Post-mortem

Automated Attendance System

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1. Introduction

Over the past 13 weeks of spring 2013 semester, Secure Com Solutions worked on RFID model and Facial recognition to be able to identify individuals. The idea was taken from everyday life as a full time student. Secure Com Solutions recognized that during exams and class times the instructors require individuals to be identified with their student ID or signature. The design of this device is in order to eliminate this action by introducing our "Automated Attendance System". The system consists of the RFID reader, the RFID tags, a camera and software solutions. When the user passes their RFID tag (student ID) over the RFID reader, the device will recognize their ID. The recognized ID will be used to access the student's picture in the database and the camera will capture the image of the student, the RFID reader will then receive the information from the tag, digitizes it and transmits it to the computer. The software gets the student information associated with the RFID tag, checks whether the student is enrolled in the class and compares the student's photo with the image captured by the camera. This post-mortem will provide the result of team dynamics and the challenges that we faced and future plan for the deviation from initial goal and personal experience acquired through this project.

2. Current State of the System

2.1 Hardware

At this stage the final circuit design of the circuit was complete but it failed to meet the desired functionalities that had listed in the function and design specifications. The microcontroller that is used to create the data stream was in complete and the data read from the antenna was not consistent. This section will explain the current state of the design implementation after explaining the issues that the team faced.

The design group realized that this design had not been very practical due to different issues that will be discussed later in the deviation section. The new design for the hardware aspect of the design was to simply use a 125kHz RFID reader with a 26-bit wiegand formatting. This simple RFID reader circuit needs a microcontoller that could be an interface between the circuit and the computer. Arduino Uno was the least costly choice, and was also a simple microcontroller that provided us with all the features that were required.

The Arduino is connected to the RFID reader with simple wiring. Two wires connect the 5V and ground power source provided by the Arduino to the RFID reader. The other two wires connect the 0 and 1 signal. The design of the RFID reader is basically what we had already explained. The difference is that the circuit the designed to omit all the noise that could have caused the malfunctions in the circuit that we had built.

The RFID reader reads the ID from the card, then the Arduino will receive the data and transmit it to the to the computer via the USB port. The GUI then will read the data from the port and compare it to the database. If the student is in the database the GUI initiates the face recognition software.

2.2 Software

The GUI interface permits the user to get an easy access to the system. We assumed that the user is logged in and the class is already selected from the database. The student identification number is retrieved through the serial connection applied between the RFID reader and the computer. After retrieving it, the number is compared to the student numbers stored in the database under the class chosen. If the numbers match, the student name is displayed on the screen. The match will trigger the camera to open to start face recognition process. The picture is processed and face recognition algorithm is applied on real time. A face detection algorithm based on Haar method is adapted to identify the face in the picture. To make the picture-processing phase easier, the image is converted to greyscale. During the face recognition process Eigen faces are constructed based on eigenvectors associated with the detected face. The distances between the Eigen face constructed from the captured image and the ones stored in database are calculated. The smaller the distance is the most likely is the recognition of the face. If a face is recognized, the name of the person is displayed under it.

3. Deviation from Proposal

3.1 Hardware

The deviation from the original idea for the project has been considerable in hardware aspect due to the following reasons.

First we realized that the circuit we had build was showing variations in reading the same card. This most probably is due to the signal noise of the circuit. The other issue is programming the microcontroller. This was a new experience for all of us and due to inexperience caused many difficulties. The timing for the reading the data and lack of time for configuring the problem lead us to the changing the design to meet our purpose. Hence the deign team decided to take another route and buy an RFID reader and focus on integrating the final system and build the final product.

3.2 Software

The team was able to achieve almost all main functional requirements for the software part. However, a database could not be used since the code is mainly derived from the open source opencv, which is written in c++ language. Unfortunately, after some research and trials we

discovered that it is very complicated to connect a code written in c++ to database. Nevertheless, we were successful to use a csv file to serve as storage for the student information.

4. Future Plans

4.1 Hardware

After the successful design and integration, the next stage will be to provide WiFi mode for the device. The WiFi capability will give the device the final feature that will lead to its commercial use.

4.2 Software

Our future plans for the software subsystem are: rewriting the code on Java to make the database/system communication easier. Optimize the code to improve the speed to make the program run on real time and improve and customize the GUI interface.

5. Budgetary and Time Constraints

Budget

Since we were not able to meet the ESSS deadline we decided to use the design that will require the minimum costs and also enable us to achieve the goal of creating a low cost design. The following Table includes all the costs for implementing this project.

Equipment List	Projected Cost	Actual Cost
RFID 125 KHz module	$30.00	$25.00
Arduino Uno R3	$35.00	$33.00
USB calbe	$4.00	$3.05
Taxes/Shipping	N/A	$7.32
Total	$69.00	$68.37

During our own final exams this semester, specially for MACM 316 we realized the significant affect our design could have for classes of large sizes and with the new regulations for checking student ID’s. We have also talked to a few Professors and TA’s to create a target market for the product of Secure Com Solutions.

Time Constraint

The time constraint was the main issue that the members of Secure Com Solutions faced. As it can be seen after the first two months since everyone got busier with their other projects as well the progress of the design was slowed down and unfortunately the hardware section of the design was not completed on the due date. With that said, all members of Secure Com Solutions have showed their out most eagerness to complete and implement the design.

Here the committee decided that the project needed more work and we were provided with an extension. Grateful for that the worked very hard during the month after the demo and revised the design. The team was able to finish most of the modifications in the month after the demo but unfortunately due to personal reasons reasons and work the demo was delayed to the end of August.

Item	Proposed	Implemented
Research	Jan 16	Jan 16
Project Proposal	Jan 16	Jan 16
Parts: Order and Pick up	Jan 22	Feb 7
Design RFID reader	Feb 19	Feb 19
Hardware design and implementation	Mar 3	Mar 17
Implement and test RFID reader	Mar 3	Mar 20
Design and Implement facial recognition algorithm	Mar 3	Mar 20
Code Implement and Test	Mar 3	April 10
System Integration	Mar 17	April 10
System Testing	April 10	April 23
Debugging modification	April 10	April 23
Documentation	April 14	April 23
Microcontroller and RFID reader research	May 11	May 11
Code Implement and Test microcontroller	May 25	May 18
System Integration	June 8	June 1
Debugging modification	June 22	June 29
Demo	July 8	August 7

6. Team Organization

Since our project had two main components, the RFID/database component and the image

processing component, we split up and specialized in one of these two areas. Omar and Tahani focused on the image processing, whereas Oldooz, Daniel, and Dong dealt with the RFID reader.

The group had consistent input from both sides to keep the project closer to our original idea and also help the integration at the final stage. Splitting the group into two main streams of software and hardware was helpful in this project since it utilized each individual's knowledge and capabilities at best. The experience was hence beneficial to the group.

Although there were problems at times with the amount of work distribution, the group held together until the end while keeping old friendships intact.

Individual Reflections

Omar Khlif – Chief Executive Officer

The idea behind the choice of this subject in the capstone project was to apply knowledge gained during my co-op position during the past two years.

The field of video coding drove me to search with my team-mate Tahani to apply our learning in video related project.

The group members were from different backgrounds. Tahani and I were responsible of the software part of the project. Our task was to get the face recognition algorithm working.

Pair programming is an efficient way to write codes, especially debugging: you anticipate errors before they happen. Getting in pair programming with Tahani has been a success in school projects as well as in projects in our first co-op term. Then we thought about a complementary hardware part to the software solution: building an RFID reader. This project could not come to an end without the knowledge of Oldooz and Daniel in electronic related project.

The outcome was not as I expected. Through difficult times I learned a more efficient way to communicate between group members. I was exposed to new areas of engineering when the team was building the RFID reader. Getting everybody up to date is critical to the success of a team project.

Planning ahead is important to encounter unplanned difficulties, especially face recognition techniques. I also learned to think more from the consumer prospective and more important to think like whoever wants to break your system.

Writing technical documents was an area that developed during the capstone project.

Tahani Trigui – Chief Technology Officer (Software)

Before the course began, I had a talk with three of the members who I used to work with a lot as lab and project partners. I had the privilege of working with not only my friends but also one of the most competent engineering students at SFU. The group dynamics was good overall and members were able to communicate their skills. However, the time constraint put a lot of pressure on me and was the main reason of the minor failures of some features on the system. Being a full time student and working part time can gradually affect the time dedicated for such important project.

The most important lesson that I took away from this project is the time management. I believe that we underestimated some parts of the project and we only dedicated few days for them. This strategy was not successful and put us behind schedule. I now strongly believe that planning ahead is vital for the success of any project. Moreover, one of the most important attributes I also learned is to accept the difference within the group members, to be patient and understanding.

From a technical perspective, the project enhanced my c++ programming skills since I didn't have exposure to it since the first year of school. Furthermore, it strengthened my problem solving and algorithmic skills. I also learned a lot about RFID readers. This was achieved by communicating with group members even though we have different responsibilities and tasks. The skillset differences within group members played in our favor .We completed and complemented each other.

If I were to repeat the experience and start fresh, I would definitely take the course during a less busy term and would dedicate a lot more time on it.

Oldooz Pooyanfar – Chief Technology Officer (Hardware)

I was glad to know that I will get a chance to work with a team that the members of I have known and worked with individually before. The previous experience and trust has significantly helped establish a great teamwork and amiable work relationship. Here are my contributions to these results.

After hearing and reading much of the previous experiences of the people involved in this course, we decided to get right into forming the idea for the project. Even though it was a bit late coming, we came up with an idea, and with the help of Dr. Andrew Rawicz and Lucky One and our own deliberation we were able to fine-tune our final design. Fortunately as the job progressed and as we talked to faculty and teaching assistance they showed their interest in our project as well.

Using my experience from my years as a student and also working in research at my co-op, I have realized that the most important part was the research. The knowledge of the background that we required for designing and implementing each section was crucial to this project.

My main contribution to this project was to organize and work on the hardware (RFID reader) design and implementation. After figuring out the circuit schematic and the operations of the microcontroller, I started working on the code parallel to Daniel designing the circuit. The let down was that there was no way to test the functionality of the microcontroller without the circuit. Although I believe that my partner delivered a great final result with the circuit. Meanwhile I was in charge of the most of the hardware documentation and writing the reports as well.

The amount of knowledge that I have obtained through this experience is tremendous. I have realized that even with knowledge and experience, there is still a lot that depends on the time management and working with everyone's busy schedules. Although one may enter this project knowing about the time constrains, still there are so many variables that happen unexpectedly.

Aside from this, I feel that this course has shaped many of my work and personal relationships as an engineer. I am glad that I have had the chance to work with my great friends and colleagues Omar Khalif, Tahani Trigui and Daniel (Hongxin) Dai, and I look forward to working with them in the future. I am glad that I got to know Dong Geun Shin as well.

Daniel Dai – Chief Operating Officer

During the project development cycle, I was mostly occupied in developing the RFID reader circuit. The RFID reader circuit includes the power supply, clock generator, antenna module, filtering module, and the microcontroller. Since I have taken the ENSC425 Electronic Circuit Design, I have the knowledge of design clock generator, passive filter, active filters, and current amplifier. In addition, the Microchip MicroID 125 KHz Reference Guide provided the necessary information for us to figure out the best way to proceed. I enjoyed developing and experimenting with different circuit to satisfy our requirements and participating in a large-scale project development.

Communication between the hardware group and software group is very important. There are many ways to design a RFID reader in terms of tradeoffs between hardware and software. For example, we can generate the 125 kHz square wave using the Microcontroller or using a 555 timer. Software is cheaper because we don't need to purchase any parts but at the same time the processing time may increase. We use the 555 timer to generate the square wave, because the 555 timer is cheap and we are familiar with it. And also, I learned how to design the electronic circuit to implement the digital communication system.

In addition, I have also found that sufficient research will help a lot for the project. I can build the RFID reader circuit and make sure every part is working since we have the 125 kHz reader reference design guide. We encountered a large amount of problems going into the microcontroller programming part mostly due to the fact that we were dealing with cards, which were manufactured with largely unknown specification.

Interpersonally, I have learned to understand. Four of us are taking 5 courses in this semester. We don't have much time, especially at the end of the term. I understand we haven't finish the microcontroller programming part because of largely unknown specification.

Overall, from practical point of view, this project helped develop my skills more fully in hardware design. I found the opportunity to, effectively and efficiently, make use of my latest engineering trainings in practice and towards the invention of a device that can make our life easier. My highest benefit from doing this project was to become familiar with team handling procedures and to realize the importance and usefulness of team approach towards problem solving techniques, and to appreciate the key role of documentation. Admittedly, accomplishing this project was a real team experience in a real design situation.

Dong Guen Shin – Chief Financial Officer

Although ENSC 440/ENSC 350 has been one of the most challenging courses that I ever took at SFU, I think it was a valuable experience to take in many aspects. I've learned a great deal of lessons in research skill, communication skills, time management, team dynamics, RFID circuit and programming the mircrocontroller. Prior to this project, I was concerned about understanding the analog circuit. Fortunately, I am taking ENSC 425 and the knowledge from lab assignment and lecture helped me a lot to do this project.

Each of our my group members that includes me had a hard time choosing feasible idea but once the idea was decided, we spent more than 3 weeks to research on RFID technology and continued on researching even while we were implementing circuit. Prior to this project, I was

concerned about understanding the analog circuit. Fortunately, I am taking ENSC 425 and the knowledge from lab assignment and lecture helped me a lot to do this project.

I contributed to the project by helping Oldooz to program the microcontroller PIC16F88 using Assembly code in MPLAB and integrate with RFID circuit. I have not had group project using assembly code since I took ENSC 251 so that it lead me to struggling to figure the solution out. I also contributed to the Proposal, Functional Specification, Design Specification and Progress Report.

The most challenging part during the project was integrating our system with PC. Daniel, Oldooz and me built the complete circuit according to our initial design and also we could manage to program the microcontroller PIC 16F88. But the communication between PC and PIC16F88 did not work. In order to view the tag data from the microcontroller, we had to debug the bits read at registers. But we were unable to transmit the data from microcontroller to PC and we realized that we needed RS 232 IC (Integrated Circuit) in the last minute.

Despite the deviation from our initial plan, I'm satisfied with what I learned from the project.

It was a great opportunity to combine the knowledge for Hardware, Software.

Overall, our group dynamics was great. We had a meeting every week and had a good communication using Trello and dropbox. I would like to appreciate each of our group members' performance and dedication on this project and also like to appreciate Andrew Rawicz, Steve Whitmore and TAs who guided us in the right direction of the project.

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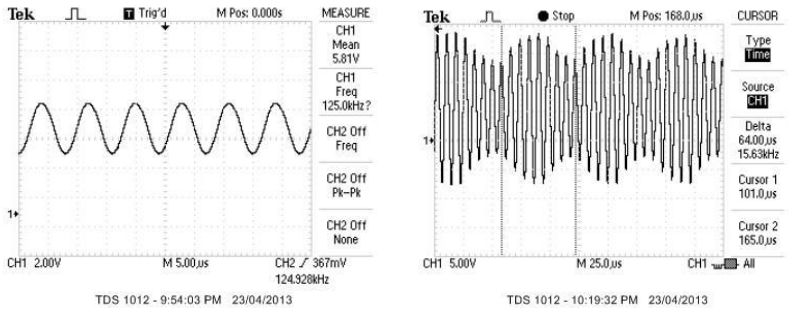
Appendix A: Pervious Hardware design

The preliminary design of the circuit and implementations were done as far as explained in this appendix and which point the team decided the hardware does not achieve the desired goals, hence the proposal was dropped and a new course of action was taken as explained in the document.

The RFID circuit consists of a transmitter and a receiver. The transmitter including the power supply, clock generator, and the antenna driver has been implemented successfully. As we can see in figure 1(a) the antenna is broadcasting a 125 kHz electromagnetic wave. The tag in the presence of this signal will modulate the signal and the receiver consisting of the same antenna will obtain this signal, as we can see in figure 1(b). The rest of the receiver consists of the envelope detector and filters, as we can see in figure 2 the input to the microcontroller is a modulated rectified signal.



(a) (b)

Figure A.1 – (a) The sine wave input to the antenna, (b) the modulated signal received from the antenna

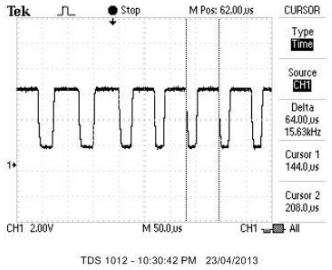


Figure A.2 - The modulated rectified signal

The 15 voltage battery set is used to generate the power for the whole circuit, using two voltage regulators the voltage is kept at 5V and 12V. The 2 kHz noise mentioned in the progress report was also a concern that with changing the wave generator circuit it was eliminated. Through

testing we have also observed that the device is able to read the data from a distance of up to 5 cm.

The programming of the microcontroller was the part that presented the most issues. Without the desired signal it was not possible to test the functionality of the code. Currently the microcontroller is able to detect the rising edge of signal which is used to measure the frequency of the signal. Hence we are able to detect the 1's and 0's of the RFID cards. The RAM on the PIC is used to store the data bits. The following tables show part of the data gathered for the same card (a, b). As we can see they match even though the address they are stored at differs.

Table A.1- (a: Read 1, b: Read 2) Similar data stored in the RAM memory for the same card

Address	Hex Value	Decimal Value	Binary Value
130	0xB0	176	10110000
131	0xEC	236	11101100
132	0xB2	178	10110010
133	0xAA	170	10101010
134	0xB5	181	10110101
135	0x53	83	01010011

Address	Hex Value	Decimal Value	Binary Value
132	0xB0	176	10110000
133	0xEC	236	11101100
134	0xB2	178	10110010
135	0xAA	170	10101010
136	0xB5	181	10110101
137	0x53	83	01010011

At this stage we need to find a header that is the same for all cards so that the device is able to detect the right unique ID number. We can see that each card generates a unique ID number but after testing we have realized that there are some bit errors that are affecting the data analysis.

The problem that set the integration behind was that we were relying on the programmer JTAG port for data transfer which we have realized that our microcontroller has an USART pin which could be connected to an MAX232 IC and connect to the computer via USB. However this stage was behind schedule and required parts that were not accessible in our time frame.

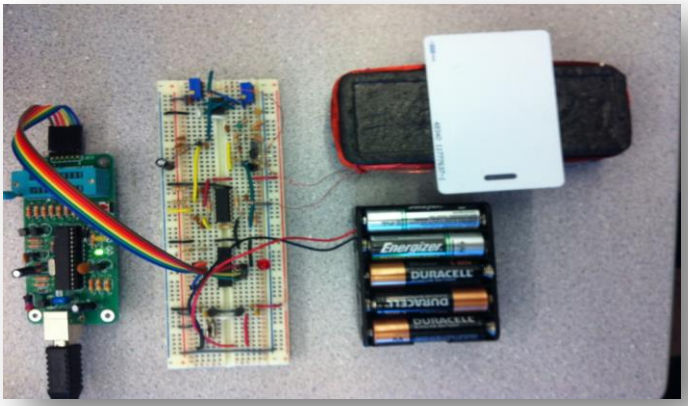


Figure A.3 - RFID reader system

Appendix B: Meetings Minutes

SecureCom: Meeting 1
Time: 11:00AM-12:00PM , Wednesday, January 16, 2013
Location: ENSC Laboratory 4
Attendance: Daniel Dai, Dong Guen Shin, Oldooz Pooyanfar, Omar Khlif, Tahani Trigui

Minutes:

Discussed proposed project ideas: automatizing home for blind people, Luggage with weight

Integrated, RFID reader with facial recognition

Next steps:

Think more about the feasibility of the project idea

Discuss ideas with Andrew

SecureCom: Meeting 2
Time: 11:00AM-12:00PM , Wednesday, January 23, 2013
Location: ENSC Laboratory 4
Attendance: Daniel Dai, Dong Guen Shin, Oldooz Pooyanfar, Omar Khlif, Tahani Trigui

Minutes:

Decided on the project idea : RFID reader with face recognition

Task division:

RFID Reader: Daniel and Oldooz

Camera: Dong

Image processing and GUI interface : Omar and Tahani

Next steps: Start working on Function specification report

SecureCom: Meeting 3
Time: 11:00AM-12:00PM , Wednesday, January 30, 2013
Location: ENSC Laboratory 4
Attendance: Daniel Dai, Dong Guen Shin, Oldooz Pooyanfar, Omar Khlif, Tahani Trigui

Minutes:

Divided tasks for functional requirement report

Discussed the research progress: RFID reader (tag, antenna, receiver..) , image processing (opencv), database..

Decided on the primary component that we need :microprocessor, camera, capacitors, resistors..

SecureCom: Meeting 4
Time: 11:00AM-11:30AM , Wednesday, February 6, 2013
Location: ENSC Laboratory 4
Attendance: Daniel Dai, Dong Guen Shin, Oldooz Pooyanfar, Omar Khlif, Tahani Trigui

Minutes:

Divided tasks for design specification report:

Software : Omar and Tahani

Hardware: Oldooz, Daniel and Dong

Executive summary and Hardware system test plan: Oldooz

System overview :Tahani

Introduction and transmissal letter: Daniel

Software system test plan: Omar and Tahani

Formatting and conclusion : Omar

SecureCom: Meeting 5
Time: 11:00AM-12:00PM, Wednesday, February 20, 2013
Location: ENSC Laboratory 4
Attendance: Daniel Dai, Dong Guen Shin, Oldooz Pooyanfar, Omar Khlif, Tahani Trigui

Minutes:

Discussed the progress of the project: decided on the microcontroller to buy, use opencv open source..

Prepared for the oral progress report : divided the tasks to be prepared

Decided to meet the following day before the presentation to get prepared

SecureCom: Meeting 6
Time: 11:00AM-12:00PM, Wednesday, February 27, 2013
Location: ENSC Laboratory 4
Attendance: Daniel Dai, Dong Guen Shin, Oldooz Pooyanfar, Omar Khlif, Tahani Trigui

Minutes:

- Discussed the progress of the design specification report
- Decided to do more unit testing , dedicate more time for the project to make up for the wasted time and catch up with the schedule.

SecureCom: Meeting 7
Time: 11:00AM-12:00PM, Wednesday, March 6, 2013
Location: ENSC Laboratory 4
Attendance: Daniel Dai, Dong Guen Shin, Oldooz Pooyanfar, Omar Khlif, Tahani Trigui

Minutes:

Final review for the design specification report

Discussed the progress of the project:

software team shared progress about being able to read an image from a camera and apply a face recognition algorithm

Hardware team shared progress about being able to build the RFID reader circuit

SecureCom: Meeting 8
Time: 11:00AM-12:00PM, Wednesday, March 13, 2013
Location: ENSC Laboratory 4
Attendance: Daniel Dai, Dong Guen Shin, Oldooz Pooyanfar, Omar Khlif, Tahani Trigui

Minutes:

Divided the tasks for writing the written progress report

Discussed some difficulties encountered by both team during the implementation phase

SecureCom: Meeting 9
Time: 11:00AM-12:00PM, Wednesday, March 20, 2013
Location: ENSC Laboratory 4
Attendance: Daniel Dai, Dong Guen Shin, Oldooz Pooyanfar, Omar Khlif, Tahani Trigui

Minutes:

Discussed the progress of the written progress report

Started the testing and tuning phase

SecureCom: Meeting 10
Time: 11:00AM-12:00PM, Wednesday, March 27, 2013
Location: ENSC Laboratory 4
Attendance: Daniel Dai, Dong Guen Shin, Oldooz Pooyanfar, Omar Khlif, Tahani Trigui

Minutes:

Final review for the written progress report

Decided to skip the meeting for the following week and focus more on the project

SecureCom: Meeting 11
Time: 11:00AM-12:00PM, Wednesday, April 10, 2013
Location: ENSC Laboratory 4
Attendance: Daniel Dai, Dong Guen Shin, Oldooz Pooyanfar, Omar Khlif, Tahani Trigui

Minutes:

Final meeting□.

Good progress for both software and hardware parts of the project, still behind schedule though □

Need to catch up, next meeting will be for integration and testing

SecureCom: Meeting 12
Time: 10:00AM-11:00PM, Saturday May 11, 2013
Location: Breka Coffeeshop (Vancouver)
Attendance: Daniel Dai, Dong Guen Shin, Oldooz Pooyanfar, Omar Khlif, Tahani Trigui

Minutes:

First Meeting after finals.

Decided that Hardware has many errors and is not reliable (programmimg the PIC is hard, no serial transmission to the computer)

RFID circuit will be bought and configured for our purposes

SecureCom: Meeting 13
Time: 10:00AM-11:00PM, Saturday May 18, 2013
Location: Breka Coffeeshop (Vancouver)
Attendance: Daniel Dai, Dong Guen Shin, Oldooz Pooyanfar, Omar Khlif, Tahani Trigui

Minutes:

The RFID circuit needed a microcontroller for programming

Work on programming the RFID reader

SecureCom: Meeting 14
Time: 11:00AM-12:00PM, Saturday June 1, 2013
Location: Breka Coffeeshop (Vancouver)
Attendance: Daniel Dai, Dong Guen Shin, Oldooz Pooyanfar, Omar Khlif, Tahani Trigui

Minutes:

Learn about reading data from the serial port

Integrate that with the check up software

Integrate with the Face recognition

SecureCom: Meeting 15
Time: 11:00AM-12:00PM, Saturday June 29, 2013
Location: Breka Coffeeshop (Vancouver)
Attendance: Daniel Dai, Dong Guen Shin, Oldooz Pooyanfar, Omar Khlif, Tahani Trigui

Minutes:

Write up the progress report with the changes

Create GUI for the integrated system

SecureCom: Meeting 16
Time: 11:00AM-12:00PM, Monday August 5, 2013
Location: Breka Coffeeshop (Vancouver)
Attendance: Daniel Dai, Dong Guen Shin, Oldooz Pooyanfar, Omar Khlif, Tahani Trigui

Minutes:

Preparation for demo

go over post-mortem document

Last meeting ☺