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Research Article

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Intelligent Drunk Driving Detection System Design Based on Alcohol Sensors and Relays

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Abstract The alcohol sensor has ability to transfer analogue alcohol density data to digital data values. Its applications are covered very wide such as in testing drivers' drinking, hospitality and other industrial applications, etc. due to the robust sense abilities of electrochemistry. In this paper, it is utilized to get data then transfer these data to window of PC by serial connection with Arduino board. Finally, the control of relay device will be used to design an intelligent drunk driving detection system (IDDDS) to decide the vehicle starting system should be powered on or not. The simulations and experimental results show that the good performances are possessed.

Keywords Arduino, Alcohol Sensor, Relay, Intelligent

1. Introduction

The Arduino introduced in 2005 is a free used software and hardware tool. All designers can develop their products by this free development kit. It is a friendly kit which is very easy to learn and combine with other devices and sensors. Now, it has also become a popular test platform to learn, design and develop any applications [1, 2]. The alcohol sensor supported to Arduino has been made and can be used to detect alcohol density on human breath. The alcohol sensor is an electro-chemical sensor based on element of SnO2. It possesses good performances of sensitivity and response time. Alcohol sensor can provide an analog resistive output based on alcohol density. The electrical circuit is very simple and just needs one resistor [2]. Many researches about alcohol applications have been proposed recently [3-5]. In [3], the high sensitivity of the sensor to the ethanol could be explained on the basis of a SnO_2, ZrO_2 activity that invokes the acid-base properties of sensing materials towards the sensitive detection of ethanol vapor in air. In [4], the alcohol sensor is developed to serve the interlock system of vehicle. In [5], the methodology has been developed to judge the driver has alcohol in the breath or not and warn will be activated by buzzer.

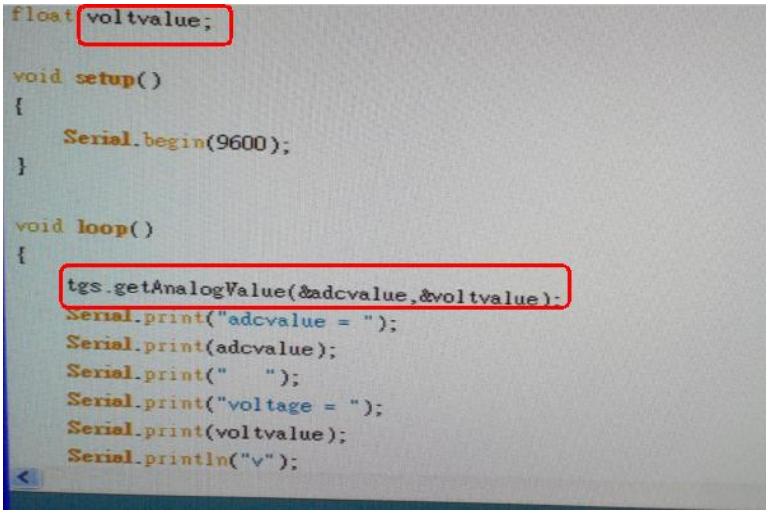
A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal [6]. Relays are amazingly simple devices. There are four parts in every relay including electromagnet, armature, spring and set of electrical contacts. A relay consists of two separate and completely independent circuits. The first is at the bottom and drives the electromagnet. In this circuit, a switch is controlling power to the electromagnet. When the switch is on, the electromagnet is on, and it attracts the armature. The armature is acting as a switch in the second circuit. When the electromagnet is energized, the armature completes the second circuit and the power is on. When the electromagnet is not energized, the spring pulls the armature away and the circuit is not complete [7]. The related researches have been proposed recently [8-10]. In [8], a new approach is introduced such that the digital

logic principle is applied to relay control circuit. In [9], a novel hybrid relay control mechanism (HRCM) that includes the static relay pre-configuration and the dynamic relay selection is designed for the ribbon topology in the low-voltage power line communication networks. In [10], a single symmetrical relay test is performed to estimate up to five unknown parameters of process model.

Drunk driving has been the main topic of traffic safety. Many countries have set strict penalties for drunk driving. However, it is important to precautionary, so drunk driving can be detected before driving, as well as let the car can not be started by drinking driver. Many researches are proposed to avoid drunk driving [11-13]. In [11], the combined-use of alcohol and energy drinks has been discussed such as to avoid potential injuries. In [12], the research was proposed to learn whether crash severity increased with alcohol involved risky behaviors. In [13], the safety system is proposed to improve safety laws and regulations. In this paper, the alcohol sensor and relay device are combined and is based Arduino board [1] to develop intelligent drunk driving detection system (IDDDS) such as to control vehicle starting system. In test implementations, alcohol data will be shown in PC window. The relay test will be verified by LED lights and power line light. The experimental results show that the good performances are possessed.

2. Intelligent Drunk Driving Detection System (IDDDS) Design

The Arduino software is free and is provided as an integrated development environment (IDE) [2]. The free open-source Arduino Software IDE is an easy use and development software such that the programming code can be compiled and upload easily to the Arduino board. The programs are written by C language and there are many supported libraries packages can be included. After the software is installed in personal computer successfully, then any applications can be developed by connecting any sensors. In this paper, the Arduino ADK is used by combining alcohol sensor and relay device. The Arduino ADK is a microcontroller board based on the ATmega2560. It has a USB host interface to connect with Android based phones, based on the MAX3421e IC. It has 54 digital input/output pins, 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. The ADK has 256 KB of flash memory for storing code (of which 8 KB is used for the bootloader), 8 KB of SRAM and 4 KB of EEPROM [1]. The programming can be combined with the libraries supported by Arduino. At first, the alcohol sensor board should be connected with ADK, then select board type and COM port number suitable. There are three steps should be done. First is compiling, second step is to upload the machine code to ADK, finally is to open serial window to monitor data of alcohol sensor. For program diagram of alcohol sensor is shown in Fig. 1 and program diagram of relay device is shown in Fig. 2. The design concept diagram is shown in Fig. 3. The determination vehicle starting signal will be generated by fuzzy methodologies [14-17]. The fuzzy algorithm is a two inputs one output system which is shown in Fig. 4. The driver and passengers are considered to let fuzzy implementation can be processed to generate determination signal to control relay. The relay devices will to shutdown the vehicle starting system if the driver's alcohol density is over threshold value of fuzzy inference.



```
float voltvalue;

void setup()
{
    Serial.begin(9600);
}

void loop()
{
    tgs.getAnalogValue(&adcvalue,&voltvalue);
    Serial.print("adcvalue = ");
    Serial.print(adcvalue);
    Serial.print("    ");
    Serial.print("voltage = ");
    Serial.print(voltvalue);
    Serial.println("v");
}
```

Figure 1: The Arduino program for alcohol sensor window

```
if(key.CheckKey(1) == 1)
{
    led.LedToggle(1,0);  // Light On Led1 (Red)
    delay(500);
    led.LedToggle(1,0);  // Light Off Led1 (Red)
    delay(500);
    relay.rON();
}
if(key.CheckKey(2) == 1)
{
    led.LedToggle(1,1);  // Light On Led1 (Green)
    delay(500);
    led.LedToggle(1,1);  // Light Off Led1 (Green)
    delay(500);
    relay.rOFF();
}
}
```

Figure 2: The Arduino program for relay device

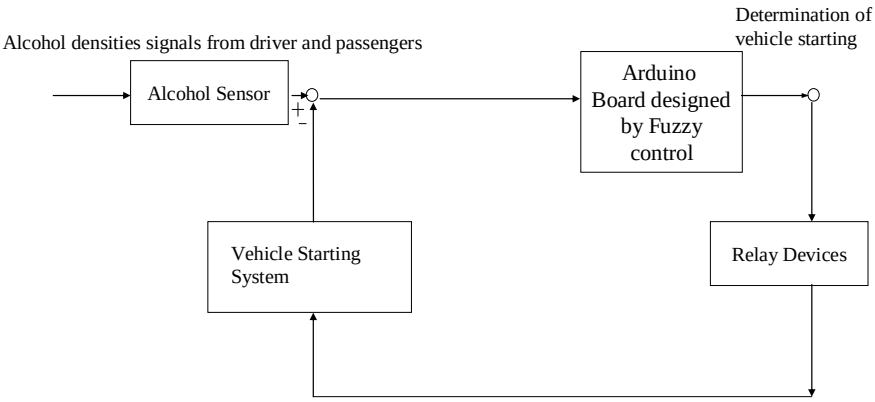


Figure 3: The design concept of IDDDS diagram

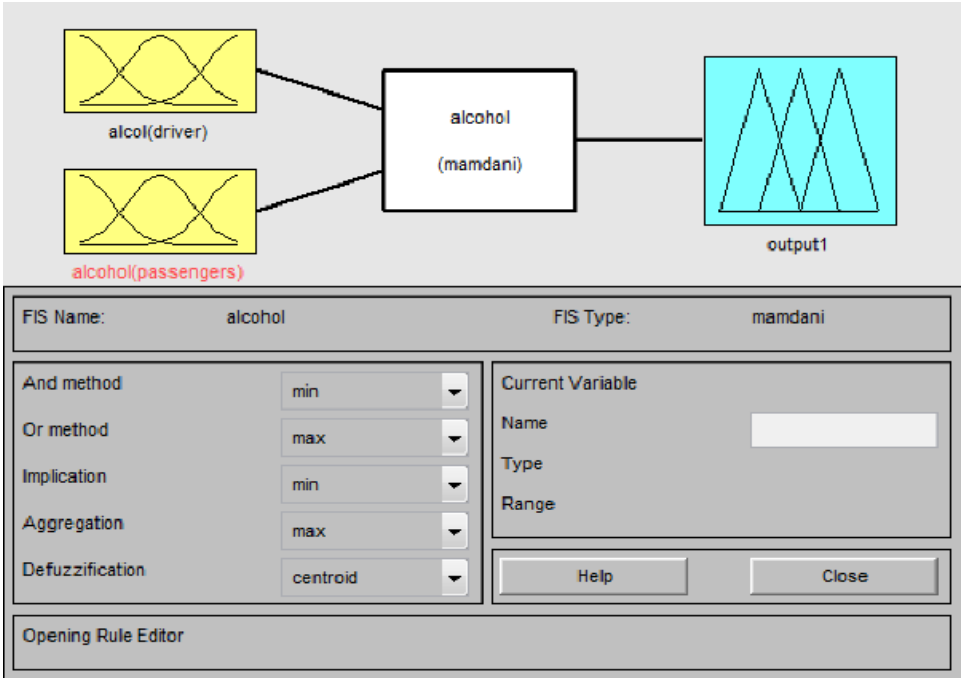


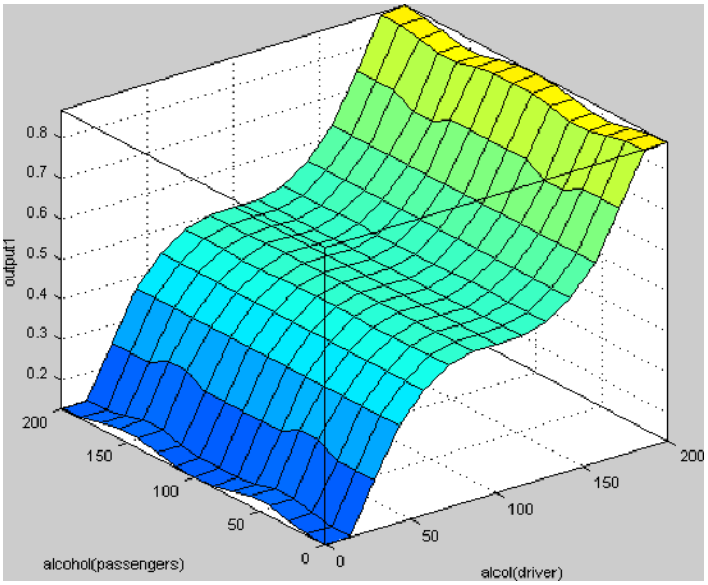
Figure 4: The fuzzy design window diagram

3. Simulation and Empirical Test Results

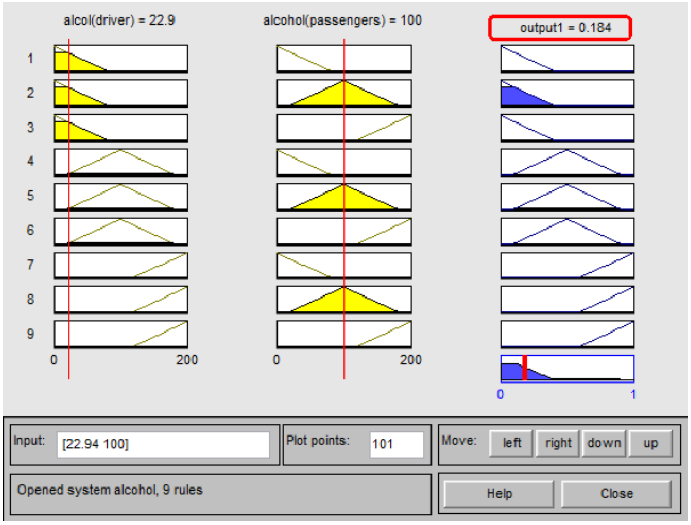
In this section, the simulation and empirical test will be processed. In simulation part, the fuzzy controller design is main part. The design is proceeded under the consideration of driver and passengers. So the fuzzy controller will have two inputs which are driver and passengers. In this consideration, the alcohol sensors of driver and passengers are necessary such that the data can be achieved. The simulation results are shown in Fig. 5. The diagrams are demonstrated that when driver's alcohol density is over the threshold then the vehicle starting system will not be working. When the passengers' alcohol densities are over threshold the starting system of vehicle will not be influenced.

For the empirical test, the alcohol board and relay device must be connected with Arduino board at first. The alcohol sensor diagram is shown in Fig. 6 and the relay device is shown in Fig. 7. After all connections are successful, the Arduino ADK will run the program. If the initial setup procedures of alcohol sensor and relay device are successful then the data of alcohol sensor will be shown in window such as in Fig. 8. The relay device will be activated as in Fig. 9.

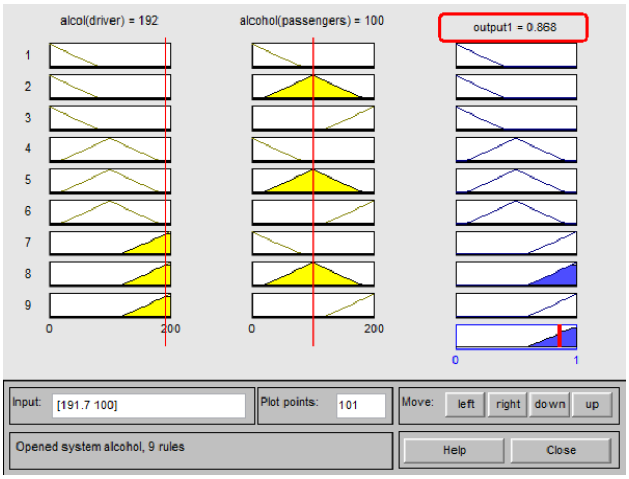
From the simulation results, the Arduino board programming, tests of alcohol sensor and relay device, a reliable application of vehicle safety system of vehicle starting system for avoiding drinking driving is got. From these results, the good simulation results and experimental results are achieved in this paper.



(a)



(b)



(c)

Figure 5: The simulation results of fuzzy inferences

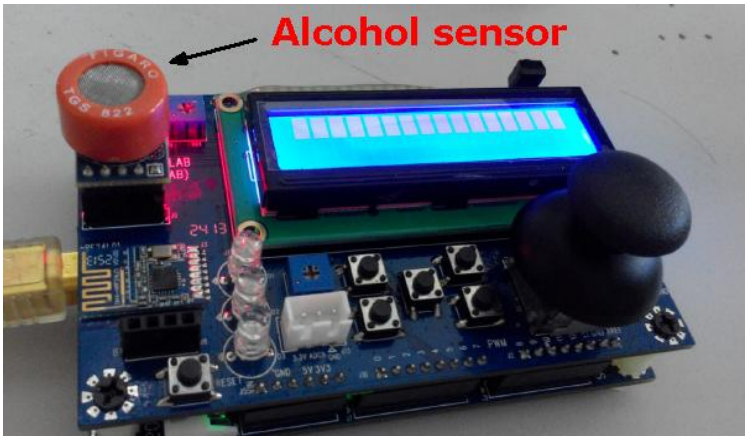


Figure 6: The alcohol sensor diagram

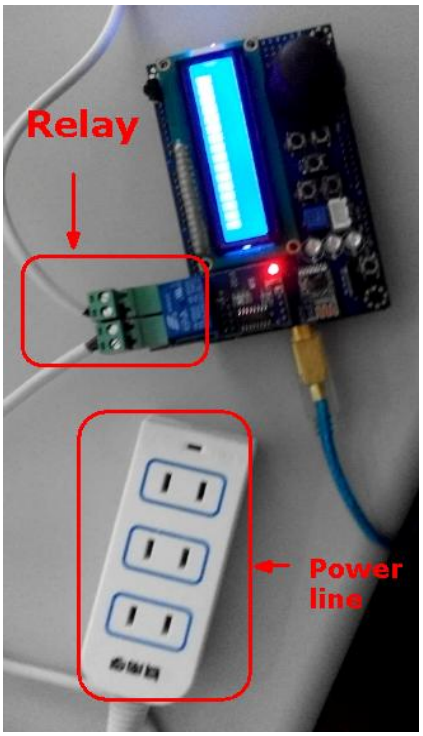
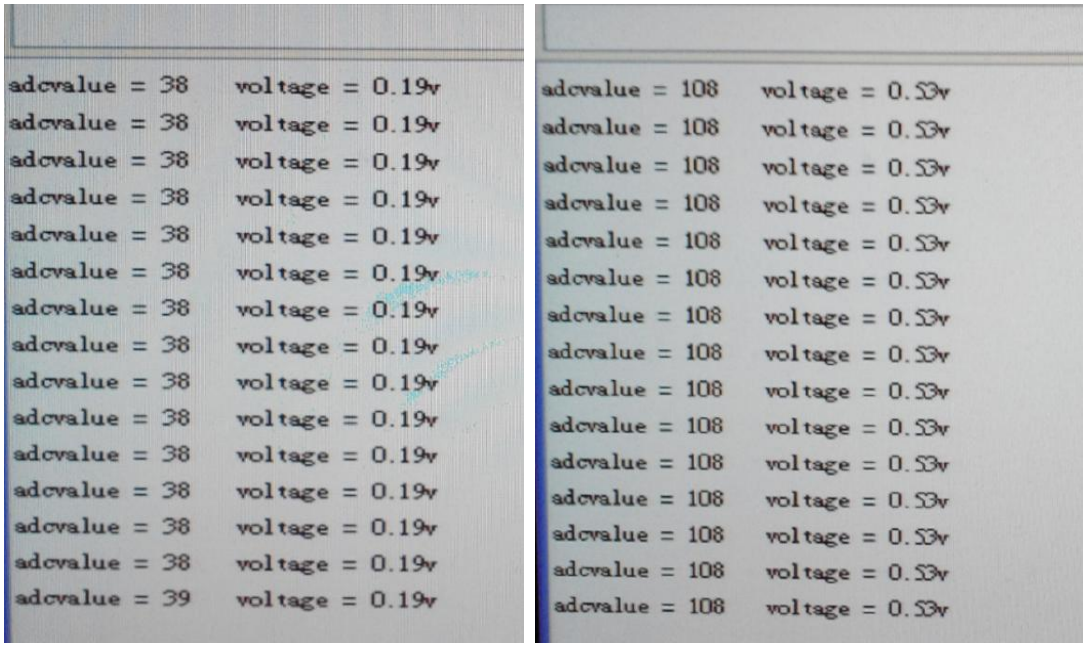
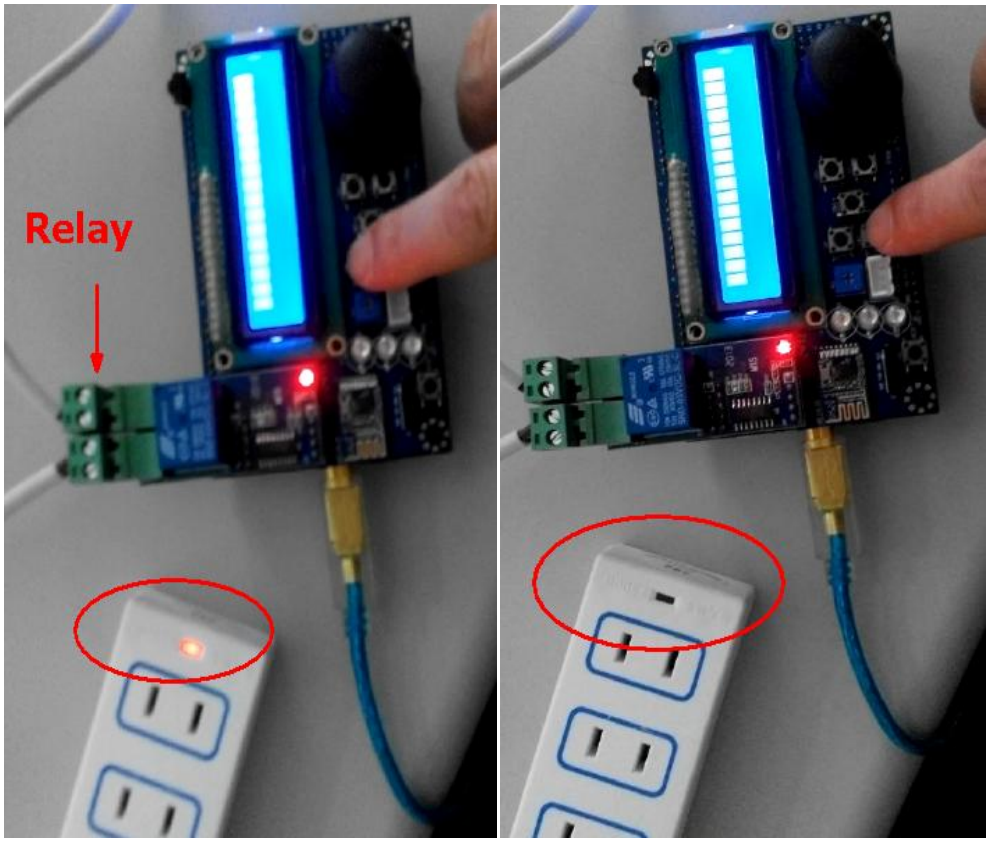


Figure 7: The relay device diagram



(a) *(b)*

Figure 8: The alcohol sensor data diagram which (a) is not drinking and (b) is drinking



(a) *(b)*

Figure 9: The relay device diagram which (a) is on and (b) is off

4. Conclusion

In this paper, the Alcohol sensor and relay device implemented to vehicle starting system by fuzzy control for Arduino board has been developed successfully. This is verified by the fuzzy simulations and empirical tests of

alcohol sensor and relay device module. The development of vehicle starting system control application can be used to develop other different useful applications such as industry, consumer electronics and building electronics, etc. The simulation and experimental results demonstrate that the effective performances are possessed.

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