed. And most of the traditional devices cannot show the actual pressure values of the Tire during the operation.

Several papers that are concerned with the single function tools corresponding to the car repairing device, such as, the Tire-pressure-meter function tools have been published (Grossmann, 1999; Kowalewski, 2004; Li, Wang, Qunzhi, & Shan, 2003; Nabipoor & Majlis, 2004; Pohl, Ostermayer, Reindl, & Seifert, 1997), the Jack function tools (Azad, Khajepour, & McPhee, 2005; Chapman, 2005; Harter, 2000; Mihali & Sobh, 1999; Wallis, Ronnquist, Jarvis, & Lucas, 2002; Yamada & Suzuki, 1990), the Lighting function tools (Kornev, Kuchma, Pokrovski, & Soms, 2005; Lie, Yu, et al., 2000; Liu, 2005), the Pneumatic-tire-machine function tools (Dai-Dai; Audi-Tai; An-Hun), and the Power bank and Battery charging function tools (Chen & Lin, 1997; Li & Liu, 2001; Liu, 2001; Yeh, 1997). However, there are few documents

* Corresponding author. Tel.: +886 2 28013131x6500; fax: +886 2 28013973.
E-mail addresses: sslin@mail.sju.edu.tw (S.-S. Lin), schong.ece90g@nctu.edu.tw (S.-C. Horng), chsinlin@cc.kyu.edu.tw (C.-H. Lin).

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and/or devices related to *how to* improve the performance of the existed single function cars repairing tools and integrate many of these scatter functions tools into a compacted expert system. About the research of the equipments of Jack device for lifting cars to replace the Tire, the traditional device – "Hand Jack" is used to lift cars for changing the broken Tire; however, it is not so easy to operate, especially, for the female drivers in the dark night. In the traditional car caring center, the oil-type Jack or the electrician lifting machine (Azad et al., 2005; Chapman, 2005; Harter, 2000; Mihali & Sobh, 1999; Wallis et al., 2002; Yamada & Suzuki, 1990) are used and can easily lift cars for cars maintains. However, these devices cannot be carried in cars, since it is too much room consuming and very heavy. Nowadays, since the applications of the Neural Network Theory technologies have become more mature as well as the Micro-chip processor, the integration management and control technology for the scatter repairing tools of cars seems to be a trend in the car repairing industrials.

The object of this paper is based on the corresponding theory of Neural Network and combining with the Micro-chip processor technology (Carstens, 1993; Comer & Comer, 2003; Laker & Sansen, 1994; MacKenzie, 1999) to design an innovative expert system – *ICRT*. The major contribution of this expert system is to *improve the performance* of the existed single function of cars repairing tools and *integrate* many of these scatter cars repairing tools into a single compacted expert system – "Integrated Cars Repairing Tools" (*ICRT*). Furthermore, the *size* of the proposed innovative expert system – *ICRT* is not only quite small and portable but also easily operated and installed in cars. The innovative expert system – *ICRT* achieves the following attractive functions:

(1) Portable Electric-jack,
(2) Electric Tire-pressure-meter,
(3) Efficiently pneumatic tire machine,
(4) LCD type Sparing Battery with the capability to show the residual capacity of Power,
(5) Trouble blinking sign and Lighting device.

The paper is organized in the following manner. Section 2 presents the combining with the Micro-chip processor technology and the Neural Network theory based innovative expert system – *ICRT*. In Section 3, we present the Hardware Implementation of the *ICRT*. The simulation tests those are used to demonstrate the performance of the *ICRT* are given in Section 4. Finally, we make a brief conclusion in Section 5.

2. Neural Network theory based innovative expert system – ICRT

We uses the corresponding theory of Neural Network and combing with the Micro-chip processor technologies to improve the performance of the existed single function Cars Repairing Tools and integrate many of these scatter cars repairing tools into a single compacted expert system – *ICRT*. The functions of the proposed *ICRT* is electrical and automatically, and can achieve quite a few time and money saving for drivers encountered some unexpected problems. The function of *ICRT* includes: Portable Electric-jack, Electric Tire-pressure-meter, Efficiently pneumatic tire machine, LCD type Sparing Battery, Trouble blinking sign and Lighting device. The special features of the *ICRT* are stated in the following:

A. *Portable Electric-jack: In the Hardware Implementation of the Portable Electric-jack device of the ICRT*, the Robotics and Feedback Control Theory of Neural Network is used to lock the working current of the Servo-Motor within some certain level to maintain the altitude of the car being lifted by the Portable Electric-jack while the changing of the broken Tire. This is the famous effect called the Neural Network lock-in effect.
B. *Electric Tire-pressure-meter: The Electric Tire-pressure-meter of the ICRT* can precisely measure the pressure of the Tire and show the measured values in digitations.
C. Efficiently pneumatic tire machine: Based on the measured values by the Electric Tire-pressure-meter, the Efficiently pneumatic tire machine of the *ICRT* uses the Neural Network theory which is embedded in the Micro-chip processor to stabilize the pressure of the Tire and will be described latter.
D. LCD type Sparing Battery: The Sparing Battery of the *ICRT* uses the LCD device to show the residual capacity of Power.
E. *Trouble blinking sign and Lighting device: The Trouble blinking sign and Lighting device of the ICRT* provides the necessary lighting service for the drivers to maintain the car while the unexpected events occurred.

2.1. Neural Network theory based Tire-Pressure-Stabilizer

In the Hardware Implementation of the Efficiently pneumatic tire machine device of the *ICRT*, the Neural Network based modified Proportional-Integral-Derivative (*P.I.D.*) Theory is used to stabilize the pressure of the Tire by the Efficiently pneumatic tire machine. The Neural Network based modified *P.I.D*. Theory which is embedded in the Micro-chip processor and associated with the proposed Electric Tire-pressure-meter are used to formulate the Tire-Pressure-Stabilizer system. Block diagram of the Tire-Pressure-Stabilizer is shown in Fig. 1. In the following, we will present the Neural Network Theory based Tire-Pressure-Stabilizer to stabilize the pressure of Tire. The detailed description of the block symbols in Fig. 1 is listed below:

#1: Denotes the block diagram of the Neural Network based Tire-Pressure-Stabilizer system.
#2: Denotes the "Efficiently pneumatic tire machine".
#3: Denotes the "Electric Tire-pressure-meter".
#4: Denotes the "Feedback Buffer" which is used to calculate the steady values of the Tire pressure originated from the "Electric Tire-pressure-meter" and transform it to the "Micro-chip Processor".
#5: Denotes the "Micro-chip Processor" which is used to process the received feedback signals and create the optimal control signals.
#6: Denotes the "Motor" which is used to speed/slow the "Efficiently pneumatic tire machine".

Before introducing the complete algorithm, we need the following notations:

P_s: Denotes the pre-set standard Tire-pressure values.
P_r: Denotes the real time Tire-pressure values.
S_h, S_m, S_s: Denote the highly, medium, and steady control signals of the "Micro-chip Processor" # 5.
f_h, f_m, fs: Denote the highly, medium, and steady output signals of the 'Motor' #6.
C: Denotes the criteria of the deviation of the Tire-pressure values.
ε: Denotes a small positive real value.

2.2. Neural Network Theory based Tire-Pressure-Stabilizer algorithm

Step 0 Initial set the parameters: C, ε.
Step 1 Input the preset Tire-pressure values of P_s.

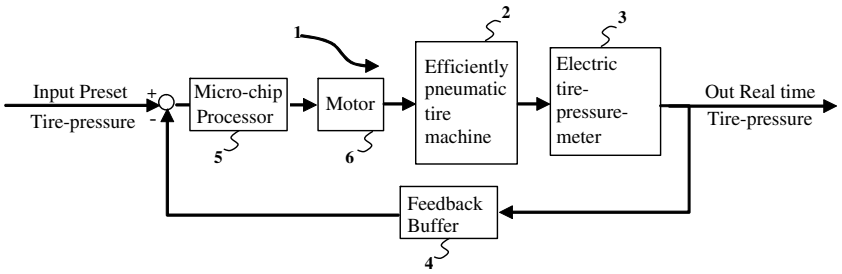

Fig. 1. Block diagram of the Neural Network theory based Tire-Pressure-Stabilizer.

Step 2 Detecting the Tire-pressure from the Electric Tire-pressure-meter, #3 and sends it to the Feedback Buffer, #4.

Step 3 Calculate the real Tire-pressure value P_r from the Feedback Buffer, #4.

Step 4 Calculate the deviation of Tire-pressure $\Delta P = |P_s - P_r|$ by the Micro-chip Processor. If $\Delta P \geqslant C$ then go to Step 5; if $\varepsilon \leqslant \Delta P < C$ then go to Step 6; if $\Delta P < C$ then go to Step 7.

Step 5 The Micro-chip Processor, #5 sends the control signal S_h to the Motor, #6, and the unit #6 process it and sends output signal f_h to drive the Pneumatic tire machine, #2 and go to Step 3.

Step 6 The Micro-chip Processor, #5 sends the control signal S_m to the Motor, #6, and the unit # 6 process it and sends the output signal f_m to drive the Pneumatic tire machine, #2 and go to Step 3.

Step 7 The Micro-chip Processor, #5 sends the control signal S_s to the Motor, #6, and the unit #6 process it and sends the output signal f_s to drive the Pneumatic tire machine, #2, and stop.

Remark 1. The efficiency of the Neural Network theory based Tire-Pressure-Stabilizer algorithm can be seen from *Step 5 to Step 7*. While the "Micro-chip Processor" #5 receives the feedback signal, P_r, of the form $|\{P_s - P_r\}| \geqslant C$ (it represents the deviation between the real-time Tire-pressures and the standard values is bigger), then the "Micro-chip Processor" #5 exports the S_h (highly control signal) to drive the 'Motor', #6. While 'Motor', #6 receives the highly control signal S_h, it sends the highly output signal f_h to drive the "Efficiently pneumatic tire machine", #2 to stabilize the Tire-pressure of the car. While the "Micro-chip Processor" #5 receives the feedback signal, P_r, of the form $(\varepsilon \leqslant |\{P_s - P_r\}| < C$ (it represents the deviation between the real-time Tire-pressures and the standard values is not so bigger), then the "Micro-chip Processor" #5 exports the S_m (medium control signal) to drive the 'Motor', #6. While 'Motor', #6 receives the medium control signal S_m, it sends the medium output signal f_m to drive the "Efficiently pneumatic tire machine", #2 to stabilize the Tire-pressure of the car. While the "Micro-chip Processor" #5 receives the feedback signal, P_r, of the form $|P_s - P_r| < \varepsilon$ (it represents the real-time Tire-pressures reaches the steady status), then the "Micro-chip Processor" #5 exports the S_s (steady control signal) to drive the 'Motor', #6. While 'Motor', #6 receives the S_s steady control signal, it sends the steady output signal f_s to drive the "Efficiently pneumatic tire machine", #2 to stabilizing operating or stop operating.

Remark 2. In this paper, we also use the similar Neural Network Theory based Tire-Pressure-Stabilizer algorithm in the Portable Electric-jack device for locking the working current of the Servo-Motor within some certain level to maintain the altitude of the car being lifted.

In the following, we will present the Hardware Implementation of the Neural Network theory based the innovative expert system – *ICRT* and use the associated figures and the corresponding photographs to make a detailed description of the proposed *ICRT*.

3. Hardware implementation of the innovative expert system – ICRT

3.1. Diagram description

Function block diagram and System structure diagram of Hardware implementation of the innovative expert system – *ICRT* are shown in Figs. 2 and 3. The definitions of the block element symbols are stated in the following:

10: Denotes the Control circuit.
12: Denotes the Micro-chip processor.
14: Denotes the Voltage-regulating circuit.
16: Denotes the Driving circuit of DC-Motor.
18: Denotes the Time delay circuit.
19: Denotes the Circuit of the Trouble blinking sign.
20: Denotes the Portable Electric-jack.
30: Denotes the Electric Tire-pressure-meter.
40: Denotes the Efficiently pneumatic tire machine.
50: Denotes the Sparing Battery.
60: Denotes the LCD displayer.
70: Denotes the Trouble blinking sign and Lighting device.
100: Denotes the Neural Network Theory based innovative expert system – *ICRT*.

3.2. Hardware implementation of the innovative expert system – ICRT

We will combine the block element symbols and their definitions associated with the Figs. 2 and 3 to describe the operation sequence control of the Hardware implementation of the innovative expert system – ICRT.

3.2.1. The detailed description the combinations and interconnections of the block element symbols

In Fig. 2, the Neural Network theory based the innovative expert system – *ICRT* 100, includes the following devices: the Portable Electric-jack 20, the Electric Tire-pressure-meter 30, the Efficiently pneumatic tire machine 40, the Sparing Battery 50, the LCD type displayer 60, and the Trouble blinking sign and Lighting device 70, in which the Control circuit 10 is including the following devices: the Micro-chip processor 12, the Voltage-regulating circuit 14, the Driving circuit of DC-Motor 16, the Time delay circuit 18, and the Circuit of the Trouble blinking sign 19, in which the Micro-chip processor 12 is connected with the portable Electric-jack 20 by the Driving circuit of DC-Motor 16 and the Micro-chip pro-

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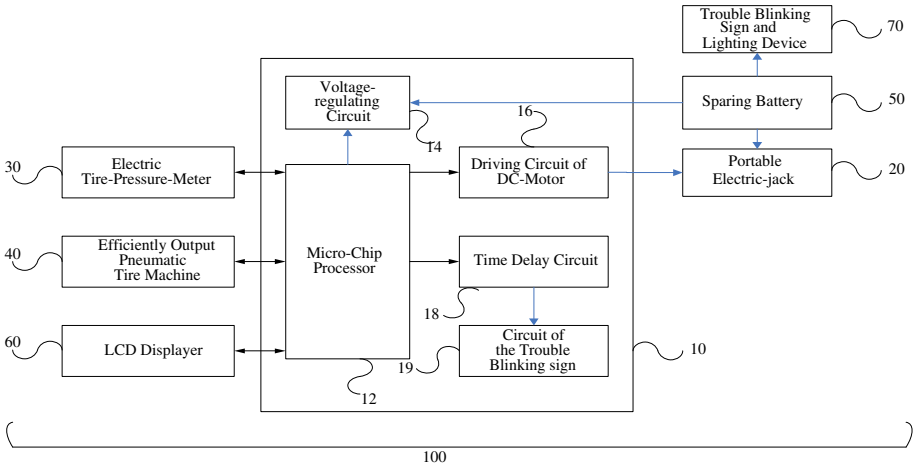

Fig. 2. Function block diagram of the hardware implementation of the innovative expert system – ICRT.

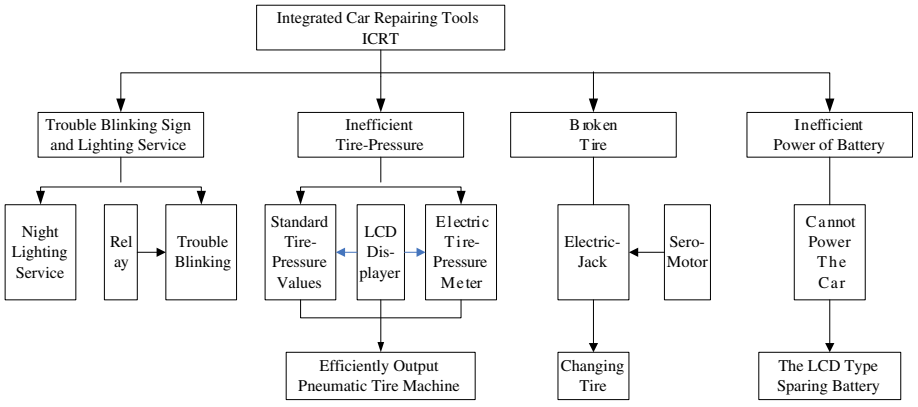

Fig. 3. System structure diagram of hardware implementation of the innovative expert system – ICRT.

cessor 12 is connected with the Sparing Battery 50 by the Voltage-regulating circuit 14; the Micro-chip processor 12 is connected with the Circuit of the Trouble blinking sign 19 by the Time delay circuit 18; beside, the Control circuit 10 is connected with the Electric Tire-pressure-meter 30, the Efficiently pneumatic tire machine 40, the LCD type displayer 60, and the Trouble blinking sign and the Lighting device 70.

3.2.2. The operation sequence control of the hardware implementation of the innovative expert system – ICRT

3.2.2.1. Portable Electric-jack. The Portable Electric-jack 20 of the *ICRT* 100 uses the Neural Network based Robotics and Feedback Control Theory to lock the working current of the DC-Motor 16 within some certain range. Therefore, the Portable Electric-jack 20 can maintain the height of the car being lifted while changing the broken Tire. This is the famous effect called the Neural Network lock-in Effect and the detailed description is stated below. In the *ICRT*, the Driving circuit of DC-Motor 16 uses the DC current to drive DC-Motor. And the DC-Motor is used to drive the Portable Electric-jack 20; the Geared system associated with the Gear-driven are included in 20 and are used to slow down the speed of the DC-Motor to facilitate the Control circuit 10 to make a miner adjusting of the operations of the DC-Motor. The Neural Network based Robotics and Feedback Control Theory is embedded in the Micro-chip processor 12 and is used to lock the working current of the DC-Motor 16 within some certain level to maintain the working position of Car being lifted up and down by the Portable Electric-jack 20.

3.2.2.2. Electric Tire-pressure-meter. The Electric Tire-pressure-meter 30 of the *ICRT* 100 uses the Tire pressure sensors and the A/D Converter associated with the Micro-chip processor 12 to measure the pressure of the Tire and shows the measured values in digitations.

3.2.2.3. Efficiently pneumatic tire machine. The Neural Network based modified *P.I.D.* control Theory (the Neural Network theory based Tire-Pressure-Stabilizer algorithm) is embedded in the Micro-chip processor 12 and is used in the Efficiently pneumatic tire machine 40 to inject the air and stabilize the pressure of the Tire. Fig. 3 shows the operation procedures of the innovative expert system – *ICRT* while the varied situations of the glitches of the general family cars occurred. The detailed description of Hardware circuits and the operation procedures of the innovative expert system – *ICRT* about the pressure of the Tire not enough is described below. The Micro-chip processor 12 associated with the Electric Tire-pressure-meter 30 and the Efficiently pneumatic tire machine 40 will stabilize the pressure of the Tire using the Neural Network theory based Tire-Pressure-Stabilizer algorithm; the real pressure values of the Tire measured by the pressure sensor of the Electric Tire-pressure-meter 30 is transferred to the Control circuit 10, and the Control circuit 10 compares and calculates the deviation between the measured values and the table of the preset standard values established inside the Micro-chip processor 12 and will make some appropriate operations to drive the Efficiently pneumatic tire machine 40; after the comparing and calculating the deviation between the real measured values and the standard Tire

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values (the preset values inside the Micro-chip processor 12), the Control circuit 10 will execute the Neural Network Theory based Tire-Pressure-Stabilizer algorithm to drive the Efficiently pneumatic tire machine 40 to stabilize the Tire pressure.

3.2.2.4. LCD type Sparing Battery. In the LCD type Sparing Battery, the Micro-chip processor 12 is used and associated with the LCD displayer 60 to show the residual capacity of the Sparing Battery 50. It should be noticed that the Micro-chip processor 12 used in 50 is to detect the residual capacity of the Sparing Battery 50, it will send an Alarming signal if the residual capacity of the Sparing Battery 50 is leaking or is insufficient to start Cars.

3.2.2.5. Trouble blinking sign and Lighting device. The Trouble blinking sign and Lighting device 70 use the highly efficient LED device associated with the Micro-chip processor 12 to provide the Lighting service. It should be noticed that the Micro-chip processor 12 used in 70 is to control the working current of the LED device within some certain level. The Control circuit 10 provides the necessary facilitations for the Micro-chip processor 12, the Voltage-regulating circuit 14, the Driving circuit of DC-Motor 16, the Time delay circuit 18, and the Circuit of the Trouble blinking sign 19 in the Neural Network Theory based the innovative expert system – *ICRT*. In the *ICRT*, the LCD displayer 60 is used to show the residual volumes of the Sparing Battery 50; the Control circuit 10 is used to monitor the residual power of the Sparing Battery 50 within some safety level. If the residual power of the Sparing Battery 50 is inefficient to start Cars, then the Control circuit 10 will sent a control signal to the LCD displayer 60 and the 60 will exhibit a Red light sign or output an Alarming signal. Moreover, the Control circuit

Fig. 4. Prototype of the proposed innovative expert system – ICRT.

Fig. 5. Real photograph of the ICRT easily and rapidly lifts the car.

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10 uses the Time delay circuit 18 associated with the Circuit of the Flashing light of the glitch sign 19 to show the situation of problem on the Trouble blinking sign and Lighting device 70. The Trouble blinking sign and Lighting device 70 can also provide the necessary assistance for the drivers, such as the lighting and alarming signal during the car repair and waiting for rescue. In the *ICRT*, the Control circuit 10 connected with the Sparing Battery 50 by the Voltage-regulating circuit 14. And the Sparing Battery 50 is used to provide the power of the Control circuit 10. The drivers can also obtain the power from the Smoking socket device in the cars. In general, the power of the *ICRT* is provided by the Sparing Battery 50, but if the residual power of the Sparing Battery 50 is inefficient, the drivers can use the Smoke socket device of the car to execute the charging.

Furthermore, there is one more important device (Wireless received/emitted device) is included in the Control circuit 10 of the *ICRT*, the Wireless received/emitted device is used to receive the control signal originated from the Emitter to make the remote control of the *ICRT*. Moreover, there are some preset values of table programmed in the Micro-chip processor 12, such as the standard values of the Tire pressure P_s for the different types of the Tire and some parameters C, ε used in the Neural Network theory based Tire-Pressure-Stabilizer algorithm and some minimum capacity of power requirement should be stored in the Sparing Battery 50 to start cars for the different type of cars; it depends on the different type of cars, we can make some appropriate settings and modifications for the preset values in the Micro-chip processor 12.

4. Test results

We have made numerous real tests of the proposed Neural Network Theory based innovative expert system - *ICRT* in many different types of Cars. Due to the page limitation of this paper, we don't have enough space to describe everything about the *ICRT*, we just present some typical test results described in the following:

The testing Car is: *Toyota Camry, Body Weight about 1600 kg, Years 2006. Toyota* is very famous cars Generation Company all over the world and the *Camry* cars produced by *Toyota* are very popular cars type in the market in the recently years. First of all, we set up the innovative expert system – *ICRT* in the *Camry* car.

Fig. 6. Real photograph of the ICRT measures and stabilizes the Tire-pressure efficiently.

Fig. 7. Prototype of the small size Battery Box.

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Fig. 8. Prototype of the Trouble blinking sign and Lighting device.

Fig. 4 is the Prototype of the proposed *ICRT* (we also label the name of every tools on *ICRT*); from Fig. 4, we can see the size of *ICRT* is quite small and the volume (*L*, *W*, *H*) is only (60, 22, 10) cm. Therefore, it is quite easy to be carried and installed in every cars not limited for the type of *Camry*. Subsequently, we show the real test results to demonstrate the attractive functions of the *ICRT*:

(1) *Portable Electric-jack*: Fig. 5 shows that the *ICRT* can easily and rapidly lift the car in the Left Back Hand Side since we just use the "white color controller panel" in *ICRT* to operate the Portable Electric-jack lifting the car up and down, therefore, it is pretty convenient to operate the device comparing to the traditional "Hand Jack", especially for female drivers; we also can see that the Tire is stationary away from the ground about 5 cm (however, we can lift the car more higher if it is necessary), hence, we can make some necessary facilitations to maintain the car, such as changing Tire.

(2) *Electric Tire-pressure-meter,* and (3) *Efficiently pneumatic tire machine*: Fig. 6 shows that the proposed *ICRT* uses the Neural Network Theory based Tire-Pressure-Stabilizer algorithm to stabilize the Tire rapidly and we also can see the measured Tire-pressure value is 27 pounds shown on the LCD (since the standard Tire value is set to be 27 pounds programmed in the micro-chip processor).

(4) *LCD type Sparing Battery*: Fig. 7 is the Prototype of the small size Battery Box, since we use the corresponding technology of micro-chip and we can see the size of the Sparing Battery is quite small comparing to the traditional Power Bank.

(5) *Trouble blinking sign and Lighting device*: Fig. 8 is the Prototype of the Trouble blinking sign and Lighting device.

From the real Hardware implementation of the innovative expert system – *ICRT*, we see the size of the device is quite small and the functions are compact and can be easily carried in Cars. Furthermore, the proposed *ICRT* is easily to be operated.

5. Conclusions

In this paper, we focus on the frequent glitches of the general family cars. Based on the Neural Network theory and combining with the micro-chip processor technology, we create an innovative expert system – "Integrated Cars Repairing Tools". The proposed *ICRT* owns the following attractive functions: (1) *Portable Electric jack, (2) Electric Tire-pressure-meter, (3) Efficiently pneumatic tire machine, (4) LCD type Sparing Battery with the capability to show the residual capacity of Power, (5) Trouble blinking sign and Lighting device*. Furthermore, the size of the *i* is quite small and can be easily carried in cars. We have installed the proposed innovative expert system – *ICRT* in many different types of Cars and made numerous simulations, the test results show that the *ICRT* is efficient for rejecting the frequent glitches of cars.

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References

Azad, N. L., Khajepour, A., & McPhee, J. (2005). Analysis of jackknifing in articulated steer vehicles. In Proceedings of the IEEE vehicle power and propulsion (VPP) conference (pp. 86–90). Chicago, USA.

Carstens, J. R. (1993). *Electrical sensors and transducers*. Englewood Cliffs, NJ: Prentice Hall.

Chapman, S. J. (2005). *Electric machinery fundamentals* (4th ed.). New York: McGraw-Hill.

Chen, T.-L., & Lin, J.-W. (1997). The battery charging circuit. *Journal of the Power Electrics, 3*, 60–66.

Comer, D. J., & Comer, D. T. (2003). *Advanced electronic circuit design*. John Wiley & Sons Inc.

Dai-Dai Technical Company. Home service station AC air compressor. <http://www.tata.com.tw/>.

Grossmann, R. (1999). Quartz crystals as remote sensors for tire pressure. In Proceedings of the 16th IEEE instrumentation and measurement technology conference (vol. 3, pp.1745–1749). Venice, Italy.

Harter, J. H. (2000). *Electromechanics: Principles, concepts and devices* (2nd ed.). Englewood Cliffs, NJ: Prentice Hall.

Kornev, A. F., Kuchma, I. G., Pokrovski, V. P., & Soms, L. N. (2005). Half-tone images in laser image projection using saturated laser Fourier-amplifiers. In Proceedings of the CAOL second international conference on advanced optoelectronics and lasers (vol. 1, pp. 202–205). Chernivtsi, Ukraine.

Kowalewski, M. (2004). Monitoring and managing tire pressure. *IEEE Potentials, 23*(3), 8–10.

Laker, K. R., & Sansen, W. M. C. (1994). *Design of analog integrated circuits and systems*. New York: McGraw-Hill.

Li, L., Wang, F. -Y., Qunzhi, Z., & Shan, G. (2003). Automatic tire pressure fault monitor using wavelet-based probability density estimation. In Proceedings of the IEEE intelligent vehicles symposium (pp. 80–84). Columbus, USA.

Li, J.-S., & Liu, Y.-H. (2001). The development of the battery charging device for the motorcycle. *Journal of the Power Electrics, 65*, 44–57.

Lie, S.-K., Yu, L.-B., et al. (2000). The development of the photo-element used in lighting service of the car. *Journal of the Technology Development, 28*(6), 442–448.

Liu, Y.-H. (2001). The development of the efficiency battery charging device. *Journal of the Power Electrics, 65*, 58–73.

Liu, J. -Y. (2005). The research of the lighting device of the technical company in Taiwan. The IEK-IT IS Project, Taiwan.

MacKenzie, I. S. (1999). *The 8051 microcontroller* (3rd ed.). Upper Saddler River, NJ: Prentice-Hall.

Mihali, R., & Sobh, T. (1999). The formula one tire changing robot (F1-TCR). In Proceedings of the IEEE international conference on robotics and automation (vol. 1, pp. 323–328). Detroit, USA.

Nabipoor, M., & Majlis, B. Y. (2004). A passive telemetry LC pressure sensor optimized for TPMS. In Proceedings of IEEE international conference on semiconductor electronics, Kuala Lumpur, Malaysia.

Pohl, A., Ostermayer, G., Reindl, L., & Seifert, F. (1997). Monitoring the tire pressure at cars using passive SAW sensors. In Proceedings of the IEEE ultrasonics symposium (vol. 1, pp. 471–474), Ontario, Canada.

The An-Hun Technical Company. The potable pneumatic tire machine-AH-C010. <http://www.szanhang.com.cn/>.

The Audi-Tai Car Technical Company. The pneumatic tire machine with the digital player. <http://www.auto-tech.com.cn/cpjs/cp5/index.htm>.

Wallis, P., Ronnquist, R., Jarvis, D., & Lucas, A. (2002). The automated wingman – Using JACK intelligent agents for unmanned autonomous vehicles. In Proceedings of the IEEE aerospace conference (vol. 5, pp. 2615–2622). Big Sky, Montana.

Yamada, T., & Suzuki, K. (1990). Fuzzy control of plural hydraulic jacks in an elastic–plastic structural test. In Proceedings of the first international symposium on uncertainty modeling and analysis (pp. 546–551). Maryland, USA.

Yeh, J.-L. (1997). The power bank and battery charging device. *Journal of the Taiwan Power Company, 590*, 44–57.

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