“A disguisable lock based on finger tapping algorithms”

A PROJECT REPORT

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2014

CERTIFICATE

Date:

This is to certify that the project entitled **"A disguisable lock based on finger tapping algorithms"** has been carried out by **Aman Batra (110370111111)**, **Rahul Soni (110370111109) and Siddharth Dhanuka (110370111082)** under my guidance in partial fulfilment of the degree of Bachelor of Engineering in Electronics & Communication (7th Semester) of Gujarat Technological University, Ahmedabad during the academic year 2014-2015.

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Acknowledgement

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Abstract

The title of the Project is **"**A Disguisable Lock based on finger tapping Algorithms**".** The idea behind this project was to find a new locking system which would be much more secure, more easier to use and economically feasible.The purpose of our Project was to fabricate such a lock that could be easily disguisable anywhere & also had capabilities to operate without any hardware keys [4].

We named it the "T-Lock" a short form for Tapping-lock.Password locks are not as much disguisable and since numerical keypad is provided, so guess work is also easy.which can be digitally recorded using tap devices, surveillance cams, etc on the other hand there are no visible buttons on a T-lock it has a flat plate which can be disguised anywhere on the surface of equipment which needs to get locked. The tapping algorithm is manually fed to lock via this touch plate.

T-lock cannot be opened if input tapping rhythm is incorrect. Unlike passwords, the rhythms cannot be easily copied by viewing hand moments. The lock was built using both hardware and software components like Arduino, Servo Motors, Infrared sensors and their compiler libraries.

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Chapter 1 Introduction

1.1 Introduction

A “lock” is defined as a mechanism for keeping a door, window, lid, locker or a container fastened. The most widely used locks are typically operated by a physical key.There are many different types of locks and several different security factors to consider before purchasing. Following are some of them which were available in market.

Padlocks: Padlocks are the only type of lock that is typically not permanently attached to anything else. Padlocks come in a range of sizes, are free standing and portable, and are one of the most easily recognizable types of lock. Padlocks come in two main varieties: combination and keyed.

Deadbolts: Deadbolts are generally installed on external doors and have a few more options to consider than padlocks. Deadbolts come in three primary varieties: single, double, and lockable thumb-turn.

Knob locks: Knob locks are frequently installed in residential situations on exterior doors in addition to deadbolts, and are sometimes used as the primary source of security for doors. The problem lies in the fact that the lock cylinder is in the knob itself and not the door.

Lever Handle Locks: Lever handle locks are frequently used for inner doors in commercial settings. They are easier to open than knob locks as they have a large push down style handle rather than a knob that one must grasp and turn.

Rim Latch Locks: A rim latch lock has a standard or custom rim cylinder on one side and a surface mount latch lock on the other. Rim latch locks can auto lock the door behind you and are popular in some apartment complexes.

Our anxiety finds its way through our fingers, We like desk drumming, tapping our fingers here and there, creating random rhythms, beats, etc anything. So we gave it a thought!

Can we turn our random tapping habit into something useful? Each individual creates his own rhythms and beats which are hard to copy and Steal. Imagine if we can use these rhythms as a key to open locks.

1.2 Problem Definition

We looked many commercial locking systems like Hardware Locks, Keypad locks, Biometrics and Retina locks. But none of the lock was highly secured, flexible in use and economically affordable at the same time. So here we have our problem.

Most of the Houses, shops, inventories, locker rooms, etc in India still use a “key” based lock as it is very cheap and readily available. But, the conventional lock that is available in market, even the most secure ones, can be easily lock-picked using pliers and hammer like instruments. If the key gets lost the user has no other option but to replace or “break” the lock open.

Instances like house robberies & collateral thefts happen almost every day in our country. News of burglaries can be found in every newspaper, main reason being the lack of secure locking systems which are readily available in the market. Hence, we decided that we had to use our knowledge of Electronics Engineering Field to solve the Major problem.

“Can we make a lock which is More Secure, More flexible,But less costly?"

1.3 Problem Solution

- We are designing a lock which is very much secured than conventional locking systems.The lock is easily disguisable anywhere and economically feasible too
- Hardware locks can be easily cracked open using conventional tools and locksmith techniques and once a key is lost the lock requires be hammering and replacing.
- Password locks aren't much disguisable and guess work is easy also it can be digitally recorded using tap devices, surveillance cams, etc on the other hand there are no visible buttons on a T-lock it has a flat plate which can be disguised anywhere on the surface.

- It cannot be opened if the rhythm is incorrect. Unlike passwords, the rhythms cannot be easily copied by viewing hand moments.
- T-Lock or tapping lock is basically an electronic lock which opens up when a particular finger tapping algorithm is performed. The tapping algorithm can be manually fed up via touch plates which can be easily disguised anywhere on the locking surface.

1.4 Usefulness of the Project to the User/Society

When surveying locks and security devices for homes, business offices, banks, etc. We found out that the number of options were overwhelming.

We asked some Jewellery store owners, how safe they feel about the security which they had implemented in his store. Their answers helped us create a baseline how an Ideal Lock should be.

Our next step was to explore marketplace for most reinforced, most secure locks. We came across biometric locks, keypad locks, retina locks, Camera locks, Voice recognition based locks. But all these locks were highly priced and not easily affordable.

So we decided to make an-electronic chip based lock which should offer much higher security then conventional locks, A lock which can be used for multiple applications like Gate locks, Safe Lockers, Vault Lockers, etc. Along with multipurpose uses and security, the cost of hardware should be low enough to make the lock affordable.

Chapter 2 Literature review and work plan

2.1 Literature review

1. We studied the ArduinoCook book V1 and V2 (A guide to arduino by Pearson Publication House).

2.We studied about many conventional locks present in the Market, and prepared a chart what every lock was lacking in it.

3. We viewed many video which showedhow a lock could be opened without the key. We then devised a new way to unlock a hardware lock.

4. We studies servo algorithms and implemented them in Arduino Compiler, then we interfaced a 6kg/cm servo motor with the arduinodev board and locker knob.

2.2 Work Plan

Month	Work
JUNE 2014	Industry/Customer Survey, Problem Identification, Project Inception
JULY 2014	Getting acquainted with locks/locking algorithms, Problem Solution
AUG 2014	Survey for HARDWARE components and cost analysis, HW Testing
SEPT 2014	Learning Arduino programming, Designing "random sequences library", Loading programs in arduino, design of circuit diagram
OCT 2014	Coding base encryption and decryption algorithms, interfacing servo motor, door levers, LEDs and touch plates.
NOV 2014	Testing/Debugging servo motor & touch plates. Interfacing micro SD card reader, and coding RESET/SET algorithms
DEC 2014	Problem/Glitches identification, Solving programming bugs
JAN 2015	Setting up final circuit and primary/secondary power supplies.
FEB 2015	Chassis design, Prototype finalization
MAR 2015	Further analysis, Scope for Improvements, Application for Patent.

Chapter 3 Hardware and Software Description

3.1 Software

- DEV C/C++, Arduino[1] DEV Compiler, Pspice&Multisim

3.2 Hardware

Arduino Mega 2560[2], Arduino Nano, Proximity/IR Sensor, Servo Motors, Door Knob, Latch/Lever, Touch Plates, A locker, RTC, Power supply +5vdc, Micro SD card reader.

- T-lock comes up with two keys: Hardware key & Software key. Software key is changeable by user, whereas hardware key is permanent.
- By default each lock comes with a randomly generated software key (Example: 1-12-4-5-9). This key can be later changed by the user.
- Hardware key is in the provided MicroSD card.
  It is used to SET/RESET the software key when required. The lock cannot be programmed without using the hardware key

Sr. No of Tap	Time on clock/Clock cycles	Relative time ratio
1	0	-
2	0.110s	2
3	0.224s	~4
4	0.110s	2
5	0.055s	1

We see here that a relative time ratio of 2:4:2:1 is formed for the applied tap pattern, now this ratio will be stored in our microcontroller chip as the reference input so that next time; If the same ratio is fed at input then only the lock will open. (Considering tolerance 20%).

Relative time ratio explained
Suppose you tap 5 fingers alternatively, so in total there are five taps and 4 time differences.

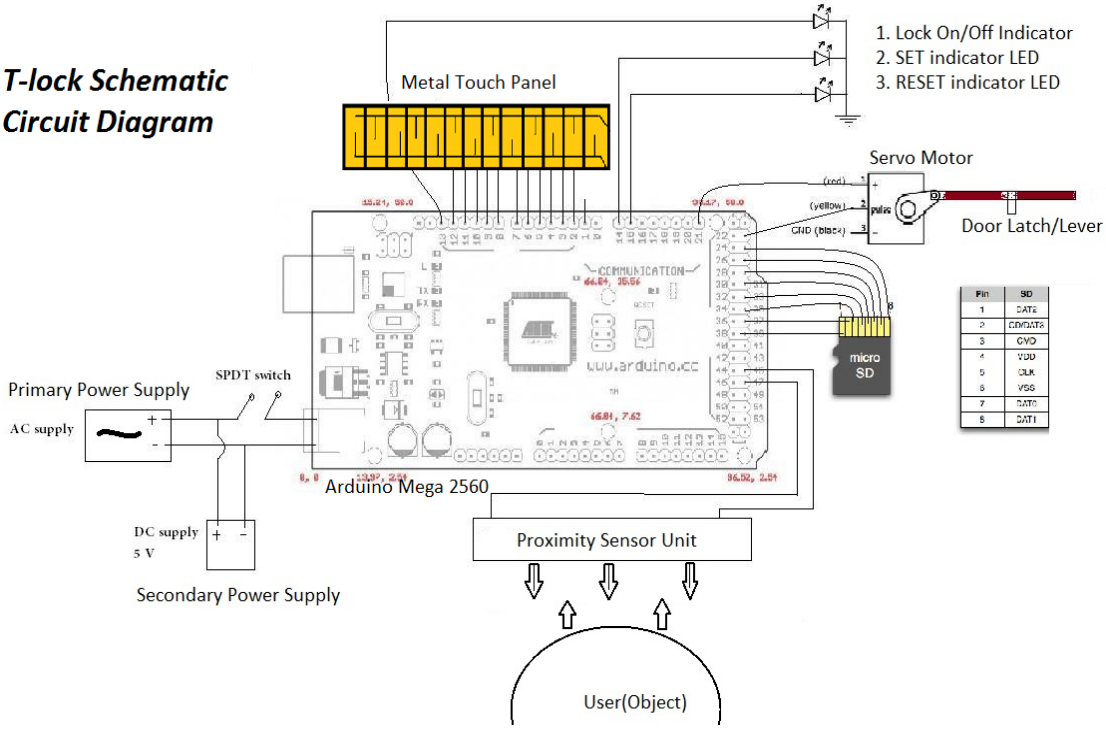
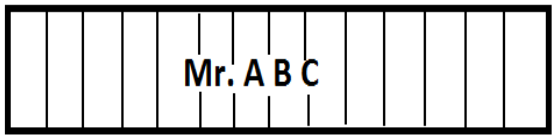
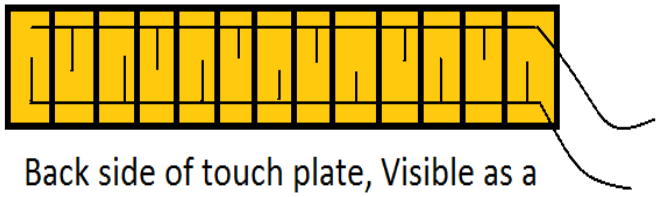


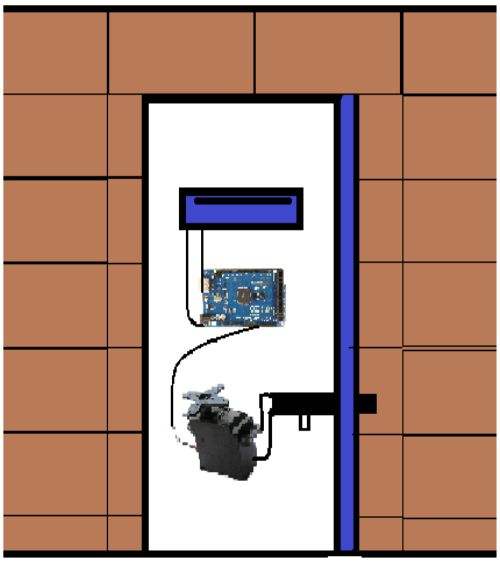
Figure 1 Circuit diagram of lock, Arduino Interfaced with i/o devices and sensors



Front side of touch plate can be used as a name plate!



Back side of touch plate, Visible as a touch switch-matrix



BACK SIDE

On the back side of door, we have a lever which is connected to servo motor (Interfaced with arduino). The board is primarily powered by AC supply.

Figure 2 Design of touch plates

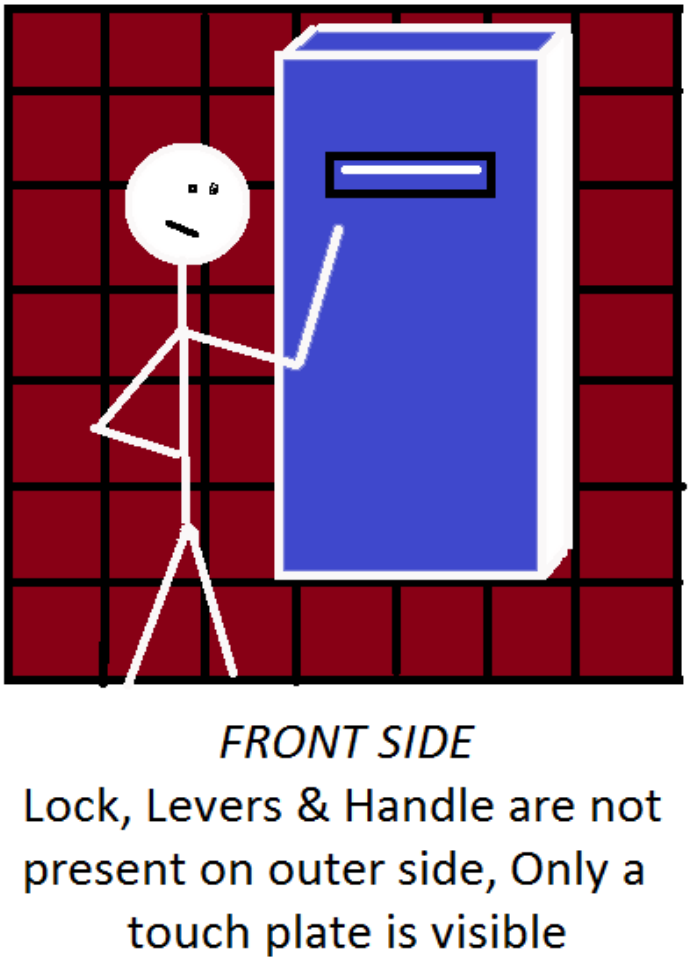


Figure 3 Front view of the door

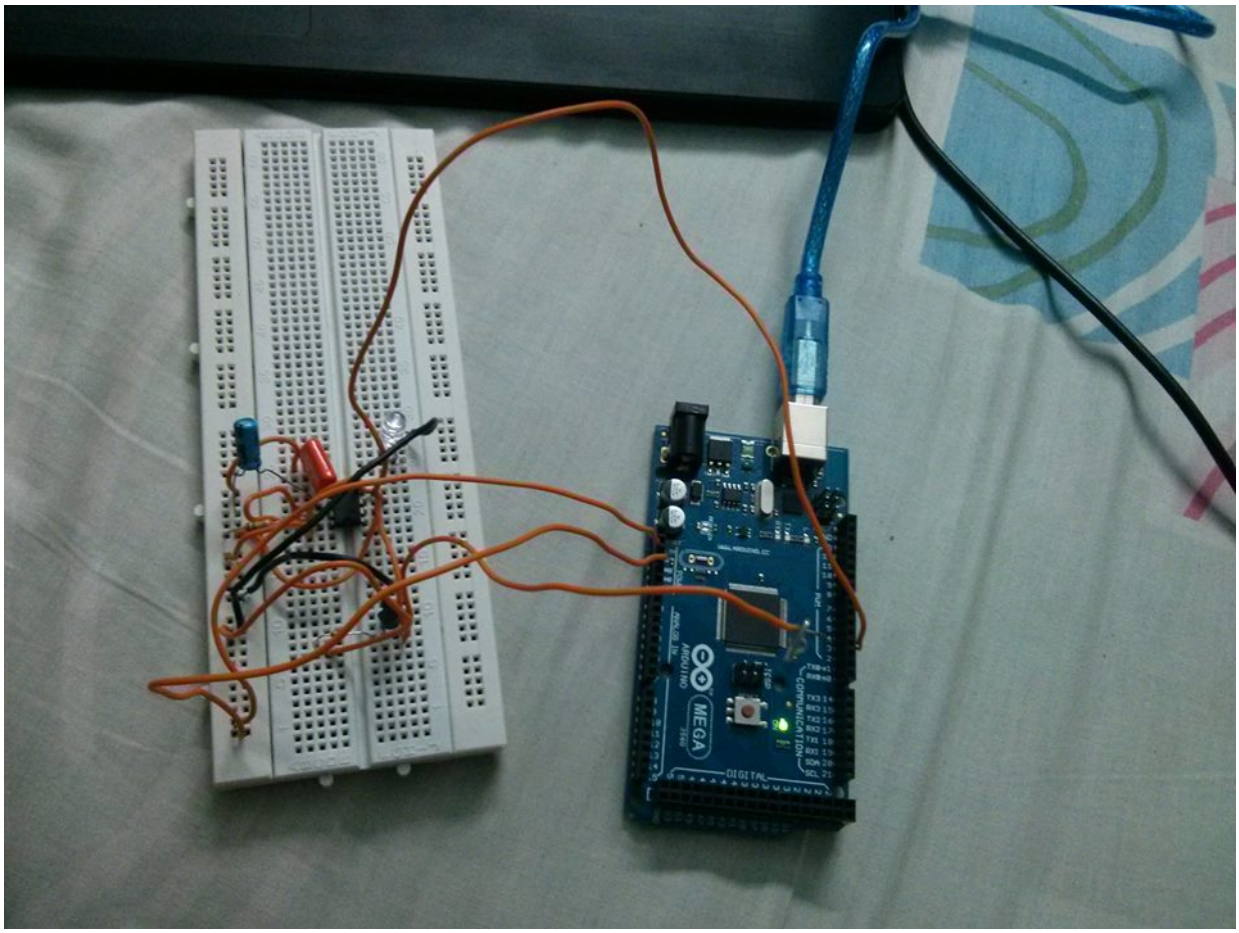


Figure 4 Testing Arduino using Arduino Compiler on Windows 7

3.3 PROCEDURE

Normal Operation:

1) A "RESET/CHECK" switch is provided. RESET clears all previous input attempts and it is used to input a new unlocking sequence.
CHECK is used to match the sequence with the key seqeunce

2) Controller reads input one-by-one from the touch-switch matrix and calculates alternate time delays & their ratios.

3) After the last tap the auto-switch turns off the lock in three seconds timeout.

4) Controller now performs the matching with stored data in the memory.

5) If the match is correct, the lock will initiate control signal to the servo motor/electromagnet which in turn will pulls the lever and opens the lock.

Recording a pattern:

1) A specific key is stored in the controller memory location, the encrypted password is provided to owner in MicroSD.

2) Once the memory card is inserted in the lock the recording process in initiated in which processor decrypts the password which is stored in MicroSD and matches it with the stored key.

3) Now the user can input the new sequence which is to be stored in the lock.

3) While using the lock in normal operation same series of steps follows as above; only difference is that instead of storing in RAM, pattern will now be saved in ROM(after entering twice).

Deleting a pattern:

1) For simplicity, a "Flush All" switch is provided which flushes all the memory contents, so any saved pattern will be lost when Flush protocol is initiated.

3.4 LOGRITHMS

Series of Steps

1. Proximity/IR sensors turn on the lock when user is nearby.
2. Metal touch plates are now active, the user inputs opening sequence after touching RESET button.
3. The sequence is read decoded and the stored in RAM for matching.
4. Matching algorithms are performed on the input sequence after touching CHECK button.
5. If the input matches the stored sequence, Lock assigns high value to pin 9. Else after 15 incorrect bits lock resets itself.
6. The servo motor at pin 9 comes into play. A 180° shift is applied to the rotor shaft, which de-latches the door and hence door is unlocked.

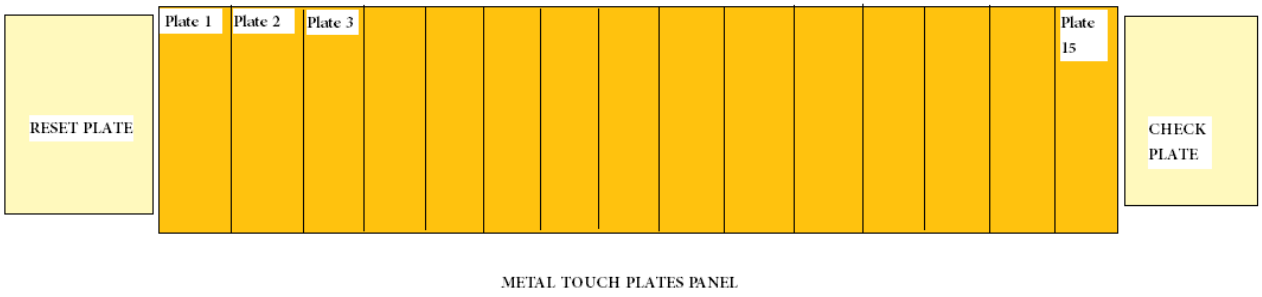
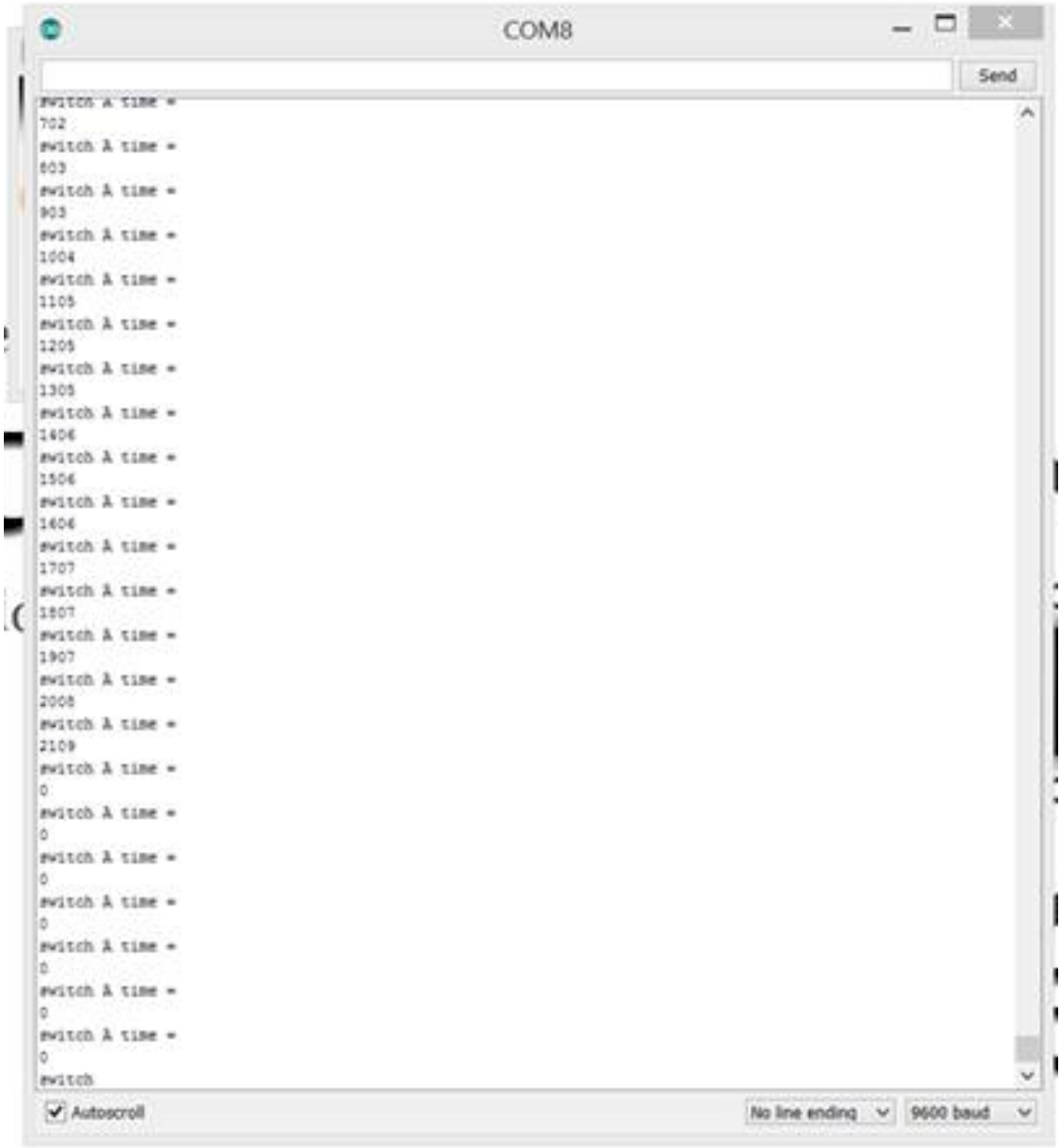


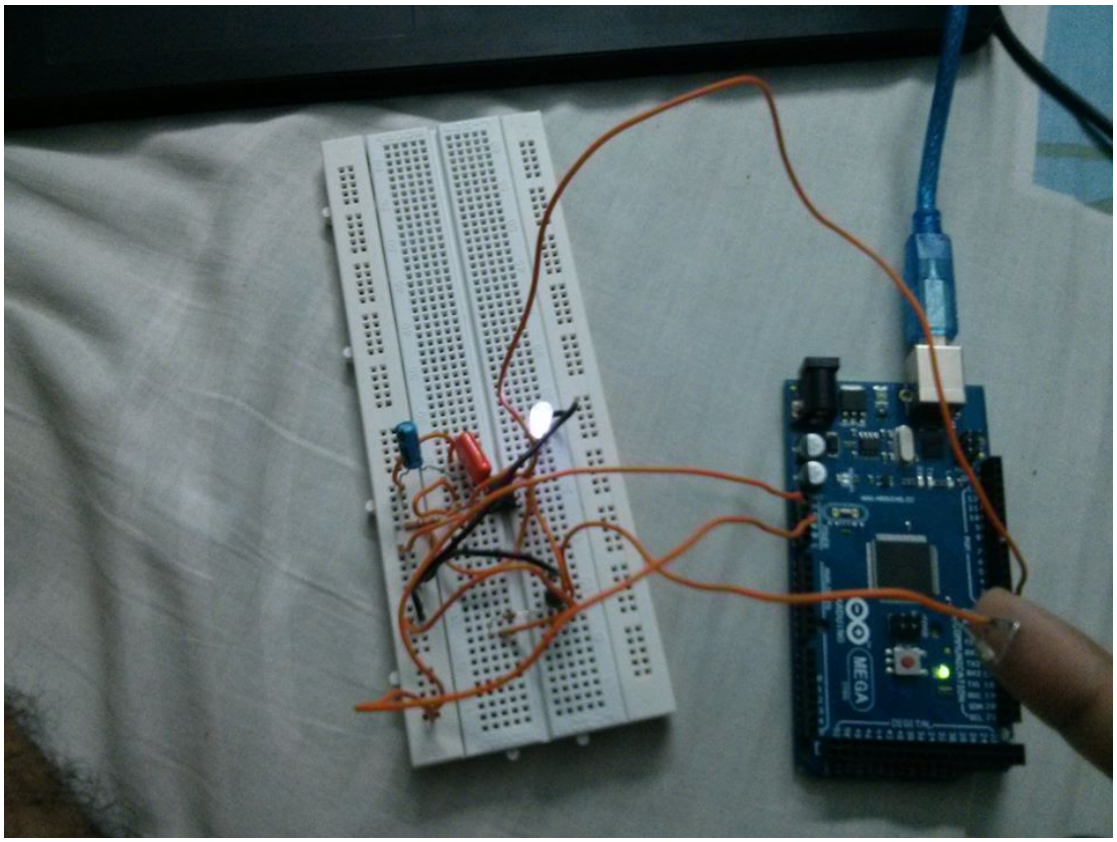
Figure 5. Metal Touch Plates Panel

Chapter 4 Results and Outcomes

4.1 Results



The above output window represents the touch input recording sequences obtained inside arduino and being displayed on terminal window of arduino compiler.



The above diagram shows the touch input wires attached to arduino board and interfaced with an indicator LED

Chapter 5 Conclusion and Future Work

5.1 Conclusion

Thus by using low cost hardware and software components we successfully designed a locking system, which is much more secure than conventional hardware locks. On the same hand it is less costly than biometric and retina locks. So it has a lot of applications in consumer and industrial locations.

Advantages of T-lock over other locks

1. It is easily disguisable anywhere on the door or inside lockers, vaults, etc.
2. It offers 1816214400 more possible combinations than the (0-9) key based keypad locks.
3. The door/vault does not need to have even a keyhole or handle. So the lock cannot be cracked easily using conventional lock-picking methods.
4. A hardware key is only required to reset lock settings. No hardware key or card is required to open the lock. The sequence is known only to user so there is no chance of counterfeit copying of the key.

5.2 Future Work

In the 8th semester we would be interfacing the Hardware with the Software, and testing the lock on doors,lockers etc.

References

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[4] *ProgrammingArduino: Getting Started With Sketches*; Monk Simon; 162 pages; 2011; ISBN 978-0071784221.

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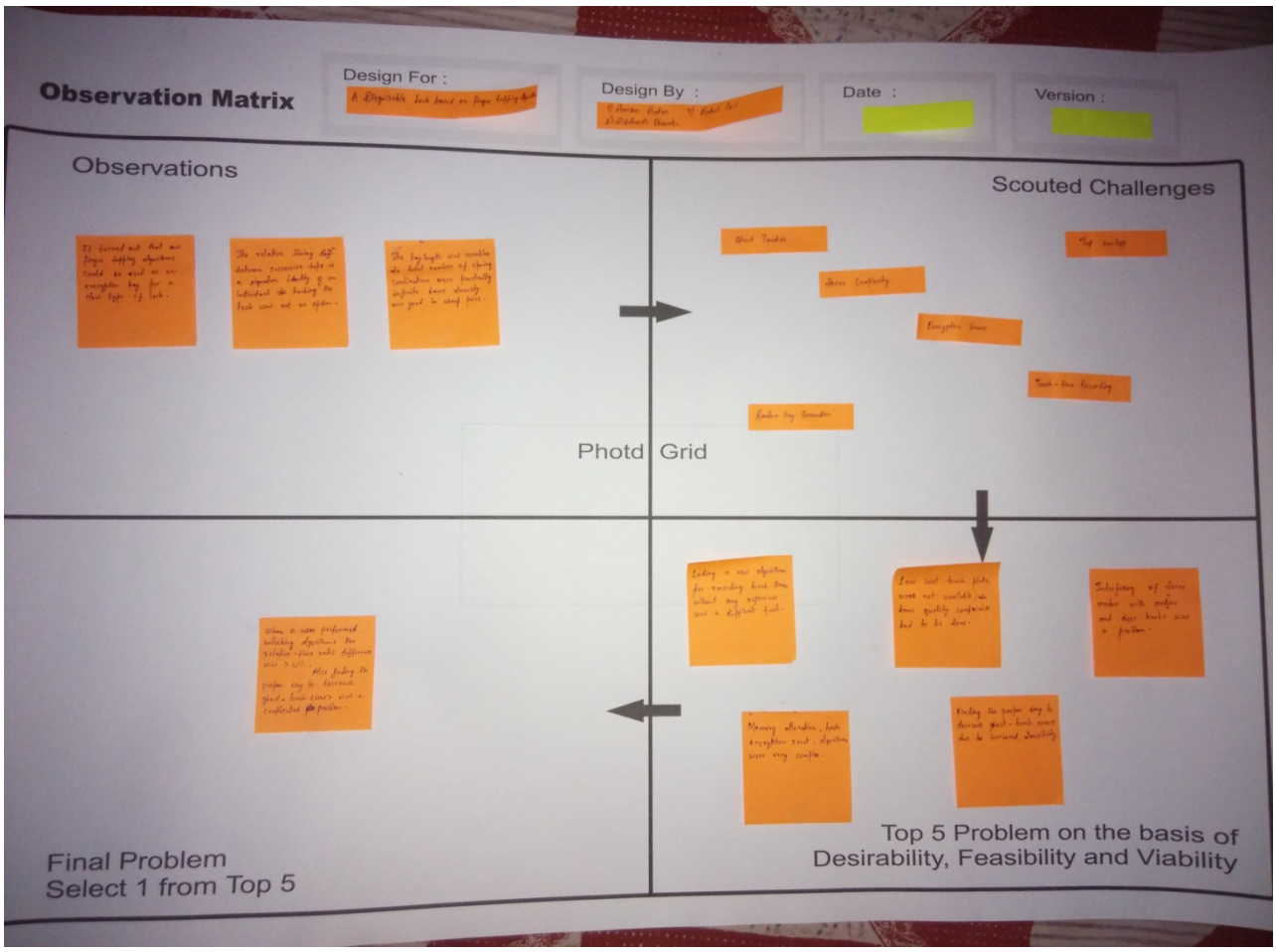
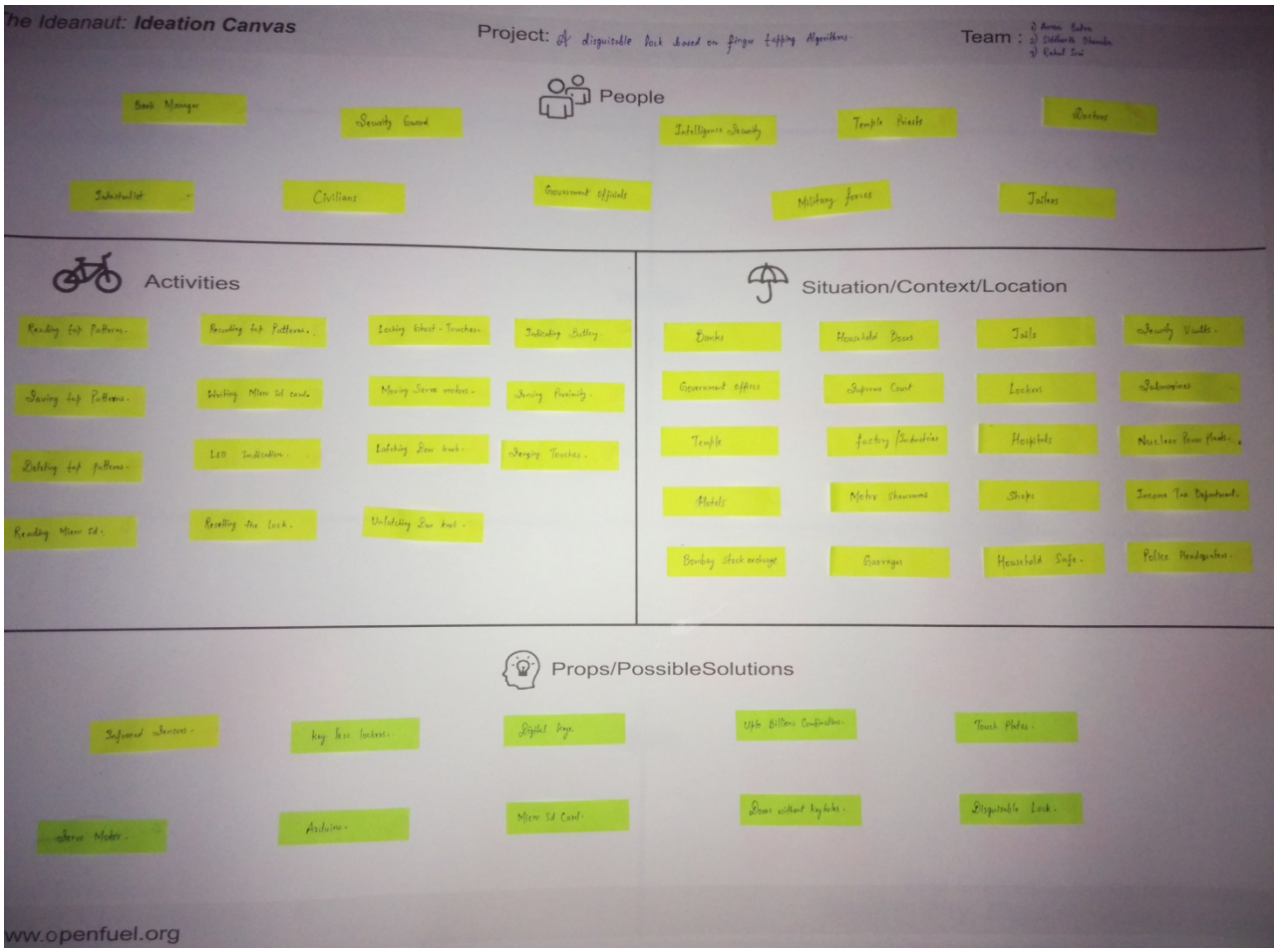
[6] "The history of locks". London Locksmiths Ltd. Retrieved

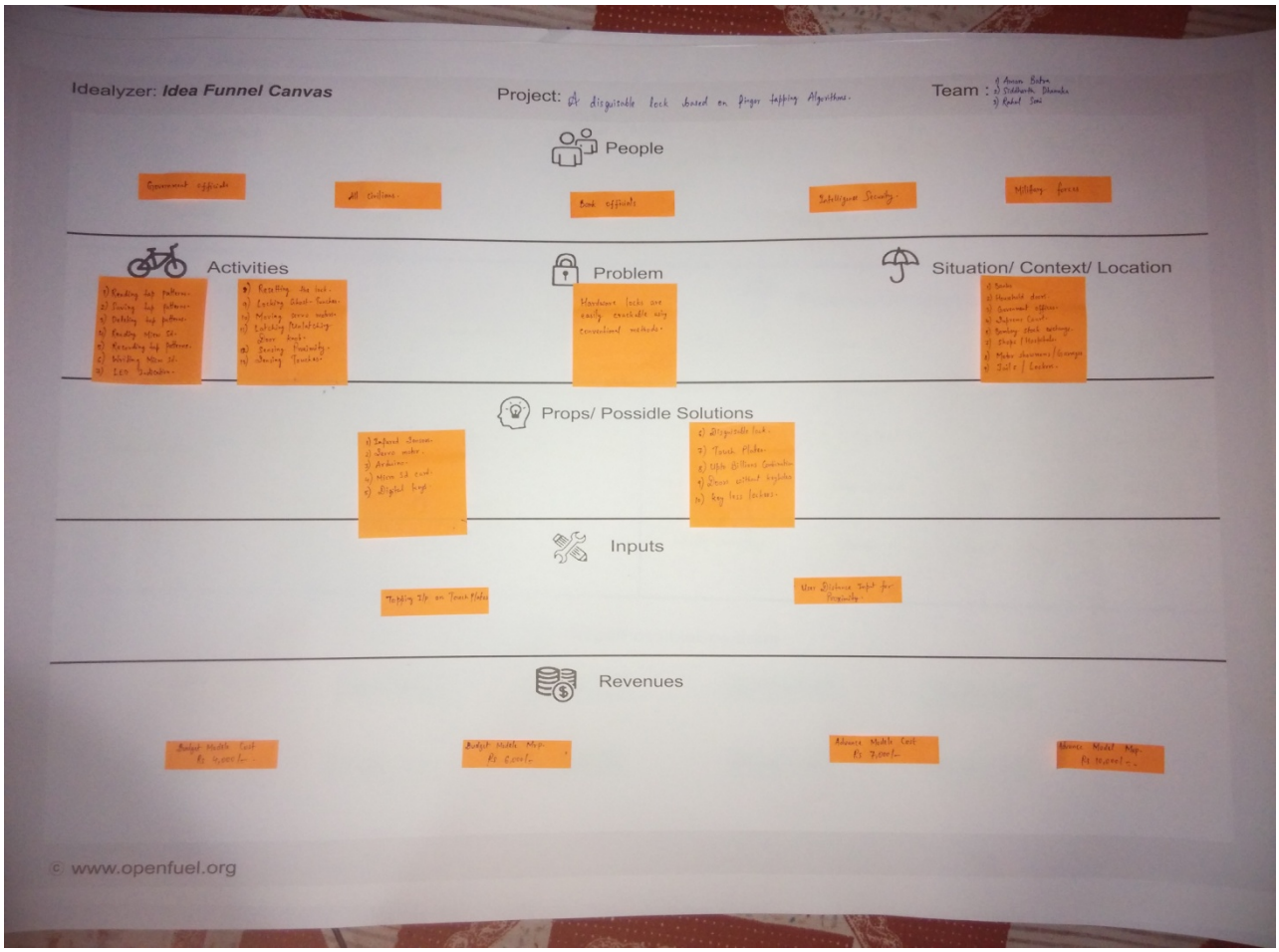
Annexure 1 Chart 1-Observation Matrix



Annexure 2 Chart 2-Ideation canvas



Annexure 3 Chart 3- idea Funnel Canvas



Annexure 4 Chart 4- Product Development Canvas