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# Research on a New Automotive Rear-View Mirror with Dual-Axis Inclined Angle Adjustment, Memory, and Restoration Functions

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***Abstract*—Nowadays, an exterior automotive rear-view mirror is one of basic driving-safety equipments for most of automobile drivers. The researching purpose of this paper is hoped to design a new controller for the control of proposed automotive rear-view mirror through hardware circuit design and software programming approaches. Hardware circuit includes an electronic control unit, an intelligent mobile device, and a pair of Bluetooth modules. To program a friendly human-machine interface (HMI) on an intelligent mobile device, let user only need to press an object which equals ordering an operating command to the controlled rear-view mirror. The corresponding command is immediately transmitted from the intelligent mobile device to the single chip embedded in the electronic control unit (ECU) via a wireless Bluetooth communication interface. The single chip immediately executes any of the dual-axis inclined angles adjustment, memory, or restoration actions after it has received the operating command. In order to verify the feasibility of the proposed system controller, an experimental prototype was established in the laboratory. Some different experiments were then carried out under different conditions. Finally, the experimental results showed that the proposed new mechanism and controller are actually feasible. Especially, this new automotive rear-view mirror is suitable for being used in lots of present conventional low-end and middle-end vehicles in the after market for promoting their operating efficiency.**

***Index Terms*—Electronic Control Unit (ECU) , Human-Machine Interface (HMI), Intelligent Mobile Device Rear-View Mirror.**

## I. Introduction

As the concept of lots of consumers facing to automotive product market is constantly updated and changed, peoples begin paying more attention to the driving safety, operating convenience, long durability, and luxury aesthetics regarding to automotive products. For a long time, most of drivers make use of interior and exterior automotive rear-view mirror to dynamically inquire of the related traffic message about the side, rear, and beneath of automobiles. If the performance of the utilized automotive rear-view mirror is better, the driver's vision would become broaden and vision distance is extended too. Of course, the happening opportunity of the traffic accidental event would be naturally reduced. In recent years, how to further improve the driving safety and operating convenience is constantly required by many automobile users, therefore, the automobile maker in the world begins attempting to integrate inclined angle memory and restoration function into their conventional electric automotive rear-view mirror. However, taking the manufacturing cost into consideration, this multi-function rear-view mirror is only being used in the high-end automobiles. As the automotive electronic is being increasingly developed, more and more scholars and engineers begin to pay their attention to research the dynamic behaviors about conventional rear-view mirror. Many years later, lots of useful and valuable researching results have been published [1-9]. Pardhy et al. designed a virtual mirror and used in interior of automobile in 2000 [5]. It can be used to observe the people and thing about side and rear of a driven automobile or truck. Zheng et al. proposed an electric controlling method to control the right-side automotive exterior rear-view mirror [2,3]. Their proposed method could overcome the distance between the user and mirror too far to be adjusted problem. Furthermore, some new wireless communication methods between two automobiles were developed. Two automobiles can then dynamically exchange their useful driving information each other. The driving safety and efficiency regarding to individual driver is then improved. Nowadays, although there are lots of people begin paying much more time for the development and analysis of the related equipments of vehicles. Nevertheless, only few researchers pay their attention to the design and implementation concerning with the mechanical mechanism and its controller of new automotive rear-view mirror. Therefore, a new automotive rear-view mirror with dual-axis inclined angles adjustment, memory, and restoration functions will be served as the main researching goal in this paper.

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## II. The Structure of the Proposed New Automotive Rear-View Mirror

Fig. 1 shows the driving circuit of dc motor embedded in the ECU. The mechanism of every proposed new automotive rear-view mirror includes two permanent-magnet brushed dc motors (abbreviated as dc motor below). They are used to control the X-axis and Y-axis inclined angle, respectively. The driving circuit of dc motor consists of three phases or six arms. There are two arms is included at a phase. In theory, the working principle of every arm is similar to a mechanical switch. In order to satisfy with the basic designing requirements, that is fast operation, modular, and small size, every arm is implemented by a power transistor here. The control signals of the driving circuit are generated by a single chip which is also embedded in the ECU. In order to reduce the needed number of single-chip pin as less as possible, only four single-chip pins are required at least. The other two controlling signals at third phase are generated by two logical OR gates, as displayed in Fig. 1. Table 1 shows the possible combinations of the controlling signals that are used to drive the dc-motor rotation in the clockwise or counter-clockwise direction.

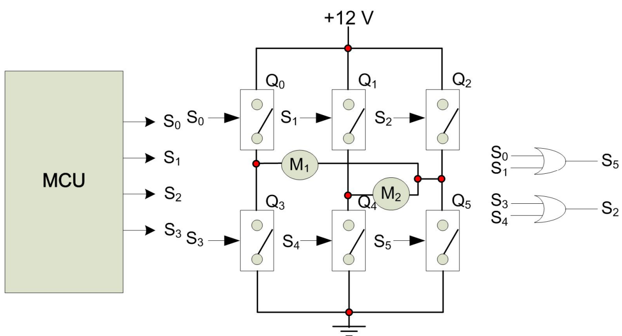



Figure 1. Demonstrates the driving circuit of dc motor of the proposed automotive rea-view mirror.

TABLE 1. DIFFERENT COMBINATIONS OF THE CONTROL SIGNALS IN THE DRIVING CIRCUIT OF DC MOTOR SHOWN IN FIG. 1.

| | $S_0$ | $S_1$ | $S_2$ | $S_3$ | $S_4$ | $S_5$ |
|---|---|---|---|---|---|---|
| M1,CK | 1 | 0 | 0 | 0 | 0 | 1 |
| M1, CCK | 0 | 0 | 1 | 1 | 0 | 0 |
| M2,CK | 0 | 1 | 0 | 0 | 0 | 1 |
| M2,CCK | 0 | 0 | 1 | 0 | 1 | 0 |

Fig. 2 demonstrates the functional block diagram of the proposed automotive rear-view mirror; the mechanical mechanism is not included here. The proposed system consists of two dc motors, two pairs of dual-axis inclined angle sensory units, and an electronic control unit (ECU). The ECU can further be divided into three parts, such as a dc-motor driving circuit, a single chip, a Bluetooth module. The operating voltage of the proposed system is +12 V.

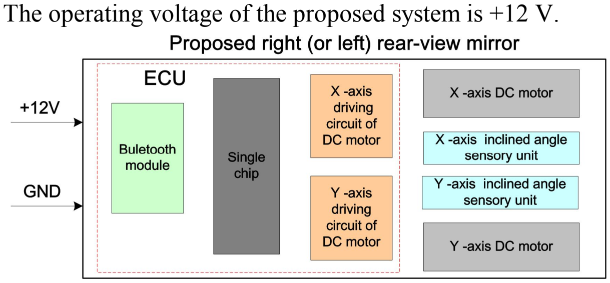



Figure 2. Besides the basic mechanical structure, showing all functional blocks of the proposed system.

## III. MATHEMATICAL MODEL

According to the basic mechanism of the proposed system, it is composed of an electrical system and a mechanical system. This means that the mathematical model of the proposed system can be considered as the combination of an electrical model and a mechanical model [15]. Fig. 3 clearly shows that proposed system is composed of the electrical and mechanical connection. In the following, the included electrical model, mechanical model, and the combined model will be explored sequentially.

### A. Electrical Model

The mechanical mechanism of the proposed system is driven by two dc motors. In Fig. 3, the electrical model of the proposed system is viewed as the mathematical model of a permanent-magnet dc motor. It is composed of an equivalent resistor, an armature and an equivalent inductor and they are connected in series. Voltage source, +12 V, is served as the operating voltage of the electrical model and applied across the armature. According to the KVL, the voltage equation around the equivalent electrical circuit of dc motor can be written as follows:

$$L_a \frac{dI_a}{dt} + R_a I_a + E = U \quad (1)$$

In Equ.(1), the parameters are defined as follows, respectively:

$U$ : the external applied voltage source;

$I_a$ : the current flows into the armature;

$R_a$ : the equivalent resistor in the armature circuit;

$L_a$ : the equivalent inductor in the armature circuit;

$E$ : the back emf, it is generated voltage due to the rotation of dc-motor rotor. The value of this parameter is proportional to the dc-motor rotation speed. Therefore, it can be further described by the following formula:

$$E = K_b \omega_m = K_b \frac{d\theta_m}{dt} \quad (2)$$

where $K_b$ represents a back-emf constant of the dc motor.

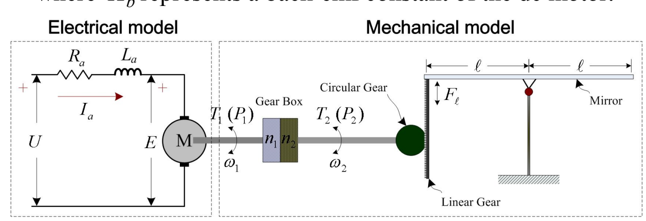



Figure 3. The mathematical model of the proposed system.

### B. Mechanical Model

When the current flows into dc motor, the stationary and rotating magnetic flux are generated at same time results in an instantaneous electromagnetic torque exerted on the dc-motor rotor. This instantaneous electromagnetic torque will be used to overcome the mechanical load and compensate for the mechanical energy loss during the energy transmission process. Fig. 3 shows that all the needed load torque and mechanical energy loss can be combined together and transferred from the secondary side to the primary side of gearbox. Therefore, if the dc motor is hoped to continually rotate, the generated instantaneous electromagnetic torque should be always larger than the needed torques. According to the second Newton's law, the equivalent mechanical model of the proposed system shown in Fig. 3 can be described in the following:

$$J_m \frac{d^2\theta_m}{dt^2} + B_m \frac{d\theta_m}{dt} = T_1 = KI_a \qquad (3)$$

In Equ. (3), the related parameters are respectively defined as follows:

$\theta_m$ : the rotation angle of dc-motor rotor;

$T_1(P_1)$ : the generated torque (power) in the primary side of gearbox;

$T_2(P_2)$ : the generated torque (power) in the secondary side of gearbox;

$B_m$ : the equivalent viscous friction coefficient;

$J_m$ : the equivalent inertia moment generated on the dc-motor rotor;

The dc-motor rotor is mechanically connected to the primary side of gearbox in series. The rotation axis in the secondary side of gearbox drives a circular gear with plastic material to rotate. Sequentially, the plastic circular gear is again used to drive another linear gear by means of mechanical connection. The generated rotation torque of dc motor is then converted into a linear motion force. As observed the right mechanical model in Fig. 3, the supporting point of the mechanical mechanism is located in its geometrical center position. When one of dual axes is driven to incline upward or downward, the resultant moment of force is equal to the multiplication of the linear motion force and the active arm length. In Equ. (4), the parameters $T$ □ $F$ □ are respectively defined as the moment of force, force, and the arm length.

$$T = F \times \quad = T_2(t) \qquad (4)$$

Regardless of all the mechanical losses, the resultant moment of force is equal to the electromagnetic torque forced on the secondary side of gearbox. The values of the same parameter in the primary and secondary sides are different. Their relationship can be described in the following formula:

$$\frac{T_1}{T_2} = \frac{\theta_2}{\theta_1} = \frac{\omega_2}{\omega_1} = \frac{R_1}{R_2} = \frac{N_1}{N_2} \qquad (5)$$

In Equ. (5), the related parameters are respectively defined and simply described in the following:

$\theta_1, \theta_2$ : the rotation angles respectively in the primary and secondary sides;

$\omega_1, \omega_2$ : the rotation angular velocity respectively in the primary and secondary sides;

$R_1, R_2$ : the rotation radius respectively in the primary and secondary sides;

$J_1, J_2$ : the rotation inertia moment respectively in the primary and secondary sides;

$B_1, B_2$ : the rotation viscous friction coefficient respectively in the primary and secondary sides;

$N_1, N_2$ : the gear ratio in the primary and secondary sides;

If the resultant load torque and mechanical friction loss in the secondary side of gearbox are converted into the primary side of gearbox, the final required electromagnetic torque exerted on the dc-motor rotor can be written as follows:

$$T(t) = [J_1 + (\frac{N_1}{N_2})^2 J_2] \frac{d^2\theta_2}{dt^2} + [B_1 + (\frac{N_1}{N_2})^2 B_2] \frac{d\theta_2}{dt}$$

(6)

## IV. Controller Design

Fig. 4 shows the controller structure of the proposed system [11,15]. It consists of an intelligent mobile device (it maybe an intelligent mobile phone or tablets), an electronic control unit (ECU), and a mechanical mechanism itself. In addition to the basic mechanical mechanism, the mechanical mechanism still includes two dc motors and two pairs of inclined angle sensory circuit. Two dc-motor are respectively used to drive the X-axis and Y-axis mechanical mechanism to incline. Dual axes are perpendicular to each other in space. For simplifying control, these dual axis are mechanically decoupled each other. Two dc motors are driven by a driving circuit, their control signals are generated by a single chip embedded in the ECU. When one of dc motors is driven to rotate an angle, the attached inclined angle sensory unit will induce and output a linear analog voltage. The single chip embedded in the ECU will sample and hold this linear analog voltage by its embedded A/D converter for achieving the dual-axis inclined angle memory or restoration operating purpose. Fig. 4 shows that ECU and the mechanical mechanism are integrated together. The ECU is composed of an 8-bits single chip, a dc-motor driving circuit, and a Bluetooth module [10-12]. The system command can only ordered by means of a friendly human-machine interface (HMI). User needs to press an object shown on the HMI. A corresponding command of this object would be transmitted from the intelligent mobile device to the single chip on the ECU. After the single chip on the ECU has received user command, the single chip will immediately execute the required action.

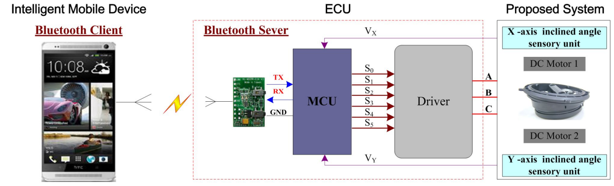



Figure 4. Draws the functional block diagram of the proposed automotive rear-view mirror.

### A. Hardware circuit design

Compared to the conventional electric automotive rear-view mirror and its controller, the proposed system involves dual-axis inclined angles memory and restoration functions. Therefore, in addition to the basic mechanical mechanism, an ECU is necessary for satisfying with the control requirements of proposed system. The control kernel of ECU is an 8-bits single chip, PIC16F1823 which is made by Microchip Corp. [13], as shown in Fig. 5. Firstly, a wireless Bluetooth communication interface between intelligent mobile device and ECU should be established. When user presses an object on the HMI, this command will be transmitted from the intelligent mobile device to single chip. The single chip is responsible for executing the corresponding command. In order to implement the dual-axis inclined angles to be memorized and restored functions through close-loop controlling strategy, the dual-axis dynamic inclined angles need to be read by the single chip on the ECU.

Fig. 5 also demonstrates that the single chip is connected with a Bluetooth module via its asynchronous serial port. To establish a wireless Bluetooth communication interface between a Bluetooth module on the ECU and the intelligent mobile device, they must have the same communication protocol settings inside [15].

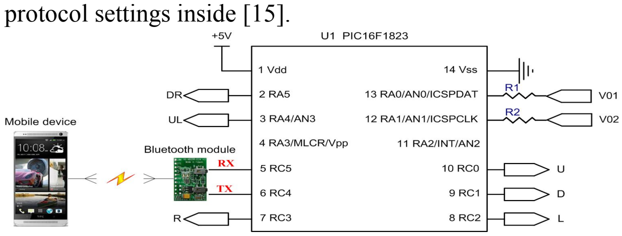


Figure 5. Sketches the single-chip pins and its functional definition.

*1) The driving circuit of dc motor*

Fig. 6 shows a detailed driving circuit of two dc motors in the proposed automotive rear-view mirror. It is integrated with a Bluetooth module and a single chip forms an ECU. As mentioned above, the dc-motor driving circuit consists of three phases or six arms. Every arm is made of a power transistor. The function of one of arms is like a mechanical switch. All control signals or only four control signals of the dc-motor driving circuit are generated by the single chip on the ECU. If these six controlling signals are carefully arranged, the rotation direction of the controlled motor will be defined.

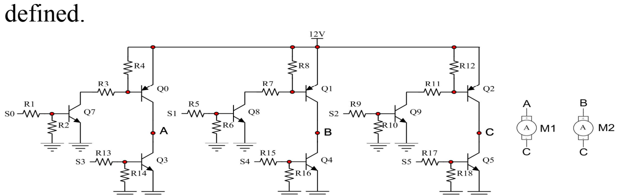
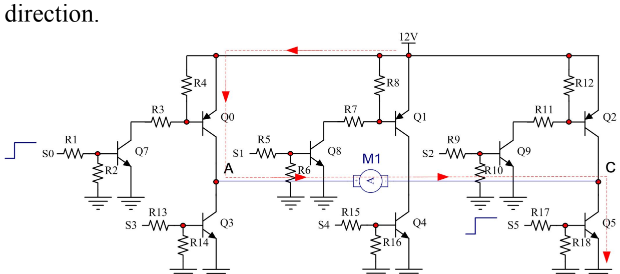
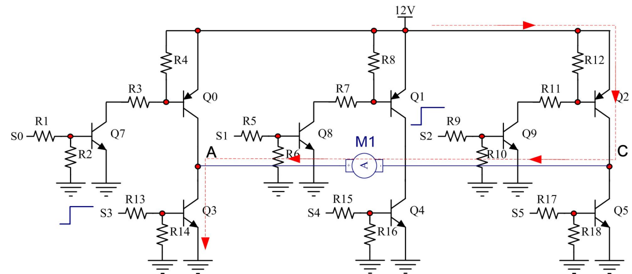


Figure 6. Draws the struture of the dc-motor driving circuit.

As indicated in Fig. 7, dc motor, M1, is connected across the terminals A and C in the driving circuit. If the controlled nodes S0 and S5 are applied to +5V, namely, the logical high level voltage, the upper arm at the first phase and the lower arm at the three phase will be triggered to turn on. Voltage source +12V, transistor Q0, dc-motor M1, and transistor Q5 form an electric circuitry loop. A current flows through these components, as indicated by a dashed line with arrow in Fig. 7(a). If the controlled nodes S2 and S5 are applied to logical high level voltage, while the other control signals are set at logical low levels, the upper arm at the third phase and the lower arm at the first phase will be triggered to turn on, Voltage source +12V, transistor Q2, dc-motor M1, and transistor Q3 form an electric circuitry loop. A current flows through these components, as indicated by a dash line with arrow in Fig. 7(b). The rotation of dc motor M1 is in reverse direction.



(a)



(b)

Figure 7. Indicates the dc motor is driven in the (a) clockwise direction (b) counter-clockwise direction.

*2) Inclined angle sensory unit*

In order to implement the memory and restoration function in the proposed system, it is necessary to arrange and fix two pairs of inclined angle sensory unit with the mechanical mechanism. Dual-axis mechanical mechanisms, that is X-axis and Y axis are perpendicular in space and mechanically decouple each other. Every inclined angle sensory unit is composed of a permanent magnet and a linear Hall-Effect sensor IC. As shown in Fig. 8, a linear Hall-Effect sensor IC is fixed on the bottom position of mechanical mechanism [16]. It is a stationary component. Relatively, the position of the permanent magnet will be changed as the inclined angle action happens. So that, as the mirror is driven to incline, the magnetic intensity exerted on the linear Hall-Effect sensor IC is changed too. The output linear analog voltage of linear Hall-Effect sensor IC is proportional to the magnetic intensity which the permanent magnet forced on it. In other words, the output analog voltage is inversely dependent on the inclined angle of mirror. Referred to the Fig. 8, more the inclined angle of mirror is, less magnetic intensity is. Fig. 9 shows that the relationship between the magnetic intensity forces on the linear Hall-Effect sensor IC and the output linear voltage value.

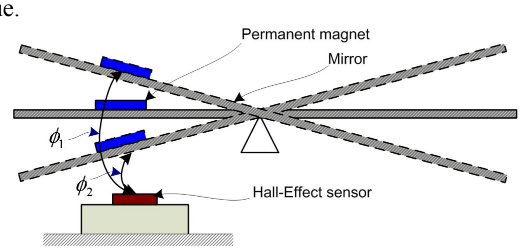


Figure 8. Explains the working principle of the inclined angle sensory circuit.

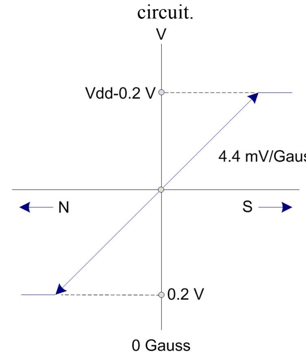


Figure 9. Shows that the relationship between the magnetic intensity acts on the linear Hall-Effect sensor IC and the output linear voltage value.

## *B. Software programming*

In the proposed system, there are two types of software should be programmed in order to satisfy with the necessary function of system, they are the single-chip program and the application program of intelligent mobile device. The designing ideas of these two kinds of application programs are described as follows:

*1) Application program of intelligent mobile device*

For implementing dual-axis inclined angle adjustment, memory, and restoration functions can be included in the proposed system at the same time. All system commands can only be ordered by pressing an object on a friendly human-machine interface (HMI). In fact, HMI is an application program and runs on an intelligent mobile device. This HMI is developed on an App Inventor platform [14]. Before starting to order a command, a wireless Bluetooth communication interface should be first established between the client and server terminals (Here, the client terminal is the intelligent mobile device, while the server is the controlled proposed system) [11]. Fig. 10 demonstrates the connection flowchart and simply describes in the following:

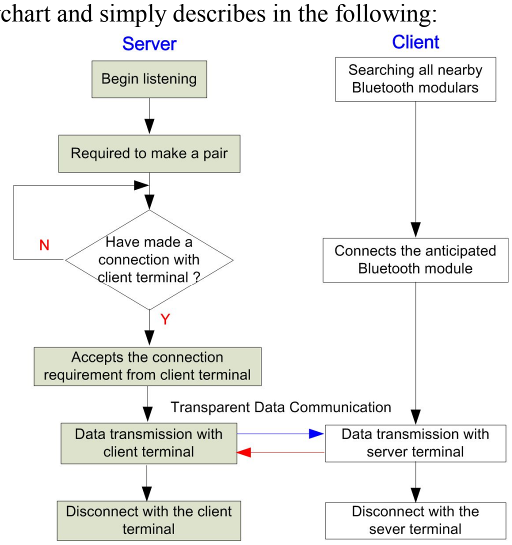



Figure 10. Shows the connection process between the server and the client terminals.

Step 1: Enabling the server to be searched, it can be found by any neighboring client Bluetooth modules.

Step 2: The client is in search of the neighboring server terminals. All the Mac addresses, which have been found servers, will be shown on a list.

Step 3: One of found Mac addresses is selected as paired and connected goal. An window appears and inquires user whether the pairing ation has been completed or not.

Step 4: If the pairing action have been completed, a wireless Bluetooth communication interface is required to be continuely executed [17-20]. After the wireless Bluetooth communication interface has been successfully established, the transparent data communication each other starts immediately.

If the connection relationship between the client and server terminals has not been established, the Bluetooth module on the ECU will always situate at a waiting connection status. Fig. 11 shows the flowchart structure of application program of intelligent mobile device.When the client trminal attempts to connect with one of the server terminals, the client terminal will be required to input a password which was set before. If the input password by user is wrong, user would be required to input again until the input password is right. After user has passed the password verification, three selection items are provided and shown on HMI. Firstly, if the password update item is selected, the system will require that user input a new password to replace old one. When the save button is pressed by user, the new password set will be memorized in a tiny database. Secondly, if the begin operation item is selected, the system will be changed to the second screen. According to controlling purpose, this new screen consists of three parts, such as inclined angle adjustment, memory, and restoration parts. Besides, the user is required to select one of four fast keys for executing the memory or restoration actions of system. When the user has finished all the wanted operation, she/he can select the bottom button, which is labeled as end operation. The working screen ends operation and then switches back to the first screen and disconnects the wireless Bluetooth communication interface with the server terminal right now.

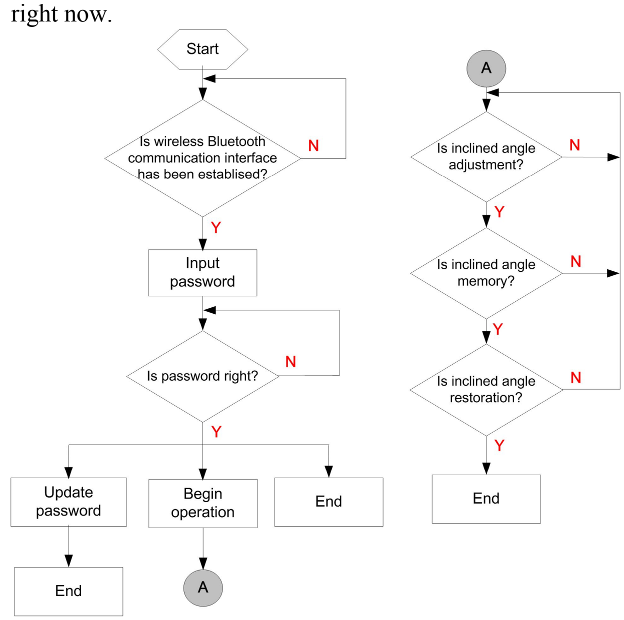



Figure 11. Sketches operating flowchart of application program of the intelligent mobile device.

*2) Single-Chip program*

After the single chip has received the command transmitted from the intelligent mobile device, the single chip will immediately deal with the corresponding action of command. According to the represented function of command, the ordered command can be further divided into three different commands, such as the dual-axis inclined angle adjustment, memory, and restoration. In fact, users can only order their command by means of the HMI of intelligent mobile device. As indicated in Fig. 11, it is the controlling flow chart of the single-chip software program.

Fig. 11 sketches the controlling flow chart of the single-chip software program. In hardware circuit, the single chip is connected with a Bluetooth module through its asynchronous serial port. When user command is ordered and transmitted from the intelligent mobile device to the single chip on the ECU via the wireless Bluetooth communication interface. Once the received data comes to one byte, the single-chip CPU will be interrupted. The single-chip program starts to execute the interrupt subroutine program. The ECU intends to complete the control purposes of the proposed system one by one according to user’s command.

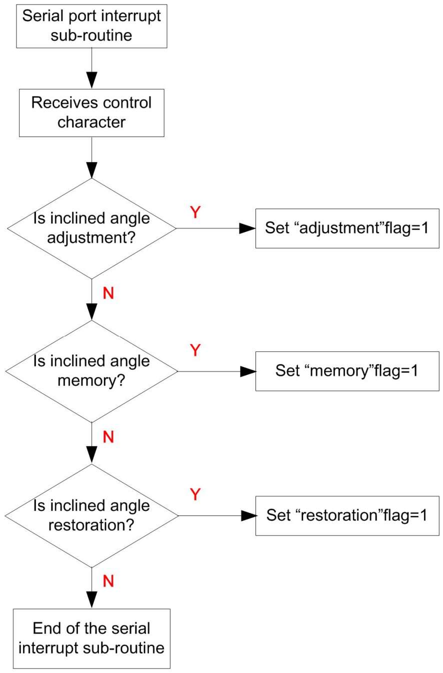


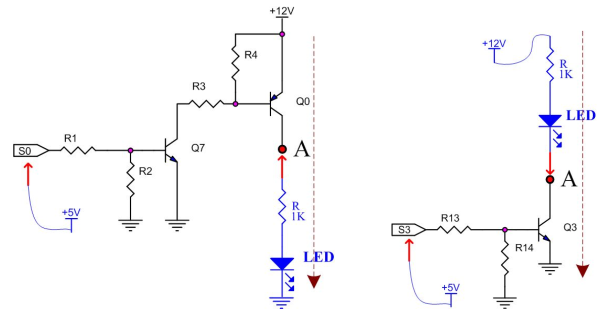

Figure 11. The controlling flow chart of the single-chip software program.

## V. Experiments and Discussions

For conveniently conducting experimental purposes, a proposed system prototype, which includes an ECU and two pairs of inclined angle sensory circuits, was established in the laboratory. The automotive battery is served as the operating voltage source of the proposed system.

### A. *Function test of dc-motor driving circuit*

As above-mentioned in the section 4, the driving circuit of dc motor consists of three phases or six arms. To realize whether the function of the dc-motor driving circuit is normal or not, the hardware circuit function of the upper and lower arms have to be tested, respectively. Fig. 12(a) shows the functional testing circuit connection of the upper arm, a resistor and a LED are first connected in series. And then they are connected with the collector of transistor, Q0, in series too. If powering voltage +5V is applied to the node S0, the transistors Q0 and Q5 are triggered to turn on. Voltage source +12 V, conducting Q0, and a series resistor and LED form a serial connection circuit. The circuit current flows through these components and the direction is indicated by a dashed line with arrow. If the LED is lighted, it represents that the function of the tested upper arm is normal. Otherwise, it is malfunction. With the use of similar manner, the hardware circuit one of the lower-arm in the driving circuit can be tested too. In Fig. 12(b), powering voltage +5 V applied to the node S3, the transistor Q3 is triggered to turn on. Voltage source +12V, a transistor Q3, and an involved resistor R and LED form a serial circuitry connection. If the LED is lighted, this means that the function of the tested lower arm is normal. Otherwise, it is malfunction.

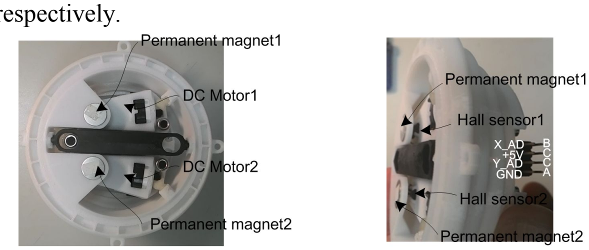



(a) (b)

Figure 12. The functional test of every arms in the dc-motor driving circuit (a) the upper arm and (b) the lower arm.

### B. *Manufacturing prototype*

According to the designing ideas, Fig. 13 demonstrates the completed top-view and side-view proposed system prototype pictures (The ECU is not included). Fig 13(a) shows that two pairs of the inclined angle sensory circuits are fixed on the mechanical mechanism. They are perpendicular each other in space and decouple. A permanent magnet is fixed and stationary beneath a linear Hall-Effect sensor IC. Fig. 13(b) also indicates that proposed system is reserved eight pins for the connection with the other control circuit. They are voltage source +5V, ground, three controlled terminals of dc motor A, B, and C, two linear analog outputs X_AD and Y_AD, respectively.




(a) (b)

Figure 13. The proposed system prototype picture, the ECU is not included here, (a) top view (b) side view.

### C. *Completed Prototype picture*

Fig. 14 shows the completed prototype picture of the new automotive rear view mirror. It is composed of the mechanical mechanism, ECU, and an intelligent mobile device. The mechanical mechanism includes two dc motors and two pairs of inclined angle sensory circuits. The ECU integrates with a dc-motor driving circuit, a single chip, a Bluetooth module, and +5 V and +3.3 V regulators. A friendly human-machine interface is implemented on an intelligent mobile device such as intelligent phone or tablet. All user commands of the proposed system are ordered by using HMI. The real executing actions are conducted with the use of the single chip on ECU and its peripheral hardware circuit.

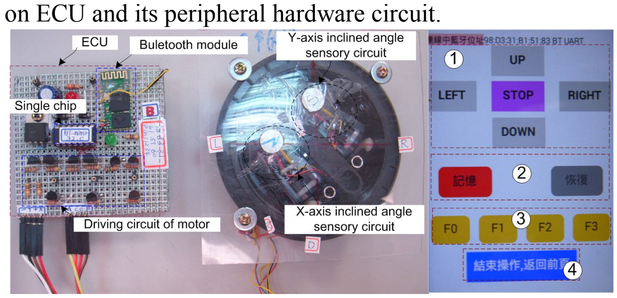
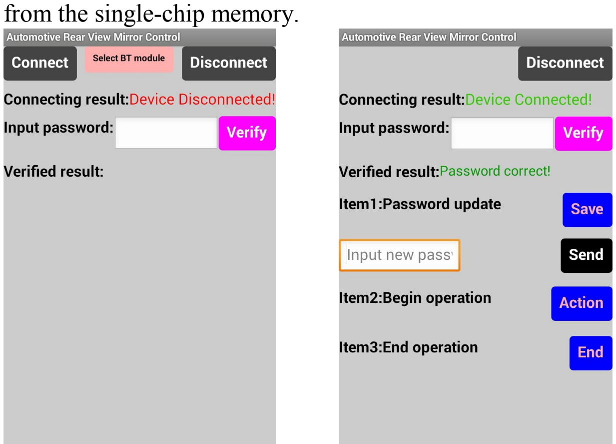
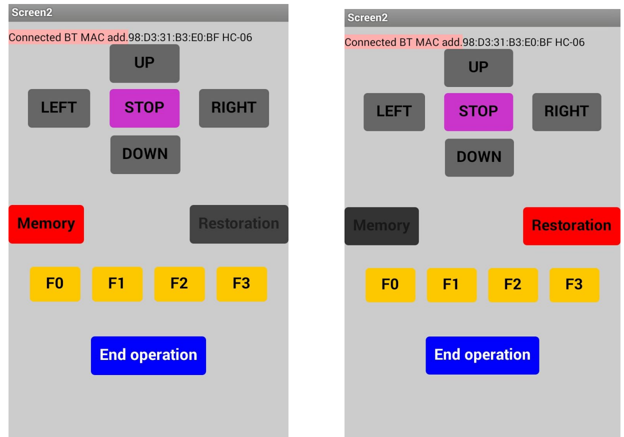


Figure 14. The prototype picture of the completed proposed system, it includes a mechanical mechanism, an ECU, and an intelligent mobile device.

Fig. 15 shows some typical operating screens which are implemented on the HMI of an intelligent mobile device. Fig. 15(a) is the initial screen which represents that the wireless Bluetooth communication interface between the client and server terminals has not been established. Firstly, the user has to select a hoped connecting server terminal from the paired lists. Then, user presses the connection button. If this connecting requirement is successful, the connecting label shows a sentence, like □Device is connected□, otherwise it shows, like □Disconnected□. Moreover, the user will be required to input a password and then press a verification button. If the input password is correct, user can continue to operate the next operation. Otherwise, the HMI will display a words like□Fail□. User is required to input another new password until the input password is correct. If the password verification passes, three selection items appears on the operating screen, as shown in Fig. 15(b). The first selection item is password update. The designing purpose of this item is for providing user to input a new password to take place an old one. The second selection item is the starting operation. When this item is enabled to work, the HMI will be changed into a new operating screen, as demonstrated as in Fig. 15(c). This new operating screen can further be divided into three parts according to their function, such as dual-axis inclined angles adjustment, memory, and restoration. In Fig. 15(c), the inclined angle of the proposed system can be adjusted to incline towards up, down, left, right, or stop and so forth. Once the dual-axis inclined angles achieves the anticipated angles. The system operation usually enters the inclined angles memory stage. Firstly, user needs to press the memory button and then chooses one of fast keys, F0~F3, (in fact, it represents a memorizing location in the single chip) to memorize the adjusted dual-axis inclined angles. Finally, user only presses the end operation button. The system operation ends towards the initial screen and breaks the wireless Bluetooth communication interface too. Fig. 15(d) shows the restoration operation regarding to the memorized dual-axis inclined angles. In the similar to the memory action, user should first press the restoration button and then choose one of fast keys to recover a group of dual-axis inclined angle from the single-chip memory.




(a) (b)




(c) (d)

Figure 15. Different operating screens of the HMI (a) initial screen (b) three selection items (c) memory operation (d) restoration operation

## VI. CONCLUSIONS

Usually, the controller of the conventional electric automotive rear-view mirror is only constructed by some mechanical switches. Only dual-axis inclined angles are provided user to adjust. For a multi-user vehicle, the operating convenience is a critical issue. To solve this problem, a new automotive rear-view mirror with their individual electronic controller is developed in this paper. Not only the conventional dual-axis inclined angles adjusting function is kept, but also there are two functions, such as memory and restoration functions are introduced. All the operations are ordered by user through the HMI. After the single chip has received the ordered command from user, the real controlling actions are driven by the single chip on the ECU. A prototype of the proposed system has been established in the laboratory. Some experiments were carried out on this experimental prototype. Experimental results showed that the mechanism and its controller of proposed new proposed system and its controller are actually feasible. Since the proposed system is not necessary to be connected with the automotive computer system, in other words, it can be worked stand alone. Easily to take place the conventional one, therefore, it is very suitable for being used in the low-end and middle-end vehicles. At present, the proposed system has obtained the patents of Taiwan and China and completed international patent record of PCT.

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