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Design and Development of a Litho-code ID based Electronic Entry-control System

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ABSTRACT

Different card operated entry control systems have been developed. However, it is desired that the system is reliable, easy to implement and available at market. In this paper, we design and develop an electronic entry control system which is based on an ID card and ID card reader. In our system, the ID card contains encoded Litho-code ID and the card reader is used to read the encoded ID. We develop offline Software to collect user information, save data and to print the ID card. We design and develop the electronic card reader to capture the ID using infra-red (IR) sensors and for computer interfacing. We develop online software to process the signals exchanged between the card reader and CPU. In this paper, first we present the system layout and design outline. Then we explain the development and implementation methodology. Finally, we test the system and present the results.

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1. INTRODUCTION

Metal room keys are not secured as they can easily be duplicated. Metal keys are being replaced by electronically coded key-cards. Keycard systems operate by presenting the keycard to the card reader by swiping or inserting the card. Key-card control is computer-based and therefore creates the necessary audit trail automatically. One of the best security features is the ability of the computer to investigate each door lock and get a printout of everyone who accessed a particular room. The security advantage of the key-cards has made it popular and many medium and large sized hotels are adopting this key-card. There are several keycard systems as Mechanical keycard, Bar code card, Magnetic stripe card, Smart card, Biometrics and RFID proximity cards [1, 2]. The mechanical hole card operated lock [3] is a mechanical type of lock operated by a plastic key card with a pattern of holes. It contains 32 positions for possible hole locations, giving up to 2^{32} different keys [6]. Mechanical key cards or holecards made the re-keying of guestroom door locks and keys easier compared to the old metal key. In addition, a mechanical key does not require power supply to operate. It does not contain any memory retention part and therefore, does not provide an audit trail on its usage. The limitation of the Mechanical hole card operated lock is that since it operates by physically moving detainers in the locking mechanism with the insertion of the card, the detainers must be arranged in pre-selected positions by the key before the bolt will move. Bar code technology is not a secure form of a key, as the bar code can be copied in a photocopier and often read by the optical reader [1]. The limitation of Magnetic strip is that it contains up to only a certain amount of letters and words. Moreover, it can be

demagnetized or erased when placed near items with magnets such as mobile phones [1]. As the Smart Card contains memory retention part it is expensive and it provides an audit trail on its usage [1]. Biometrics system requires lot of data to be kept on a person. The system is not always reliable as human beings change over time due to illness such as puffy eyes, hoarse voice or roughness of the fingers from labor. Besides this, every time a person uses biometrics he/she is being tracked by a database bringing up a range of privacy issues. Some people don't like to register their fingerprint for an overnight stay [4]. Some common problems [5] with RFID are reader collision and tag collision. Hackers can use devices called "cloners" to gather encoded chip information. The cards are somewhat sensitive to physical damage. If they do get hurt they stop working at once since it changes the RF emission characteristics of the card.

Litho-code [6] is basically Binary code & Decimal number which is printed on the Optical Machine Readable (O.M.R.) sheet. Fig 1 shows how litho code is printed on an OMR sheet. Here "*" (Star bubble) represents the 1 of the Binary code & " " (blank bubble) represents the 0 of the Binary Code. In Bangladesh, OMR system [7] is used in student registration and result processing. In the registration process, data is captured from compatible scripts by scanning through O.M.R. (Optical Mark Reader) machine.

In this paper, our main focus is to design and develop an entry control system for any establishment which is based on ID card and ID card reader. In the Litho-code OMR system [6, 7], we observe that litho-code printed OMR sheet is scanned using OMR machine for student registration and result processing. Using the same concept of coding and scanning, we design and develop an entry control system based on litho-code printed machine readable ID card and ID card reader. Hence, the ID card is used as the key card and the ID card reader is used as the ID reader and gate operation controller. The ID cardholder is assigned a predefined individual ID number which is converted to binary code composed of data bits and check bits. The bits are then converted to Litho-Code of shaded and blank bubbles. The bubbles are then placed in a predefined random manner on the bottom of the card. The ID card is then printed on a transparent plastic paper. We develop offline Software to collect user information, save data and to print the ID card. We design and develop the electronic card reader to capture the ID using infra-red (IR) sensors and for computer interfacing. We develop online software to process the signals exchanged between the card reader and CPU. All individual units of the card reader have been designed and developed using inexpensive electronic components and simple reliable electronic technology. The ID card is easy to re-key and can be used for any number of guests or users depending on the number of bubbles used on the ID card. For example, for 8 bubbles 2^8 codes may be generated. In addition, the card does not require power supply to operate. It does not contain any memory retention part and therefore, does not provide an audit trail on its usage. It is applicable to any organization to control the entry to the room of individuals or office of large population. The above features make the system reliable, inexpensive, easy to implement and easy to reproduce for any establishment of large population.

The rest of the paper is organized as follows. In section 2, the system layout and design outline has been explained. The development and implementation methodology is explained in section 3. Test Results have been presented in section 4 and finally, section 5 concludes the paper with potential limitations and directions for future developments.

2. SYSTEM LAYOUT AND DESIGN OUTLINE

The entire system is divided into: Hardware, Offline software and online software as shown in Figs. 2, 3 and 4, respectively.

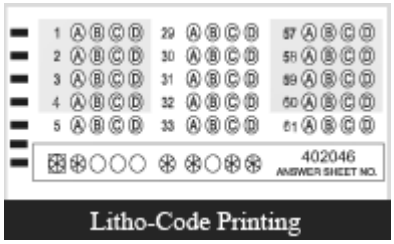

Figure 1. Litho-code printing on OMR sheet

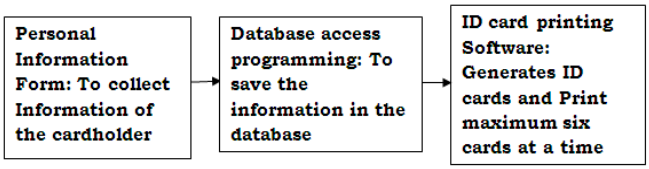

Figure 2. Offline software Layout

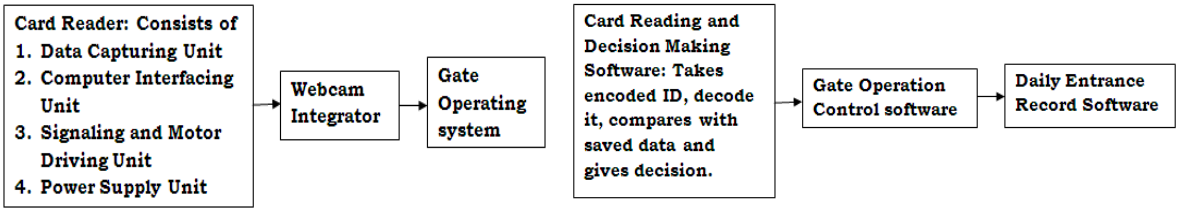

Figure 3. Hardware layout

Figure 4. Online software layout

3. DEVELOPMENT AND IMPLEMENTATION

In this section, the development and implementation methodologies have been explained with comprehensive discussion.

3.1. Offline software

We develop offline software to collect user information and to print ID card. The information form is the interface to collect information of the cardholder. The form provides various options like new data entry, search for existing data, modify data, delete data etc. The data is collected and saved in the database with an ID number. The ID card printing software generates and prints ID cards as required quantity. The ID card printing software generates Litho code from the ID which contains some bits, two of which are check bits, the rest are data bits. The ID is converted to binary code which is used as the data bits of the litho code. Check bits are used to check whether the card is inserted properly or not. We use Visual basic and Microsoft access to develop offline software. The Personal information form is developed using Visual basic to collect information which is saved in database. We use ADODC component of the visual basic for database linking. The flowchart of the data collection software using Information Form has been shown in Figure 5.

The ID card printing software is developed using Visual Basic. First of all, it will ask to enter the number of ID cards to be printed. Then it will ask to enter the ID number of the cards to be printed and will check the corresponding encoded ID from the database. Finally, it will show the ID cards with Litho code on the bottom. The ID card is printed on a transparent paper. The program first converts the encoded ID into binary form and then represents the “0” as white shadow and “1 “as black shadow. Some basic information is also delivered from the database to the card by ADODC linking. The flow chart of the card printing software development is shown in Figure 6.

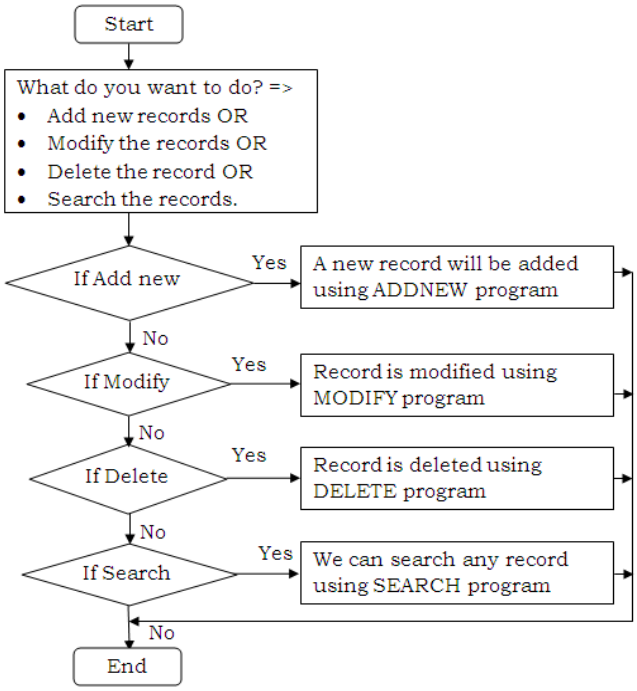

Figure 5. Flowchart of preparing the database using personal information form

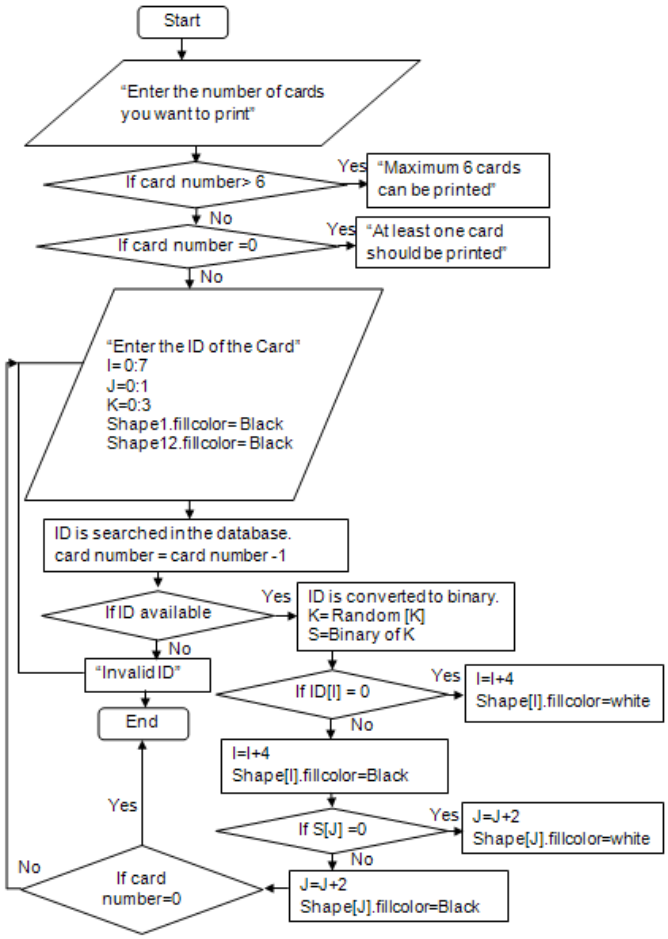

Figure 6. Flowchart for the ID card printing software

3.2. Hardware

It consists of Card reader, webcam integrator and Gate operation controller. The main function of the card reader is to capture the encoded data from the ID card. When the card is inserted, the card reader reads the litho code (unique for individual user) using data capturing unit and send the code to the CPU using computer interfacing unit. An acceptance or rejection signal is sent by the CPU to the signaling and motor driving unit. Signaling unit is used to lit different indicators for different status and the motor driving unit is used to drive the motor to open or close the gate. The power supply unit is used to produce +5 volts, +15 volts, -15 volts and +12 volts dc power supply for the different parts of the hardware. A webcam is set on the gate and interfaced with the CPU by USB port. It is used to capture the live image of the cardholder and display it on the monitor. The gate operating system is used for gate operation. A stepper motor is rotated in certain angles in both directions to open and close the door.

3.2.1 Card Reader

The card reader has five basic units; Power supply unit data Capturing unit, logic level producing unit, computer interfacing unit, signaling and motor driving unit. Figure 7 shows the power supply unit.

Data capturing unit consists of IR (Infra Red) emitter and sensors. Figure 8 shows the data capturing unit. One pair of IR needs to implement to capture each bit of the litho code. The IR emitters are placed at the upper side of the card slot and the sensors are placed at bottom side of the slot. Each pair is placed at a distance according to the litho code bit spacing of the ID card. Emitters and sensors pairs need to be aligned perfectly.

The logic level producing unit, computer interfacing unit, signaling and motor driving unit are connected to each other as shown in Figure 9. Logic level producing unit contains two-Schmitt trigger inverter to produce logic levels “0” or “1”. IC7414 is used as Schmitt trigger inverter. It gives a fixed output

voltage for a certain range of input voltage, which is either logic high or logic low. It gives logic high output for logic low input and vice versa. Circuit diagram of the logic level producing unit is shown in Figure 10.

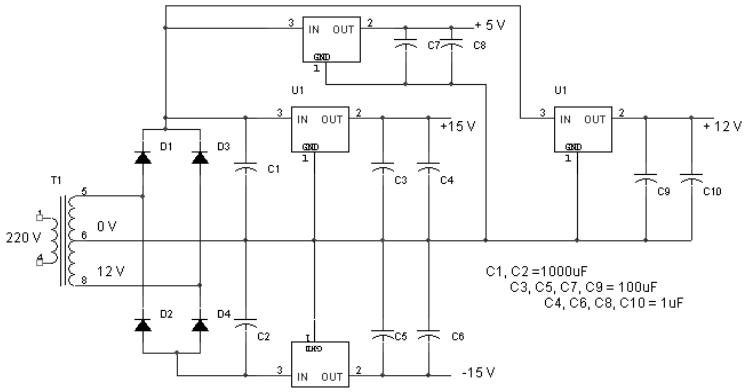

Figure 7. Power supply unit

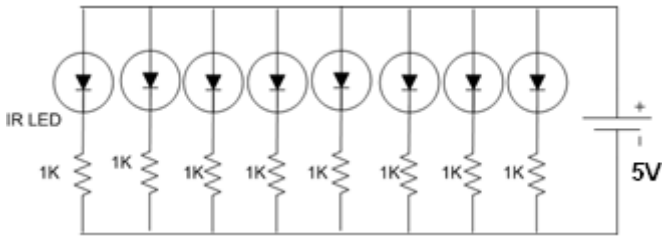

Figure 8. Data capturing unit

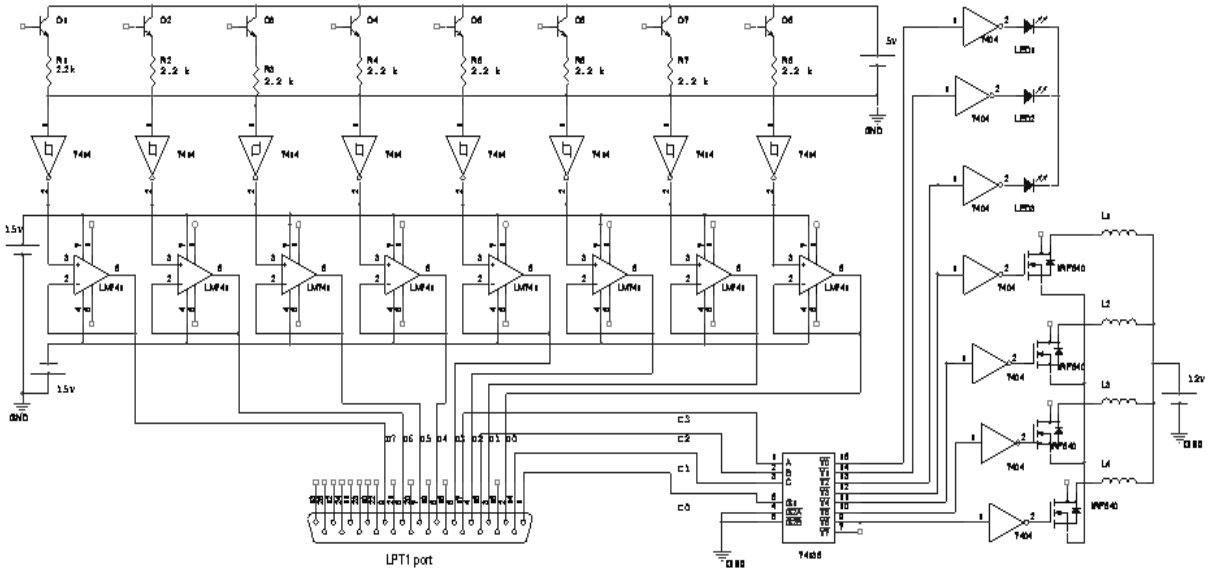

Figure 9: Logic level producing, Computer interfacing, Signaling and motor driving unit

The computer interfacing unit must contain a 25 pin female connector to be connected to the parallel port of the CPU. The pin configuration of the parallel port (LPT1) port of the CPU is shown in Figure 11.

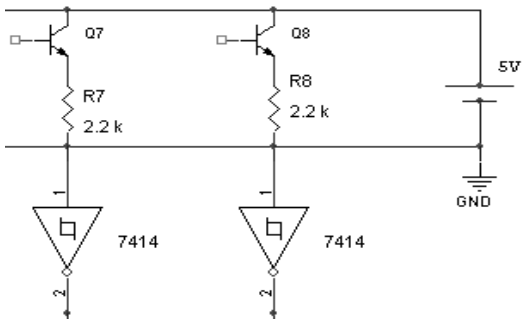

Figure 10. Logic level producing unit

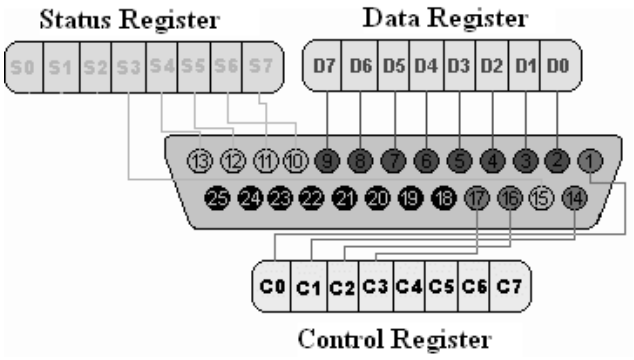

Figure 11. Pin configuration of printer parallel port

A 741 op-amp, configured as voltage follower is used as buffer to protect the CPU. The circuit diagram of the computer interfacing unit is shown in Figure 12. Figure 12 shows how the data pins of the parallel port are connected to the 741 buffer. Figure 13 shows how the control pins of the LPT1 port are connected to the 3 to 8 decoder.

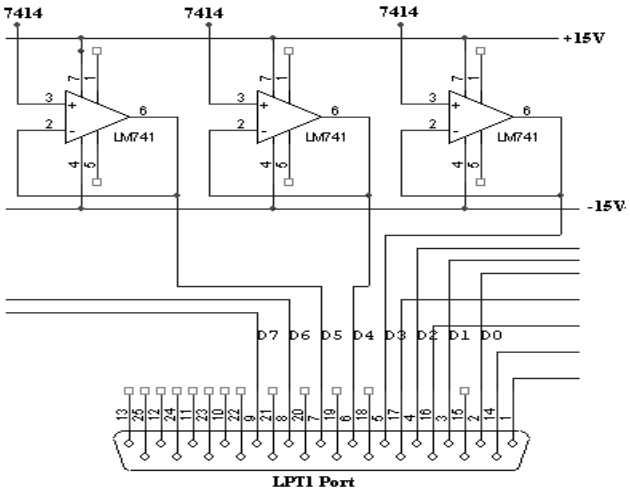

Figure 12. Computer interfacing unit

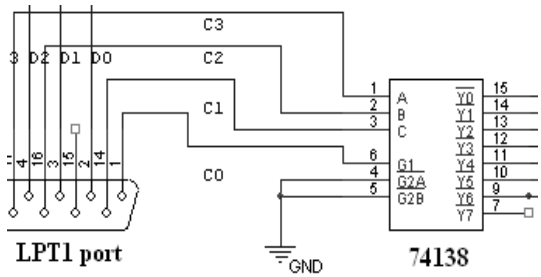

Figure 13. Connection of the control pins to the 3 to 8 decoder.

The LEDs of three different colors are used as signal lights. Three of the outputs of the decoder are used to operate the LEDs and four of them are used to send signal to the motor driving circuit. The signaling unit has been shown in Figure 14.

The motor driving unit consists of four MOSFETs to rotate the motor at certain angles on both sides to operate the gate. IRF540 is used as switch. Inverter IC7404 is connected at the output of the decoder to invert the output of the decoder as shown in Figure 15.

3.2.2 Webcam Integrator

A webcam is set on the gate and interfaced with the CPU by USB port.

3.2.3 Gate Operation

A 12V-33ohm six wired stepper motor is used for the gate operation as the motor is rotated in certain angles in both directions to open and close the door. The Stepper motor driving circuit is shown in Figure 13. Power MOSFETs (N-Type) such as IRF series are suitable to implement the motor drive control circuit. The four terminals of the motor are connected to four drains of the MOSFETs. The remaining two terminal of the motor is connected to 12 V dc supply. The source terminal of the MOSFETs is grounded.

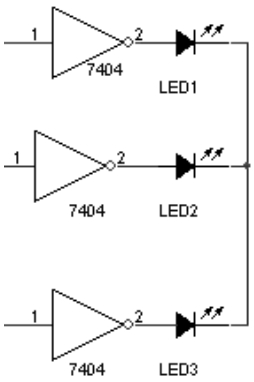

Figure 14. Signaling unit

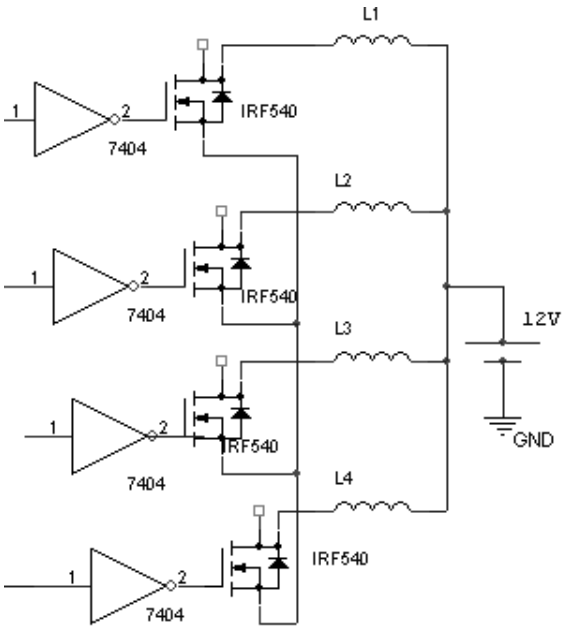

Figure 15. Motor driving unit

When the gate of the MOSFET gets pulse the corresponding motor coil is energized that gives a rotation of 1.8 degree. The gate pulse is provided by CPU. The motor rotation speed can be easily controlled by the program.

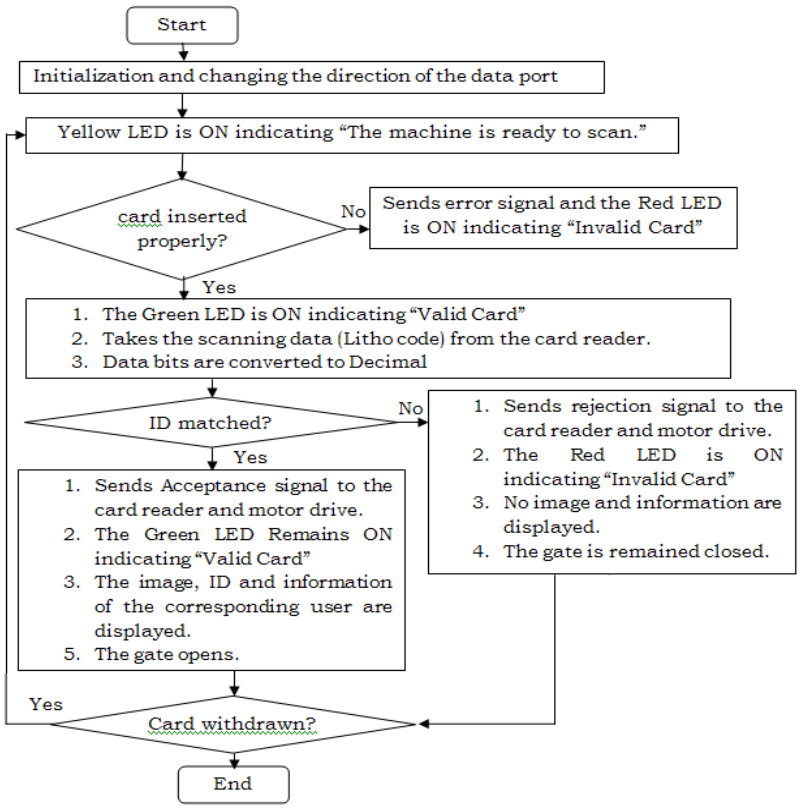

Figure 16. Flow chart of online software development.

3.3 Online Software

It consists of card reading and decision making software, daily entrance record software, gate operation control software. Card reading and decision making software takes encoded ID from the card, decode it into decimal, compare it with the saved ID numbers and decide whether the card is valid or not. It generates and sends decision signals (acceptance or rejection signal) to the card reader and the motor driver. It also displays the image and the necessary information of the cardholder on the display unit. Daily entrance record software stores the ID number, date, time and other information of the cardholder who have been allowed to enter into the establishment. The stepping angle and the rotation of the stepper motor are controlled by the Gate operation control software. The gate opens when the motor drive gets the acceptance signal and closes after a certain period. The gate remains closed if the motor driver gets rejection signal. We develop the online software using visual basic. The online software flow chart has been shown in Figure 16.

As visual basic is a windows based program, it does not have direct access to the parallel port. So, we develop a DLL (Dynamic Link Library) file in Visual C++. The DLL file contains the functions of port access. We exported two functions from the DLL. One of them is used for reading signals from a device where the other is for writing signal to the register. This functions are inport () and outport (). Inport takes the parameter; the address of the register to be read and the output is two types; the register to which the data to be written and the data itself.

Printer parallel port has three types of port: Data port (Bidirectional), Status port (Input) and Control port (Output). We used data port as input port by sending logic "1" to the 6th bit (C5) of the control port. We used 8 pins of data port as input to read the binary data sent by the Data capturing unit. To read additional data bits (in case of more cardholders) the pins of the Status port may also be used as input. Four pins of the control port have been used as output. Three of them have been used to send the "Indicator status signals" and one of them has been used to send the "Acceptance or Rejection signal".

4. RESULTS

In this section, we test all the modules of the system. The main interface form and the personal information form developed by visual basic are presented in Figure 17 and 18, respectively. We collect information of some users using Personal information form. We checked the database update after saving the information. The database is updated accordingly with allocated ID number of the user.

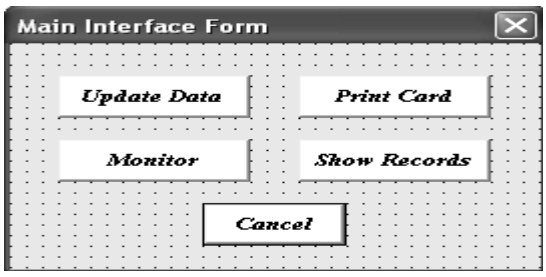

Figure 17. Main Interface form

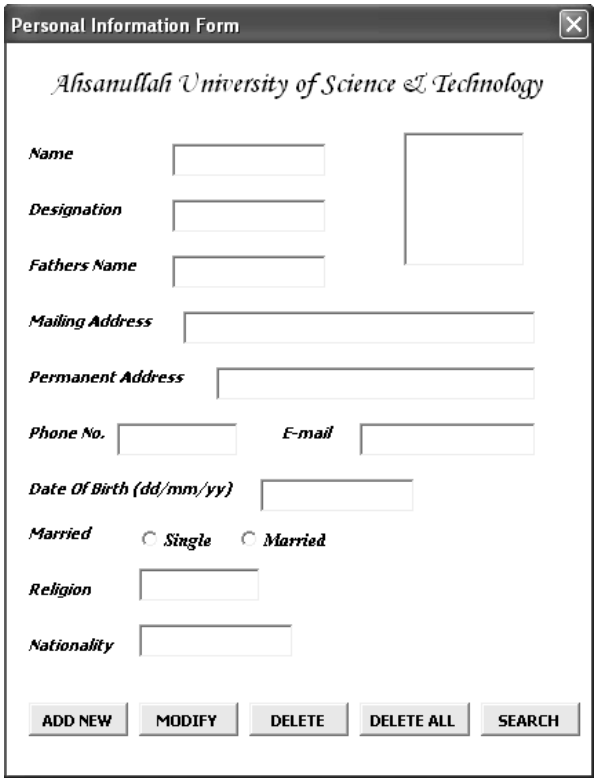

Figure 18. Personal information form

Litho-code printed ID cards of required quantity can be printed by executing the ID card printing software which is linked with the database. We print the following Litho-code printed ID cards as shown in Figure 19 by executing the ID card printing software.

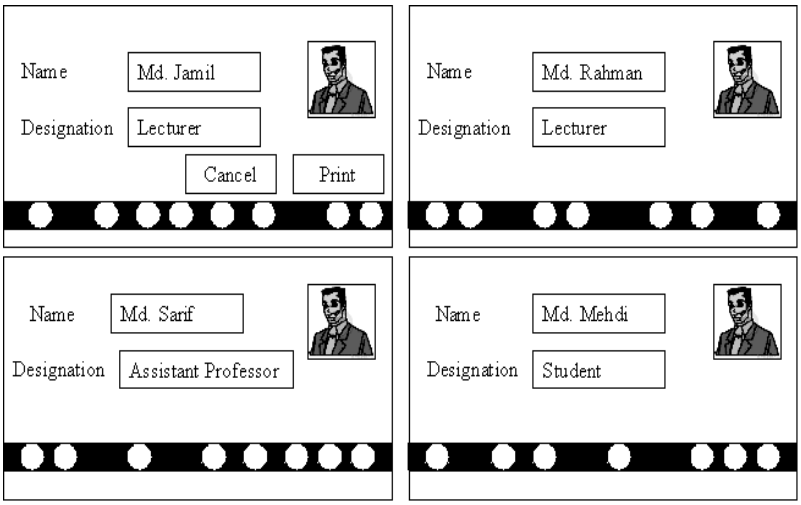

Figure 19. ID cards printed using ID card printing software

We connect the Card reader to the CPU and execute the online software to test the card reader operation. It is observed that the "Yellow" LED of the signaling unit is on indicating "the Machine is ready for scanning". When a valid ID card is inserted the "Yellow" LED is OFF and the "Green" LED is ON indicating "Valid Card". The name and the photograph of the cardholder are displayed on the display unit. We observe that it displays the associated photograph and name of the inserted card. We also observe that using webcam the live image of the cardholder is also displayed on the monitor at a time which can be compared manually with the displayed photograph by the operator. After withdrawal of the card the "Green" LED is off and the "Yellow" LED turned on indicating the machine is ready to scan another ID card. We also observed that if the card is not properly inserted or if the card is invalid, the "Red" LED is turned on indicating "The Card is invalid/ not properly inserted". We observed that valid ID cards the motor driving unit is also working properly. For valid the motor is rotating in one direction and for invalid cards the motor is rotating in the reverse direction.

We also check the database update for each data entry and observed the database is updated accordingly. We also check the daily database and verify the data. It contains the correct information of the daily entrance.

5. CONCLUSION

We design and develop a entry-security system using litho code printed ID card and ID card reader. The system is reliable, easy to implement and easy to reproduce. As litho code printed card can be copied using any photocopier machine, the encoded ID of the user may be hacked by any hacker. As the coding is based on a simple binary coding concept, there may be more security bits to ensure security of the encoding. Thus, our future directions would be to develop an encoded ID card with more security features.

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REFERENCES

[1] A. Esmeralda, "Hotel Keycard Options", *SecurityMatters*, April 23, 2009.
[2] B. Phillips, "The Complete Book of Locks and Locksmithing", *McGraw-Hill Professional*, 2005.

[3] "Lock arrangement employing mechanically acting code card and key card", *US Patent 4149394*, April 17, 1979.
[4] "What are the disadvantages and advantages of biometrics?", *www.wiki.answers.com* , 2011.
[5] J. Orrill, "RFID Technology Disadvantages and Alternatives", *www.ehow.com* , Nov 04, 2011.
[6] "Litho-code printing", *ABS Computech*, *www.omrprinter.com/litho.html* , 2012.
[7] "O.M.R. System in Student Registration and Result Processing", *Board of Intermediate and Secondary Education, Dhaka, Bangladesh*, *www.dhakaeducationboard.gov.bd* , 2009.