Automatic Secure Locker System (SLS)

F. H. Anuar, S. S. N. Alhady*, A. A. A. Wahab*, Y. E. Chew

School of Electrical & Electronic Engineering, Universiti Sains Malaysia, 14300 Nibong Tebal, Pulau Pinang, Malaysia

**Corresponding E-mail: sahal@usm.my, aeizaal@usm.my*

Abstract— Nowadays, the demand for an effective locker system is higher due to the increase in safety. The ineffective locker system will cause valuable things could not be safe. To solve those problems, we come put with an idea to create a Secure Locker System (SLS). In this project, SLS was designed by using Nuvoton Development Board NUC140 interfacing with external hard-wares such as servo motor, tilt sensor module, and Bluetooth module. The fundamental c language such as if-else, while-loop, string, array, etc. was used to write the coding of the SLS. The program of this prototype was separated into three important parts they are keypad password lock, servo control, Bluetooth wireless password lock, and vibration detection to activate the buzzer. The main program of the project is keypad lock, whereas the interrupt program is the button to turn off the buzzer and the UART interrupt used for Bluetooth device. LCDs display the information and status of the locker. The locker would be unlocked if the correct password was inserted. The security checking system denied access to the locker if the entered password is incorrect. If the incorrect password was keyed in three times, the buzzer will ring to alert the people's surroundings. When someone is trying to move or vibrate the locker, the buzzer would also ring. The user was able to unlock the in future, the SLS can be improved with the RFID system and the IoT system.

Keywords— Automation; Embedded System; Security

I. INTRODUCTION

Security alarms could be used in residential, commercial, industrial and military properties for protection against burglary or property damage, as well as personal protection against intruders. It could be implemented in many fields. For example, personal assets such as cars, houses, and prisons. Either both of them were having their security system, which protects them from being stolen or being broken-in. Prisons also use security systems for the control of inmates.

Thus, we decided to design a Secure Locker System (SLS) by applying knowledge on the NUC140VE3CN Nuvoton Board and C Programming language. We aim to provide a security lock to the lockers of workplace and house, sensors on the door and an alarm. In this project, we use keypad, LCD, Servo motor, IR Sensors, Resistors, LEDs and Bluetooth module.

Security is a major problem in our daily life due to an increase in cases of robberies caused by insecure lockers. In the era of automation technology nowadays, the locker has undergone the new evolution of development with the advancement of a microprocessor. This automation has been applied to various areas such as medical applications [1, 2], monitoring systems [3, 4], optimization [4, 5], decision making [6, 7]. The secure locker system can bring advantage to the user such as to provide a more secure space..

Traditional lock-and-key access locker is an outdating system as the user is prone to forget or misplace their keys. Usually, we will make spare keys for our family members just in case of an emergency. For example, door lock, room key,

and car key. Thus, the locking system plays an important role in providing an efficient locking system [8].

II. METHODOLOGY

Fig 1 above shows the block diagram between the Microcontroller Nuvoton and components also the concept of the circuit functionality. Keypad, 4x16 LCD, LEDs, switch button and buzzer are built on the board while one servo motor, 2 IR sensors, and a Bluetooth module are used as external components. LCD, servo motor, buzzer, and LEDs act as output devices. Meanwhile, keypad, IR sensors, switch button and Bluetooth module are used as input devices. Based on the block diagram above, a circuit is designed and programmed by using C language.

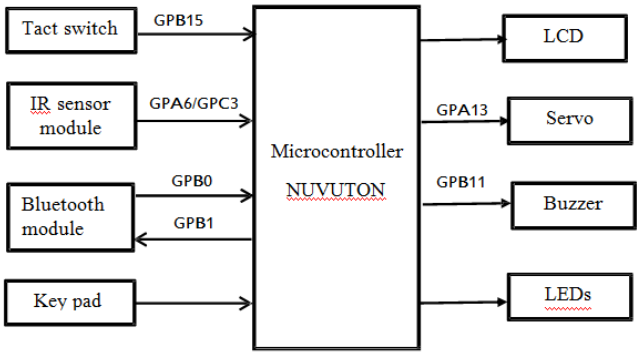

Fig. 1 Block diagram of the Secure Locker System

A. *Nuvoton Development Board NUC140*

Nuvoton Development Board NUC140 series are ARM® Cortex™-M0 core embedded microcontroller for industrial control and the applications which need rich communication functions. The Cortex™-M0 is the newest ARM embedded processor with 32-bit performance and at a cost equivalent traditional 8-bit microcontroller.

The NUC140 series with Cortex™- M0 core runs up to 50MHz, up to 32K/64K/128k-byte embedded flash and 4K/8K/16K-bytes embedded SRAM. It also integrates Timers, Watchdog Timer, RTC, PDMA, UART, SPI/SSP. I2C, PWM Timer, GPIO, LIN, CAN, USB 2.0 FS Device, 12-bit ADC, Analog Comparator Low Voltage Detector and Brown-out detector. The onboard components such as LCD, keypad matrix, buzzer, LEDs, and interrupt button are used to implement the digital safe locker.

B. *Bluetooth Module*

HC - 05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. The HC-05 Bluetooth Module can be used in a Master or Slave configuration, making it a great solution for wireless communication.This serial port Bluetooth module is a fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with a complete 2.4GHz radio transceiver and baseband. It uses the CSR Bluecore 04 - External single-chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature). Table 1 shows the pin available on the Bluetooth module.

TABLE I
PIN DESCRIPTION OF BLUETOOTH MODULE

Pin	Pin Name	Description
1	Enable/ Key	This pin is used to toggle between Data Mode (set low) and AT
2	Vcc	Power the module. Connect to +5V
3	Ground	Ground pin of module, connect to system
4	TX-Transmitter	Transmit Serial Data. Everything received via Bluetooth will be given out by this
5	RX-Receiver	Received Serial Data. Every serial data given to this pin will be broadcasted via
6	State	The state pin is connected to on board LED, it can be used as a feedback to
7	LED	Indicates the status of Module □ Blink once in 2 Sec: Module has entered Command Mode □ Repeated Blinking: Waiting for Connection in Data Mode □ Blink twice in 1 sec: Connection successful in Data
8	Button	Used to control the Key/Enable pin to toggle between Data and command

For the password system, the only correct password is allowed to unlock the door. First of all, the password system will start with some setup before it can be used. A keypad is used to allow a user to key in the code. 4x16 LCD is used to

display the message. When the system is activated, the system will ask for a set of default passwords. The default password is a factory code which used to activate the password system.

This code will only give to the owner who bought this system. The default password consists of 6 digits and not editable. The default password of the Locker is “111111”. After that, the user can choose to change the password or continue using the default password. The password can be changed by key in the password master code. The master code consists of 6 digits and not editable which is “123456”.

The system will enter password resetting mode which requires a user to enter the new password to replace an old password. User needs to enter the new password twice to check as confirmation. Once the new password matched, the user can use the new password to unlock the locker.

If the user entered the correct password that matches the preset password, the servo motor will turn 90-degrees anticlockwise which indicates that the locker is opened.

When the IR sensor which connected to GPC6 deactivated, the servo motor turns 90-degrees clockwise which indicates the locker is closing or lock. IR sensor also used to detect the closure of the door.

Furthermore, if the user key in wrong passwords 3 times continuously, the system will temporarily lock and triggered the buzzer to warn its surroundings. To turn off the buzzer, the user needs to press the interrupt button GPB15.

III. RESULT

In the beginning, the 4x16 LCD screen will display the main page as shown in Fig 2. Users will be asked to key in the password. By default, the password will be "111111". The servo will be turning 90 degrees anticlockwise to unlock the door when the default password is key in by using a keyboard that is built on the Nuvoton board. The LCD will display messages and LEDG (GPA 13) will lights on as shown in Fig 3.

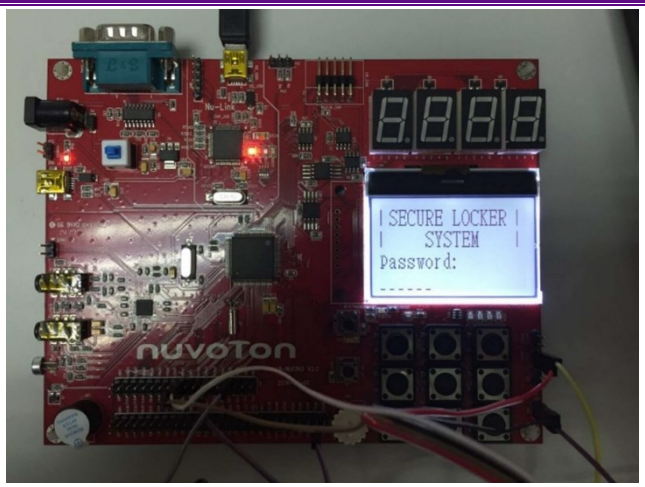

Fig. 2 Dislay of Main page

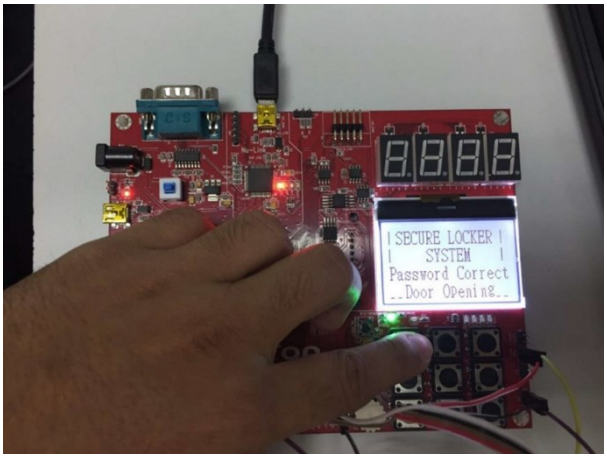

Fig. 3 Correct password enter

After the user closes the door, the IR sensor detects the presence of the door, the servo will automatically turn 90 degrees clockwise to lock the door. The LEDG (GPA 13) will light off. To reset the password for the door locking system, a master code which is "123456" is keyed into the system. After the master code is keyed in, The LCD will display messages as shown in Fig 4.

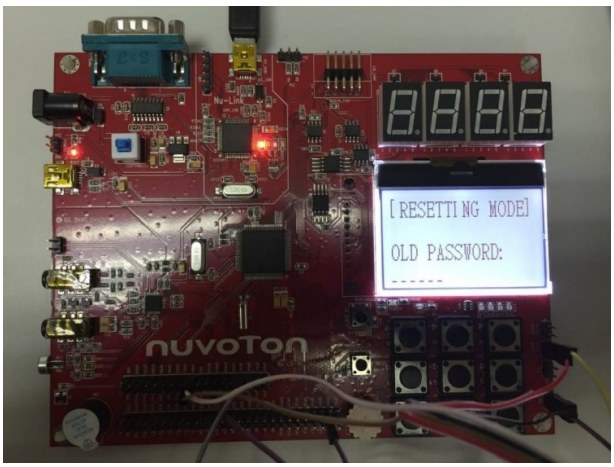

Fig. 4 Resetting password

The user has to key in the old password to proceed to the next step. Next, the system will ask the user to key in the new password twice for confirmation as shown in Fig 5 and Fig 6.

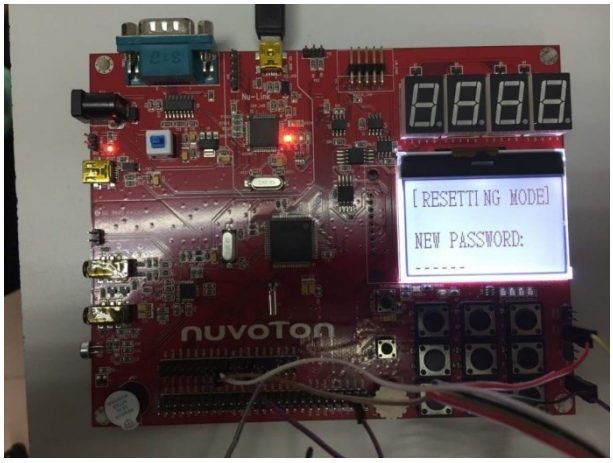

Fig. 5 Enter new password

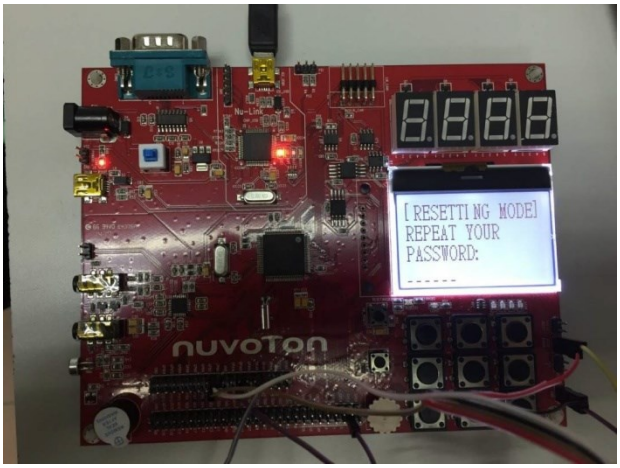

Fig. 6 Reenter new password

If the password is keyed in wrongly 3 times continuously, the system will temporarily be locked and the buzzer will ring. The LCD will display the message "Password wrong" and the LEDRs (GPB 12-14) will light on in sequence as shown in Fig 7. The user needs to press the interrupt button which is built on the Nuvoton board to stop the alarm.

If anyone breaks into the house through windows, an EMERGENCY message as shown in Fig 8 will pop out and the buzzer will be activated and ring. The user needs to press the interrupt button which is built on the Nuvoton board to stop the alarm.

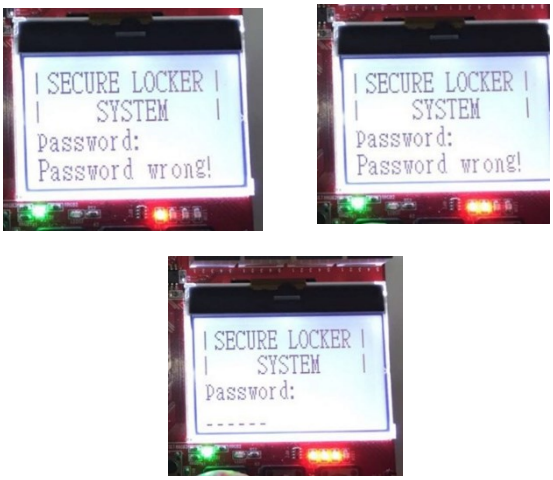

Fig. 7 LEDRs light in sequence while error detected

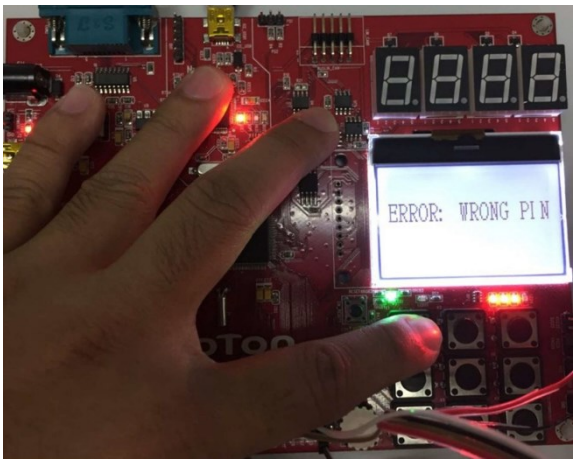

Fig. 8 Error message and buzzer for wrong pin activated

IV. CONCLUSIONS

The paper shows the successful development of the Secure Locker System. The SLS consists of keypad lock and wireless Bluetooth control. We increase the security and reliability by using the Alarm system. Plus, users can use the password to unlock the locker and reset the password when needed. If the user was unable to enter the correct password for 3 times continuously, the buzzer will trigger to alert its surrounding.

SLS has been designed by using the Nuvoton NUC140 development board. The fundamental knowledge and skills learned during lecture and lab sessions have being applied throughout this mini project. Moreover, this system is easy to use since it is a friendly user.

In the future, we can improve this system by implement Radio Frequency Identification (RFID)

which can save time and energy. Wi-Fi module and GSM module can be added to send a notification to the user the status of the Secure Locker System.

REFERENCES

[1] SSN Alhady, PA Venkatachalam, M Sulaiman. "Noiseless ECG monitoring system with integrated expert system". *IEE Conference Publication*. pp 79 – 87, 2000

[2] Tarmizi Amani Izzah, Syed Sahal Nazli Alhady, Umi Kalthum Ngah, Wan Pauzi Ibrahim. "A journal of real peak recognition of electrocardiogram (ecg) signals using neural network". *American Journal of Networks and Communications*. Vol. 2, Issue 1, pp 9 – 16, 2013

[3] AAM Zahir, SSN Alhady, WAFW Othman, MF Ahmad. "Genetic Algorithm Optimization of PID Controller for Brushed DC Motor". *Intelligent Manufacturing & Mechatronics, Springer*. pp 427 – 437, 2018

[4] NSS Hameed, WAFW Othman, AAA Wahab, SSN Alhady. "OPTIMISING PID CONTROLLER USING BEES ALGORITHM AND FIREFLY ALGORITHM". *Robotika*. Vol 1, issue 1, pp 22 – 27, 2019

[5] SSN Alhady, MR Arshad, MY Mashor. "Suitable features selection for HMLP network to identify R-wave in the ECG signal". *Proc. of the Intl. Conf. on Robotics, Vision, ROVISP Information and Signal Processing*. pp 871 – 875, 2005

[6] Syed Sahal Nazli Alhady, Mohd Rizal Arshad, Mohd Yusoff Mashor. "P, Q, R, S and T peaks recognition of ECG using MRBF with selected features". *Proc of the 4th WSEAS Intl. Conf. on Software Engineering, Parallel & Distributed Systems*. pp 21, 2005

[7] SSN Alhady, and XY Kai. "Butterfly Species Recognition Using Artificial Neural Network". *Intelligent Manufacturing & Mechatronics, Springer*. pp 449 – 457, 2018.

[8] Chaitanya Rane (2019, 23 Febuary). Password Based Door Locking System Using GS. Retrieved from http://www.ijetajournal.org/volume-2/issue-4/IJETA-V2I4P7.pdf.