Smart Locker System using Nuvoton NUC140VE3CN Development Board

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ABSTRACT

A smart locker system has been introduced in this project. It is more convenient to be used and has improved safety as it requires a unique access code to unlock it. User availability in front of the locker is detected by the ultrasonic sensor, they will be greeted through an LDR and then be prompted to enter the password. If the password entered is correct, the locker will be unlocked and the door is opened. The LED inside the locker will light up when the door is opened. The user can use the locker more comfort and convenience in a dark condition. The user needs to enter the correct password again to close the door to ensure double safety. If the password is entered wrong 3 times continuously, the alarm would be activated. The activated alarm only can be deactivated by pressing a reset button allocated at the security room. After deactivating the alarm, the user is still able to use the locker by just waving again at the ultrasonic sensor and the system would be reloaded. When someone is going to destroy and damage the locker, their action will be sensed by the IR sensor and the alarm will be activated to warning the saboteurs. The alarm will stop to beep once the destroyer stop to wreck the locker. The implementation of the prototype is monitored well by several steps including the planning of the project, information researching, construction of codes, test runs, troubleshooting and fabrication of prototype to ensure a successful prototype is produced. Overall, the smart locker developed would bring great convenience and privacy to the users.

Keywords: *automated; embedded system; security.*

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1. INTRODUCTION

Lockers are commonly found in various public places such as locker rooms, workplaces, schools, and universities. They normally vary in size, purpose, construction, and security. The typical lockers are usually equipped with a lock, which has a lower level of security and requires the users to unlock with a key. The probability of privacy invasion is high as lock picking happens a lot nowadays. The use of traditional lock becomes less safe because it can be easily damaged by others. Smart locker is developed in such a way that it has an alarm system that guarantees a higher security level and brings great convenience to people as it requires no physical key to unlock it. The smart locker becomes more user-friendly by an automatic lighting system.

The security sector is given the most attention while users are reviewing lockers. Using a typical locker can be challenging as lock picking happens a lot nowadays. People are looking for a smart and more safety system to ensure their privacy protection. The problem of vandalism needs to be highlighted. It always costs a lot of money to renew, maintain and repair this kind of communal facilities. The security level of a typical locker is too low such that it is not installed with an alarm system. In addition, it is difficult for people to use a typical locker in the dark for searching their belonging as most of the locker does not include lighting system.

In general, an automatic locker system using the Nuvoton development board is developed. Below is a list of the objectives

i. To design a high safety system for the locker by prompting the user to enter the unique access code before opening the door using a servo motor.

ii. To design an alarm system that ensures the safety of the locker and the property inside the locker.

iii. To design an automatic lighting system that enhances the user's experience during night time.

1.1 Literature Review

Around 2000BC, the oldest mechanical functioning lock was an Egyptian door lock which is made of wood and fastened vertically on the doorpost. The wooden block contained moveable pins or “pin tumblers” that are dropped by gravity into openings in the crosspiece of “bolts” and locked the door [1]. It could be opened with a wooden key with pegs that raised the number of tumblers sufficiently to clear the bolt so that it could be pulled back.

However, in this fast-growing technology era, the lock has evolved from a pure mechanical type into an electrical and electronic type which requires an authentication method. In the current market, there are many authentication methods to trigger the electronic lock including the button sequence, radio frequency identification (RFID), biometrics, security token, and etcetera. In general, Automation has become a new trend in designing an embedded system in various area such as monitoring systems [2], medical applications [3], optimization [4, 5], decision making [6, 7, 8].

The implementation of these high-tech locks guarantees a more secured locker which can prevent lock picking by the intruders. For an electronic code lock, which is designed to respond to an electronic logic signal mechanism, is implemented with a digit sequence counter performing the function of a key. They are operated by inputting the correct code through a keypad into a microcontroller which already has a pin number in its EEPROM memory (internal) to compare with so that if it is correct, it activates the port to which the load (door) is connected.

2. METHODOLOGY

2.1 Hardware Description

NUC140VE3CN Nuvoton board is an evaluation board with NUC100 series microcontrollers. This microcontroller provides many different development environments for NUC140 microcontrollers, integrated timers, watchdog timers, RTC, PDMA, UART, SPI, I2C, PWM, GPIO, LIN, CAN, USB, ADC and others. The development board can be programmed using C language with the aid of software Keil version 5 to perform a specific function. External components can be interfaced with the Nuvoton board through the GPIO pins. Nuvoton board consists of a buzzer, LEDs, 3 X 3 key matrix, 128 X 64 Dot Matrix LCD panel, four 7-segment, LEDs, variable resistance, UART port, USB port, GPIO external pins and debounce switches.

The Nuvoton NUC140VE3CN development board is shown in Fig 1 with block description [9].

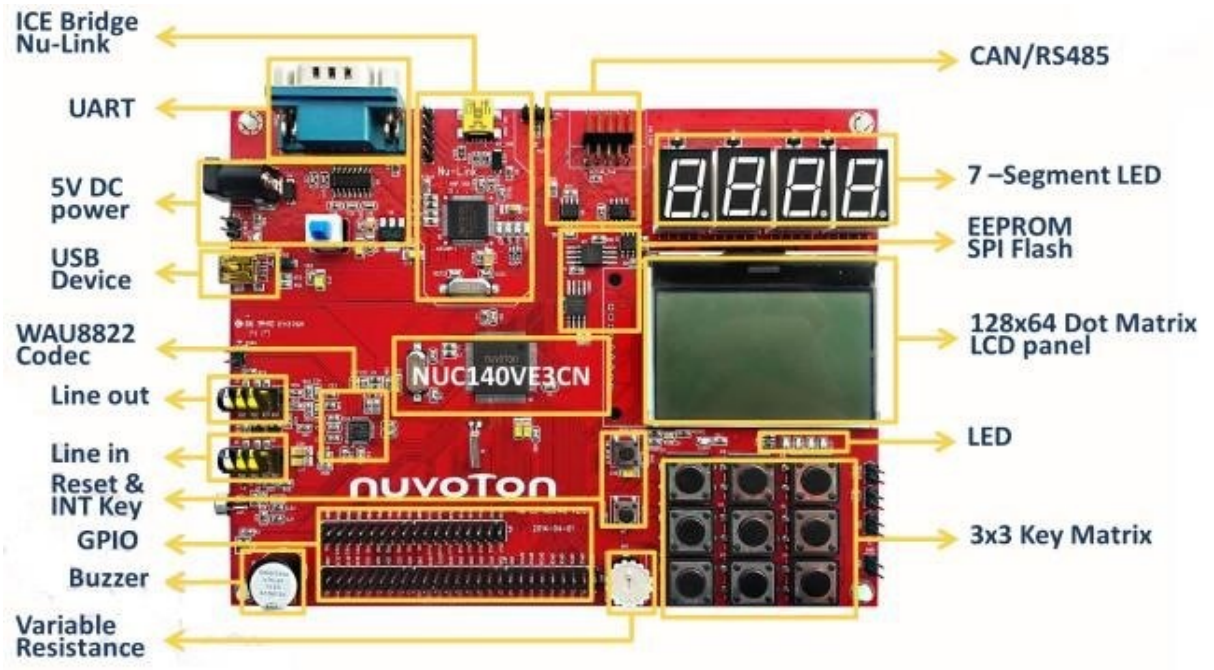

Fig. 1. Nuvoton NUC140VE3CN board with the function of block tagged

This experimental section can be divided into subsections, the contents of which vary according to the subject matter of the article. It must contain all the information about the experimental procedure and materials used to carry out experiments.

2.2 Schematic diagram

A circuit is set up as shown in Fig 2. An external LED that used as a light bulb is connected to pin 7 of GPB port. The RX pin of the IR sensor is connected to pin 8 of the GPA port.

The servo motor that used to open the locker's door is connected to pin 9 of the GPA port. The trigger pin of the ultrasonic sensor is connected to pin 10 of the GPA port and the echo pin of the ultrasonic sensor is connected to pin 11 of the GPA port. The built-in buzzer is controlled by pin 11 of GPB port. The reset interrupt button is controlled by pin 15 of GPB port. After connection had done, a complete assembly source code was uploaded to the microcontroller. In the source code, pin 7, 9, 10, 12, 13 of GPA port, pin 11 of GPB port and pin 15 of GPC port are declared as the output port while pin 8, 11 of GPA port and pin 15 of GPB port are declared as the input port. Fig 3 shows the block diagram of NUC140VE3CN Nuvoton board interfaced

with the electronic components.

Table 1. List of components used in the project

Components	*Quantity*
NUC140VE3CN Nuvoton board	1
Ultrasonic sensor	1
Servo motor	1
IR sensor	1
LED	1
Resistor	1

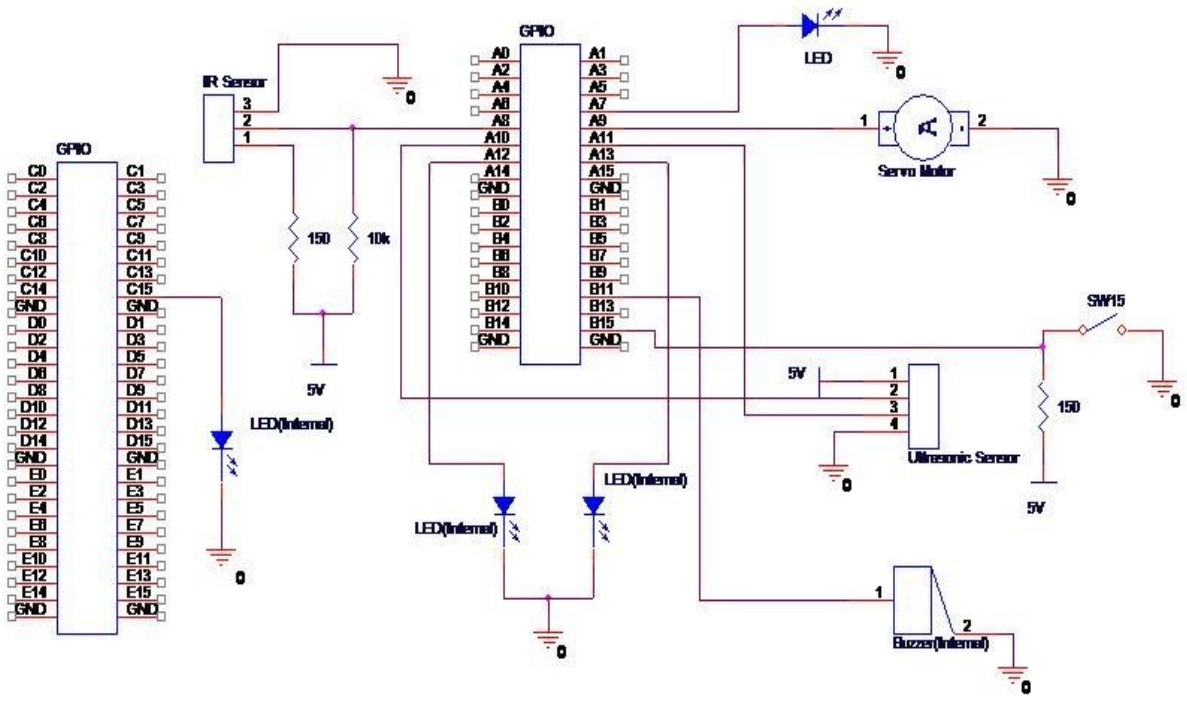

Fig. 2. Schematic circuit designs of Smart Locker System.

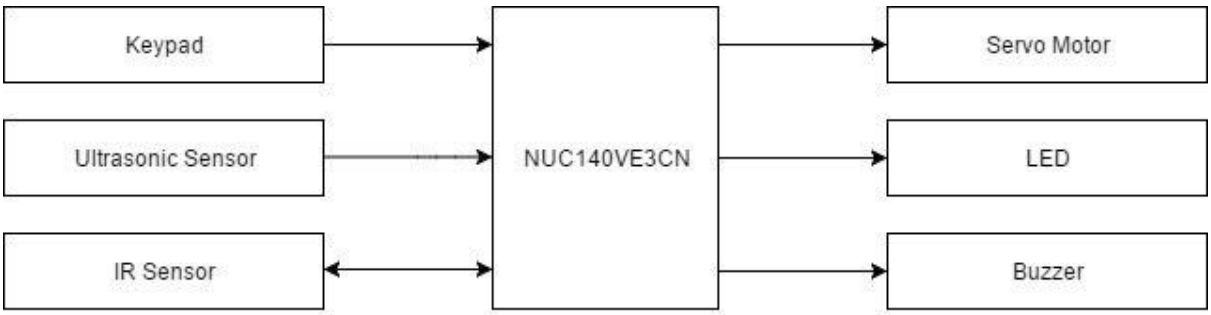

Fig. 3. Block diagram of Smart Locker System.

3. RESULT

At the beginning of program execution, the main program will not start to function unless the ultrasonic sensor detects some object is placed at a distance of 5 cm in front of it. The welcoming message and asking for a password message will be displayed once the ultrasonic sensor sends the signal to LCD. When the IR sensor detects someone wants to destroy the locker, the buzzer will be activated and a warning message will be displayed.

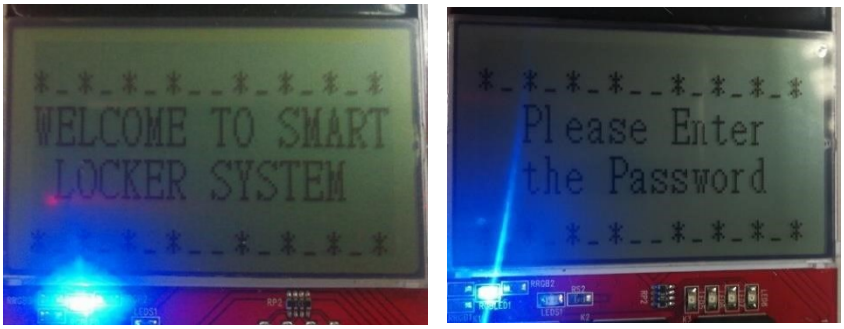

Fig. 4. The welcoming message and user allow to enter the password

The welcoming message is displayed once the user is available, and the user is allowed to enter the password as shown in Fig. 4. If the correct password (password=4258) is entered, the servo motor will start to rotate to open the door. Once the door is opened, the external LED (light bulb) will switch on as shown in Fig. 5.

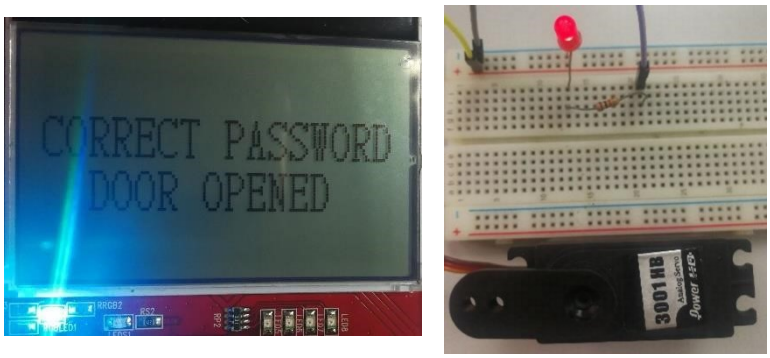

Fig. 5. Correct password enter and servo will opened the door

If the wrong password is entered, the LCD will display the wrong password message and the buzzer will ring one time. If the wrong password is entered three times, the LCD will display the message as shown in Fig. 6 and the buzzer will continue to ring until the reset button is pressed.

Fig. 6. Wrong password enter

Table 2 summarizes all the available condition can occur while the system fully operated. The system also can identify the type of available person approach the Smart Locker System as shown in Table 2.

4. CONCLUSION

In this project, a smart locker successfully being developed using the NUC140VE3CN Nuvoton board. This system uses components such as the NUC140VE3CN Nuvoton board, ultrasonic sensor, IR sensor, servo motor, and buzzer. Each of them performs different functions to build up the functional smart locker.

Table 2. Summarized all the available condition can occur while the system fully operated

User (Ultrasonic Sensor)	*Intruder (IR Sensor)*	*Reset (Interrupt Button)*	*Password (Keypad)*	*Door (Servo Motor)*	*Blue LED*	*Green LED*	*Light Bulb (LED)*	*Red LED*	*Buzzer*
Less than 5 cm	No	No	Correct	Open	ON	ON	ON	OFF	OFF
Less than 5 cm	No	No	Wrong	Close	ON	OFF	OFF	ON	ON
More than 5cm	No	No	-	Close	OFF	OFF	OFF	OFF	OFF
-	Yes	No	-	-	-	-	-	ON	ON
-	-	Yes	-	Close	OFF	OFF	OFF	OFF	OFF

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