2017

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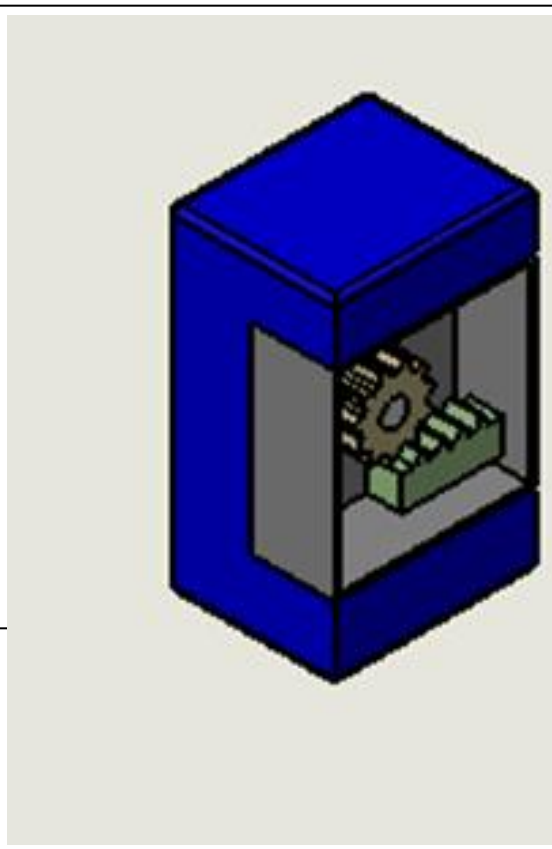
Creating Value
Leveraging Knowledge

Smart Lock

Engineering Design and Product Realization
a course project report



KLE Technological University

CERTIFICATE

This is to certify that the project entitled “Smart Lock” is carried out by below mentioned students as part of third semester Engineering Design and Product Realization Course, KLE Technological University, Hubballi, during B.E program for the academic year 2017-18. The project report fulfils the requirements prescribed.

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Abstract

The proposed method in this study uses the IoT technology and the application of smartphone communication technology to conventional device (door lock) to open or close a door remotely through authentication. In particular, this study proposes the Smart Door Lock System based security enhancement plan for the safety issue caused by the physical key used in unmanned automation machines, such as ATMs, KIOSKs, and vending machines.

We propose a smart digital door lock system for any lock system. A digital door lock system is any equipment that uses the digital information such as a secret code instead of the legacy key system. In our proposed system, a Central Control module is embedded in the door itself, this is required to prevent additional complications and more robust mechanism for the door as a whole.

Introduction

The technology of keys and locks remained the same for the last century while everything else is evolving exponentially. So why not use current technologies and apply it with old ones to build something new and innovative.

Around 4000 years ago, the concept of Locks and Keys were invented, and until today, regardless of some minimal variation in security and sustainability, locks are installed in doors stimulated mechanically by the right key. Recently, the Internet was enhanced, and everything was connected to it (phones, televisions, laptops, tablets, cars and so on…). This was done because we wanted to make systems “smarter”, in other term “more productive”.

Why not do the same thing with Locks? Enhancing the locks mechanism by connecting them to the internet, making them more robust and productive.

Today, the number of mobile device users including smartphone users has rapidly been increasing worldwide, and various convenient and useful smartphone applications have been developed .Now smartphones are not only used to send and receive phone calls, send text messages, and perform mobile banking operations, but they also are used to control various other devices in our real everyday lives. Through a mobile operating system and internal applications, we can remotely control a variety of external devices such as TVs, projectors, computers, cars, etc.

Acknowledgement

The final outcome of the subject required a lot of guidance and assistance we would not forget to thank the people who helped us

It is genuine pleasure to express our deep felt gratitude to the whole ED faculty for helping us out in every possible way in designing the model, pcb and in designing a software.

Below are the people without whom our efforts would not be rendered complete.

Prof. Satish (Mentor and instructor for Engineer Design course)

Prof. Shilpa (Mentor and Instructor for Engineer Design course)

Prof. Malikarjun Akki (mentor and Instructor for Engineer Design course)

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1. Need statement

A secured home/office is of prime importance for any user in today scenario. The same with a smart feature would be need of the day with high end technology available. Thus a portable device which fits into any door or windows of home/office to lock and unlock without hard keys and also remotely. To complete the project you will have to follow structured design step which have already been put in place for your reference. What we expect you to produce, Firstly you will be researching to understand and enlist design requirements, followed be by ideation set the level of generality at which you will be working. Secondly, at the selected level of generality, you will be conceptualizing to develop feasible alternatives which meet design requirements. Since, the nature of the project is multi-disciplinary; you will be working within heterogeneous group of students. This step involves system level design and co-simulation of system is expected outcome at end of this step. Finally you will need to build the functional product to display its functionality, form and fit.

2. Planning

GANTT CHART																
Phase	**Task**	**Weeks**														
	Dates															
		1	**2**		**3**	**4**	**5**		**6**	**7**	**8**		**9**	**10**	**11**	
Planning		7/8	27/8													
	Analyse Need	7/8														
	Formulate a product proposal		14/8													
	Clarify the task		14/8													
	Elaborate Requirement list		21/8													
	Requirement Modelling(SRS)		28/8													
Concept Development				**GATE 1**	28/8	1/9	11/9	**GATE 2**				**GATE 3**				**End Semester Assessment**
	Function to Architecture				28/8											
	Establish Function Structure				28/8											
	State &Sequence Diagram				28/8											
	Working principles and structures					1/9	8/9									
	Combine and frim-up in to concept variants						8/9									
	Evaluate against technical and economic criteria						11/9									
System Level									18/9	25/9	9/10					

Design	**Product Architecture**								18/9								
	Data flow diagram								24/9								
	Architecture Design									25/9							
	Configuration design									25/9	9/10						
	Parametric design										15/9						
Detail Design													16/10	23/10	30/10		
	Geometry, dimensions material												16/10				
	PCB design, Component selection												16/10				
	Data flow and class diagram												22/10				
	User interface design													23/10			
	Code generation													23/10	30/10		
	Design verification														30/10		

2.1 Potential Customer identification

1) School
2) House
3) Banks
4) Shopping malls
5) Hostel
6) Apartments
7) colleges
8) hospitals
9) Research centres

2.2 Market Survey

Companies that have a same kind of product

1) August smart lock
2) The wire cutter
3) Fiasco
4) Uplinks connected c alarm shield
5) Kwikst 925 kevorkian smart lock
6) Danalock v2 smart lock

2.3 Market Trends

The report aims at estimating the market size and future growth potential of the security solutions market based on type, end use industry, and region. The report analyses the market structure by identifying various sub segments of the security solutions market. It aims at identifying the major market trends and factors driving or restraining the growth of the security solutions market and its various submarkets. Some of secondary sources used in this research include information from various fire protection associations and organization such as the national fire protection association and security magazine among others.

2.4 Patent search

Companies that produce similar product:

Company	Patent Number
Packard Bell nec,Portugal	US5854736
International Business Machines Corporation ,New York	US5047575
S LC Technological,Netherlands	US6975255
International Business Machines Corporation ,New York	US8353187
Yiqi Wc Woodling, Japan	US8922333
Master Lock Company	US2006008021
Acco Brands innc USA	US20070169523

Table 1. Arriving at engineering requirements from customer statements

Customer: Interviewer(s): Date:		
Question/Prompt	**Customer Statement**	**Interpreted Need**
Typical uses	Look should be safe	Smart clock can be safer Look should be safe
	Lock should be operated feasible distance	It should be operated from 10m distance
	I wish to grant across to my home and office to other people	It can be accessible by many people
Likes current tool	It should be accessible by multiple devices	It is accessible by multi devices
	It should send an alert messages if there is any Problem	It send alert messages if someone tries to thicken it
Suggested improvements	It should have aesthetic look	Smart have good look
	I wish to know who is near the door	It sends a image of a person who is near to your lock door

2.5 Initial requirements

Table 2 Initial requirement list

Source Client/ Team/ Survey	Requirement
Client	Should be safe.
Client	Should be strong.
Client	Should have multiple ways of operating.
Survey	Feasible size
Team	Accessible through multiple users.
Client	Can be used for home safety, treasuries and banks.
Client	Alert supervisor on hazard/failure.
Team	Should be durable.
Client	Can be operated from a maximum distance of 10m.
Team	Should send information when authentication fails.
Client	Ease of maintenance.
Client	Time lapse for response should be as less as possible.
Team	Aesthetically good.
Client	Signals during operation.
Client	Uniqueness.
Client	Reasonable price.

2.6 Elaborate requirements

Table 3 Elaborated and Prioritised requirement

R	Requirement	Importance	D/W	Sub Category
1	Should be safe.	10	D	Safe to device
2	Should be strong.	5	W	Safety to device
3	Should have multiple ways of operating.	5	W	Convenience
4	Feasible size	6	W	Size
5	Accessible through multiple users.	10	D	Easy to use
6	Can be used for home safety, treasuries and banks.	10	D	Safety to user
7	Alert supervisor on hazard/failure.	8	W	Safety to user
8	Should be durable.	10	D	Ease to maintain
9	Can be operated from a maximum distance of 10m.	10	D	Ease to use
10	Should send information when authentication fails.	10	D	Safe to user
11	Ease of maintenance.	4	W	Ease to maintain
12	Time lapse for response should be as less as possible.	7	W	Efficiency
13	Aesthetically good.	7	W	Appearance
14	Signals during operation.	8	W	Efficiency
15	Uniqueness.	4	W	Appearance
16	Reasonable price.	7	W	Inexpensive

2.7 Affinity groups

R#	Sub Category 2	Sub Category 1	Category
1	Safety to device		safety
2	Safety to device		safety
3		Convenience	performance
4		size	
5	Ease to use		
6	Safety to user		
7	Safety to user		
8	Ease to maintain		
9	Ease to use		
10	Safety to user		
11	Ease to maintain		
12		Efficiency	
13			Appearance
14		Efficiency	
15			Appearance
16			inexpensive

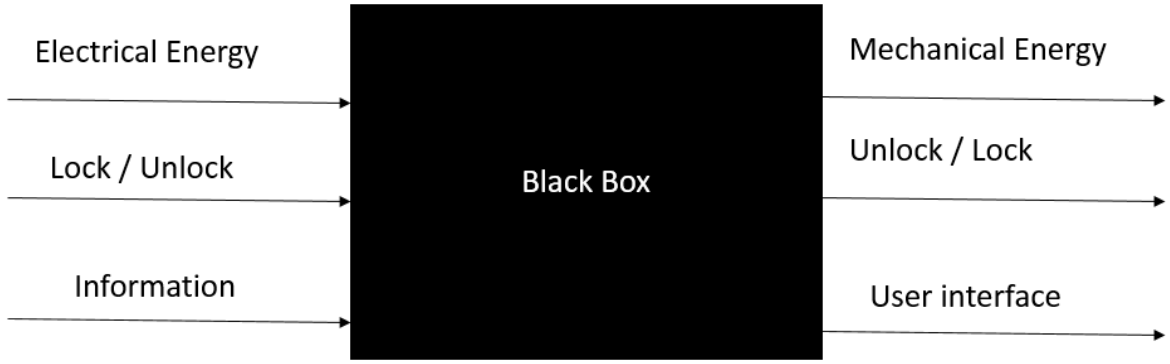
2.8 Finalized Problem statement

To Design and build a Smart lock which works automatically works with the help of user interface. It should take approximately 4 sec to lock and can be locked/unlocked at a maximum distance of 10 meters. It should also warn to owner in case of unauthorized entry and should also contain the history of who all checked in to the home.

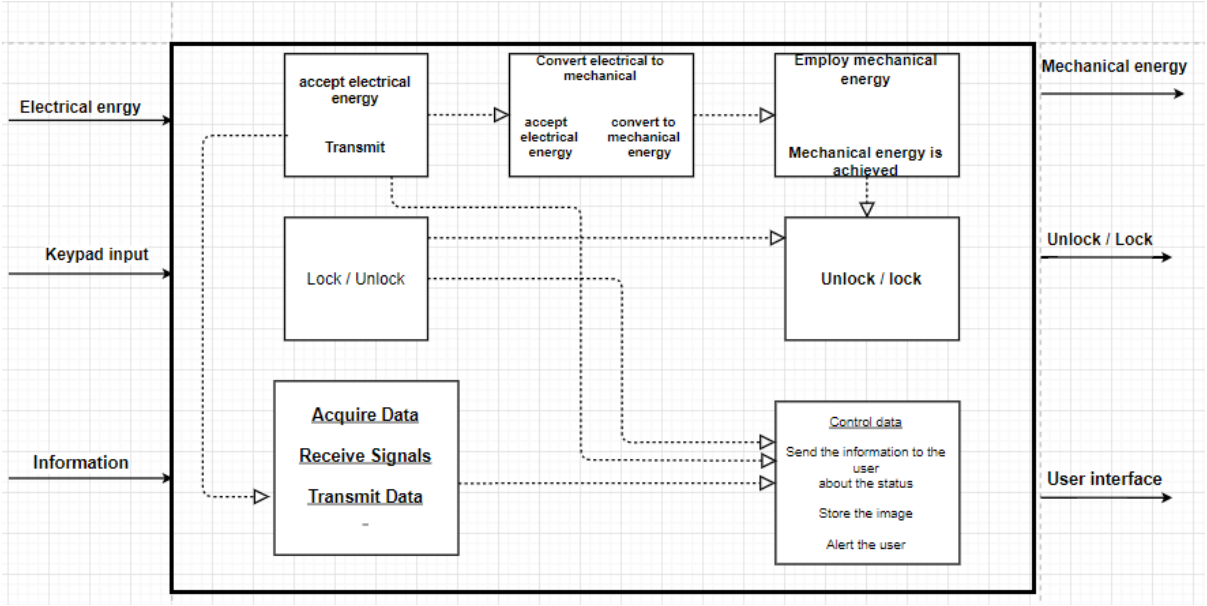
3. Conceptual Design

3.1 Establishing Functional Structure

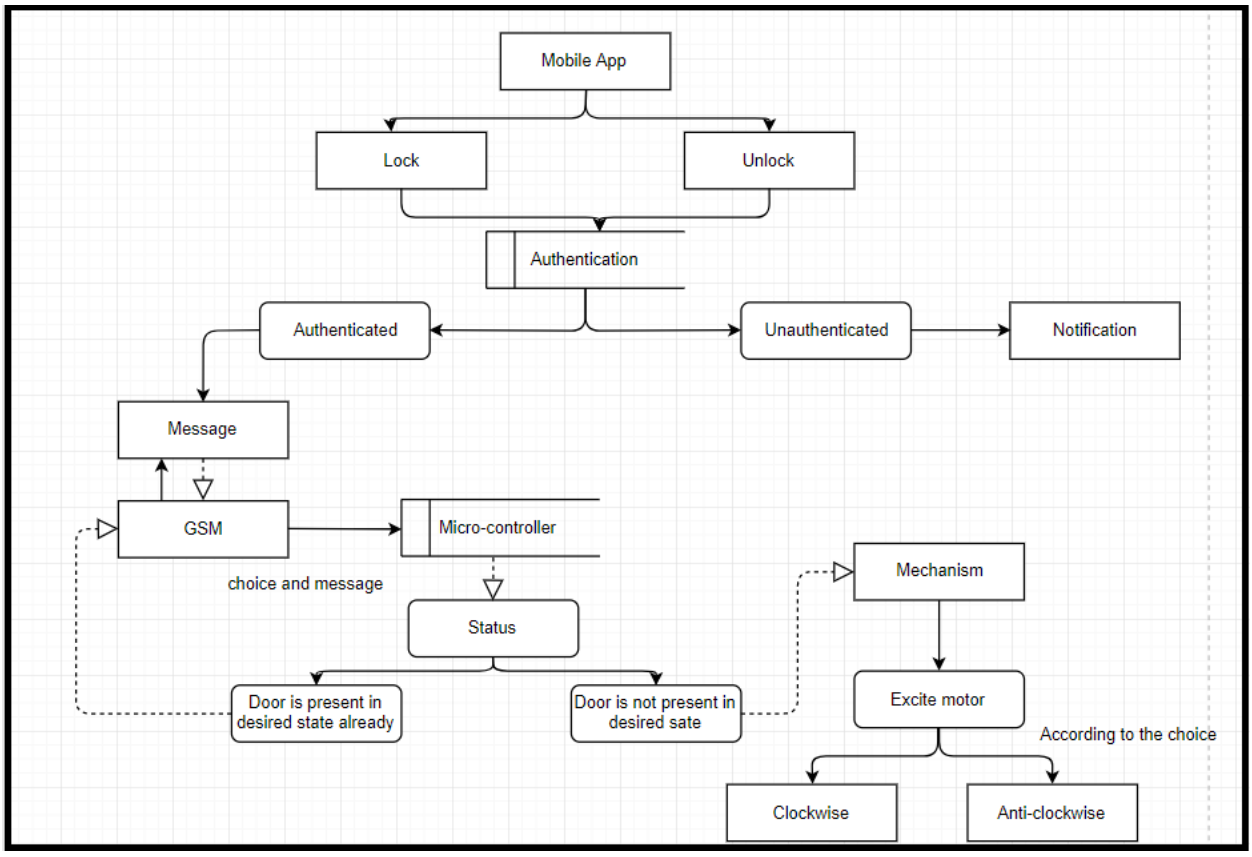
3.1.1 Black box model



3.1.2 Transparent box model



3.2 Data flow diagram

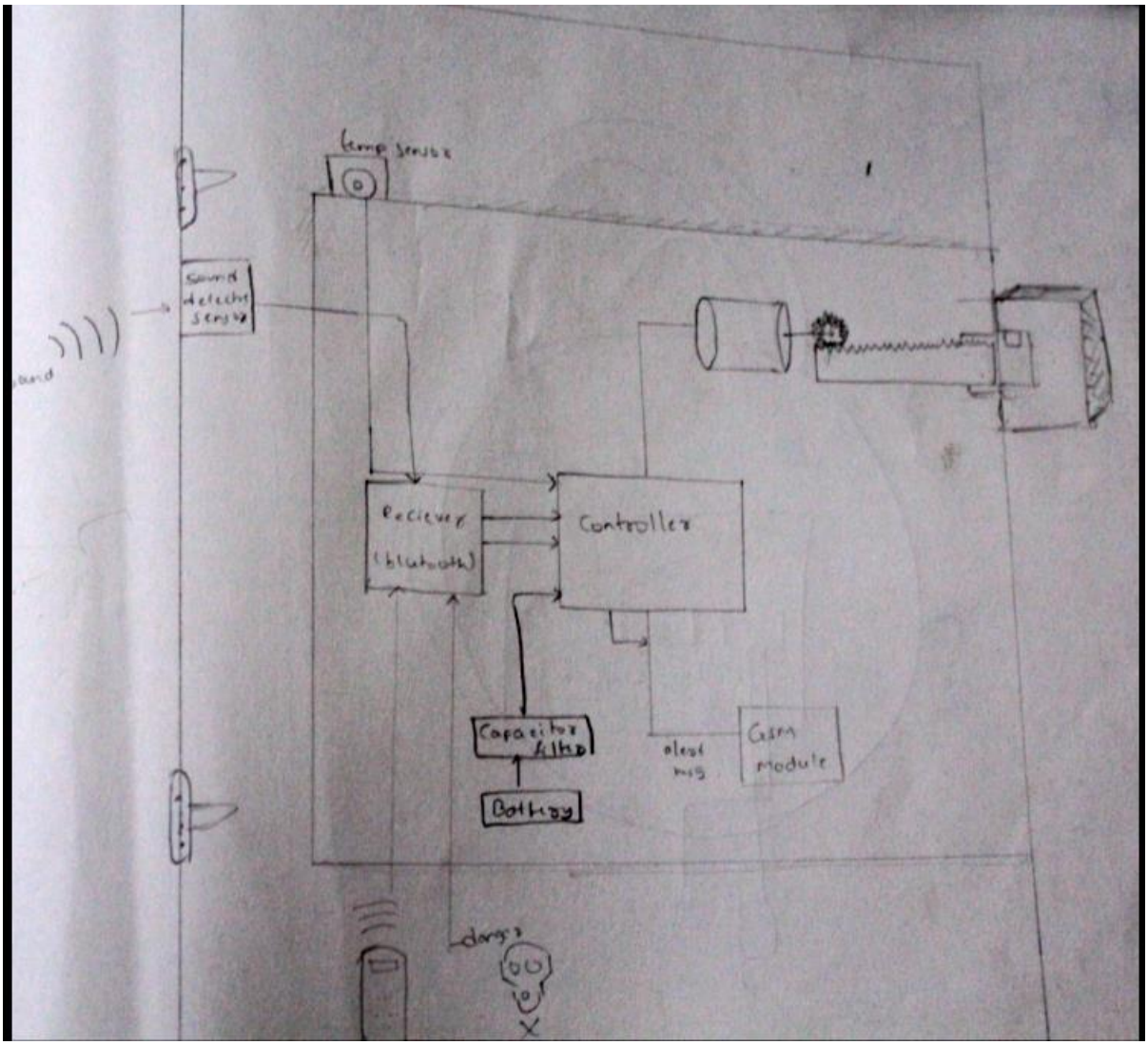


3.3 Working structures and Working Principles

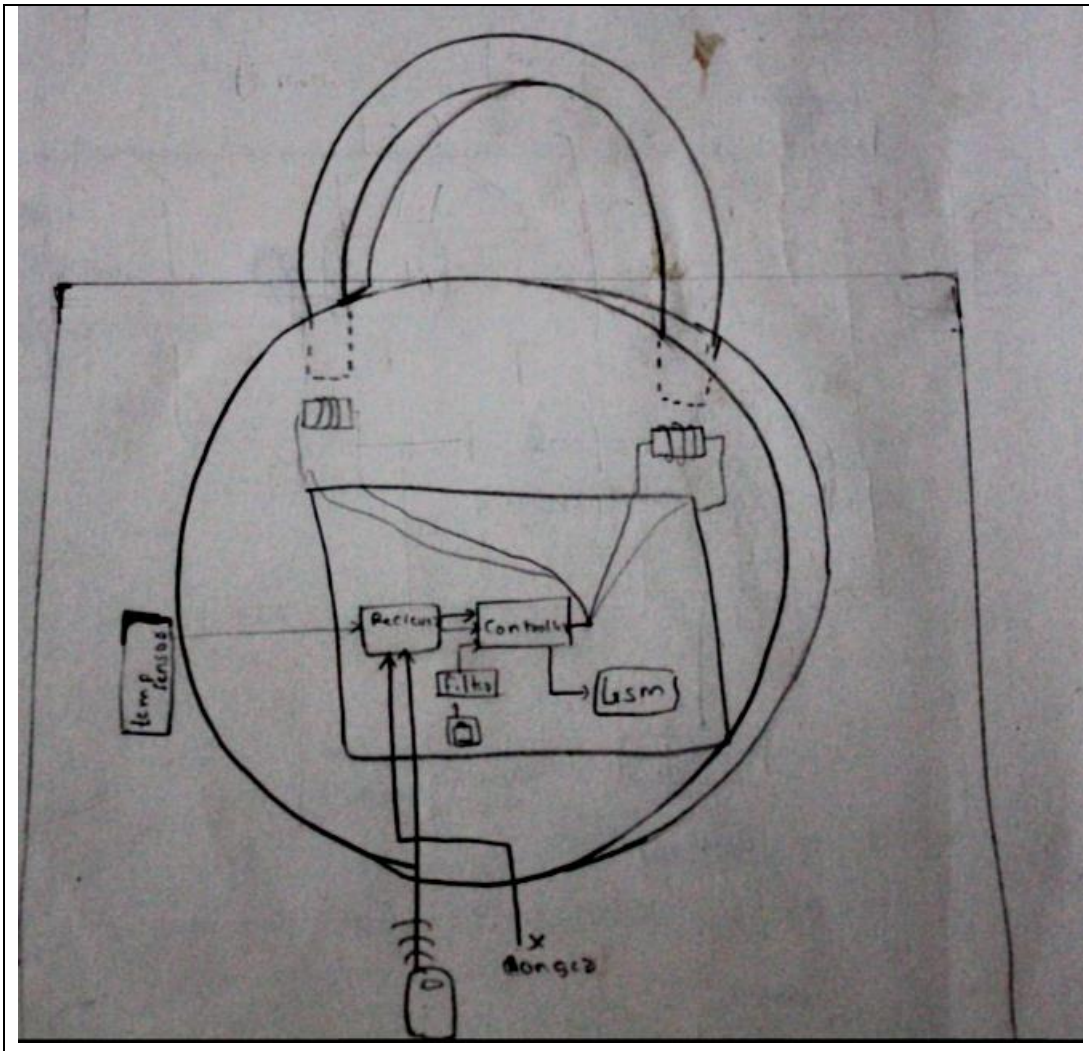
Functions	Working Principle 1	Working Principle 2	Working Principle 3	Working Principle 4
POWER SUPPLY	BATTRY	SOLAR	Ac source	
ACCESS	BLUETOOTH	WIFI		
CONTROL	MOBILE	PC	TAB	
ALERT MASSAGE	BUZZER	GSM MODULE		
FILTER	CAPACITOR FILTER	PI FILTER		
ACCEPT MECH ENERGY AND TRANSMIT	RACK/PINION	BEVEL GEAR	WORM GEAR	SPUR GEAR
INFORMATION ABOUT WHO IS NEAR BY	CCTV CAMERA	TEMP SENSOR		
ACTUATOR	DC MOTOR	SERVO MOTOR	Stepper motor	
ALTERNATE DETECTION WAYS	FINGER PRINT	VOICE DETECTION	SOUND DETECTING SENSOR	

3.4 Developing solution variants

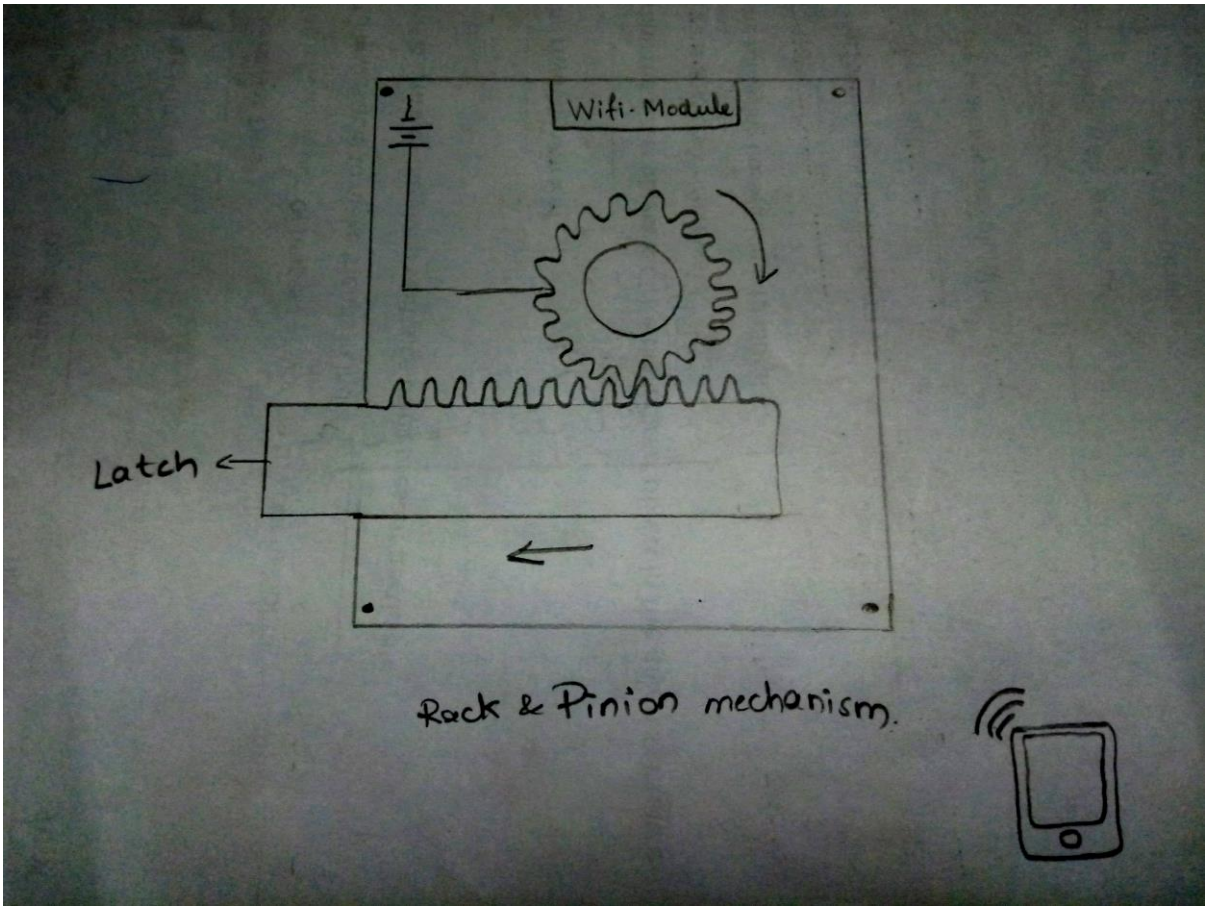
Variant 1:



This design on the gear mechanism, precisely rack and pinion gear method. Firstly the signal from the mobile app send to the controller atmega IC which receives signals and process it send to the stepper motor which rotates in turn clockwise or anticlockwise according to the given signal which in turn connected with rack as rack moves circular pinion follows linear motion.by this the lock is locked or unlocked, and the entire setup is placed inside the house.

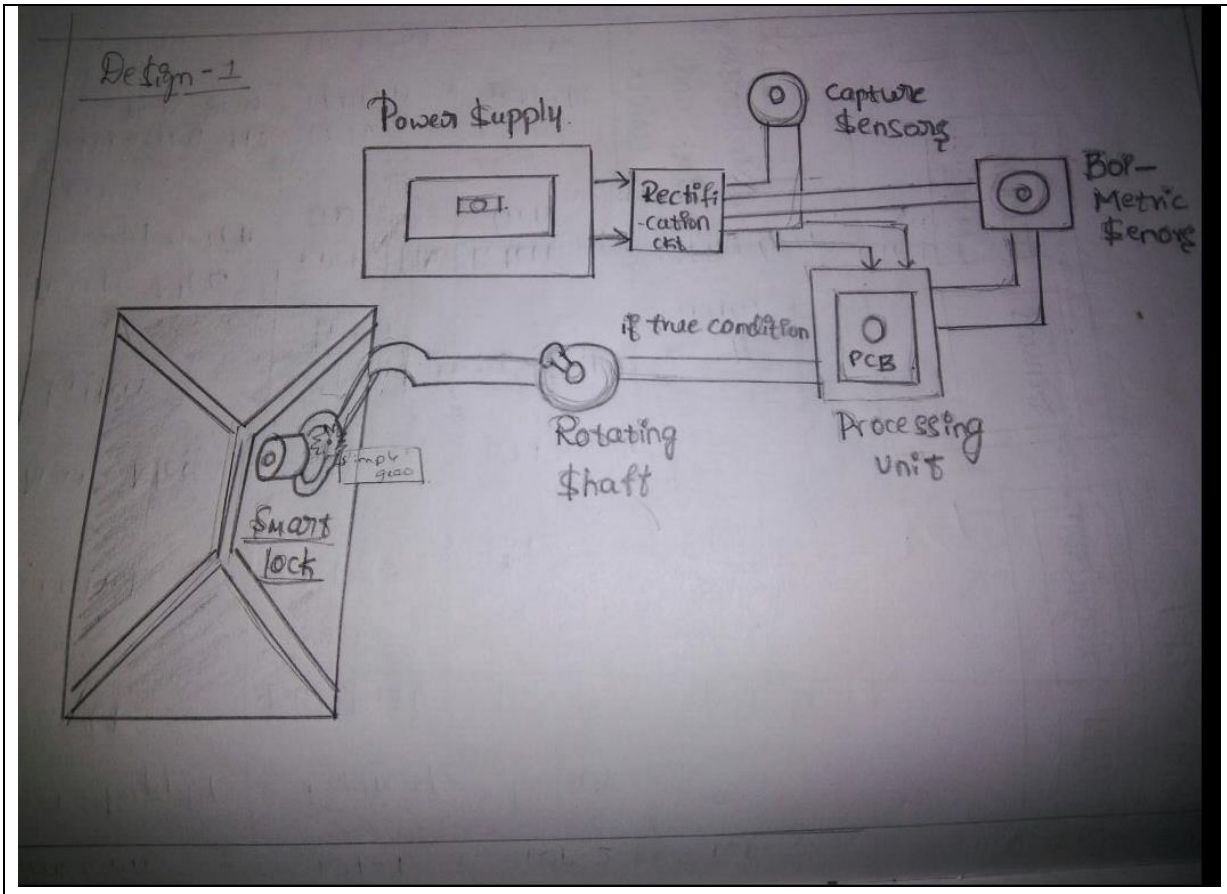


This design mainly works on the principle of magnetic poles attraction or repulsion. This design resembles the current locking system we are using in our house. Where the body of lock is place at the edge of door and the U shape part is placed to the frame. Firstly the signals is send to the controller atmega IC which receive the signals and send to the windings arm .due to the signals there is flux in the windings which in turn produces magnetic attraction so the U shape part is attracted by it and fit into the holes. By changing the polarity it separates from the main body part. So the locking and unlocking occurs.

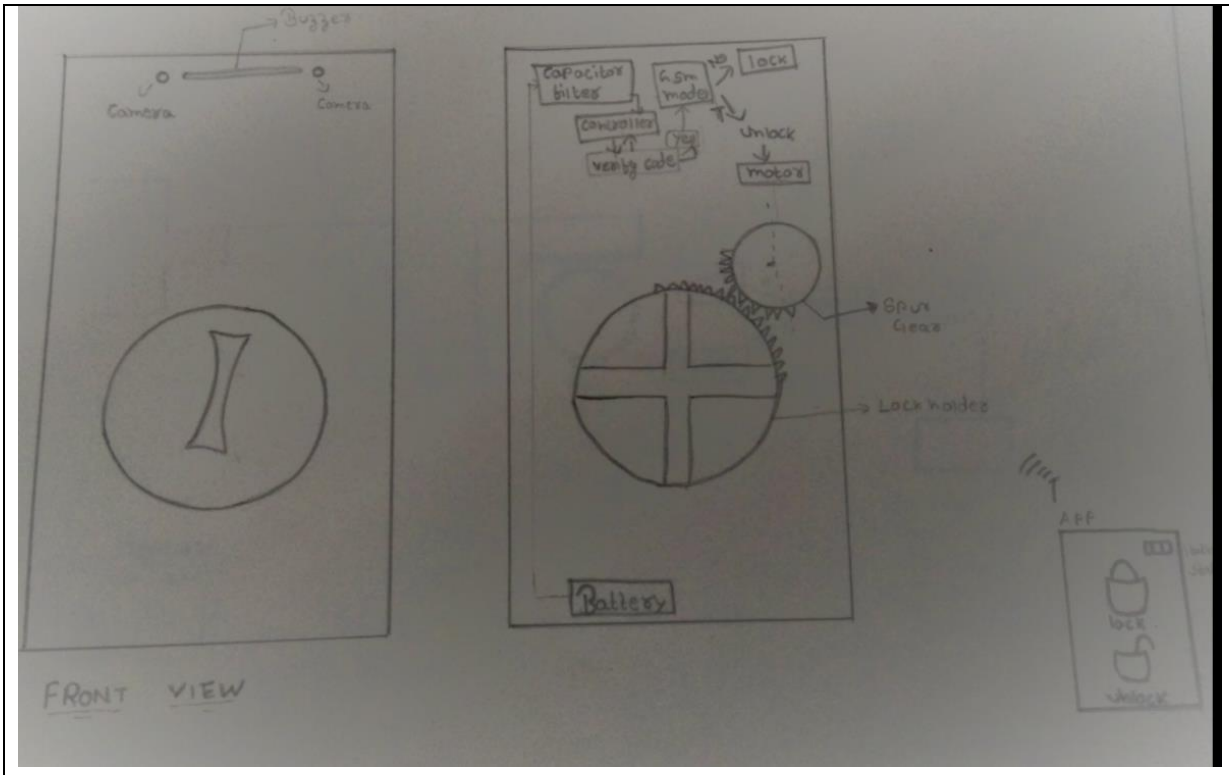


This design works on the mechanism of rack and pinion. When the user gives the input as lock or unlock, the app authenticates the signal and transmits the same to the GSM module.

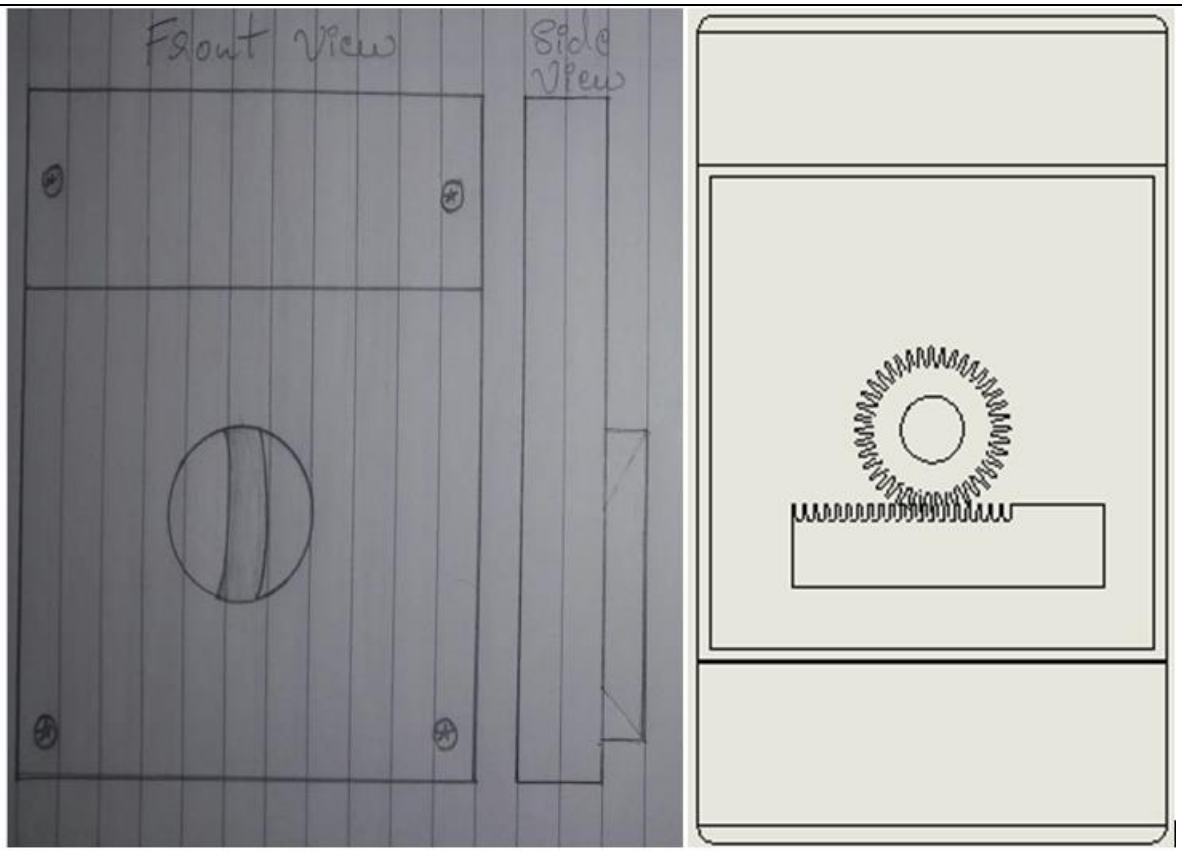
GSM excites the motor as per the user input signal. If the user input is ‘lock’ then the motor rotates in clockwise direction and the latch gets locked inside the wall. If the user says ‘unlock’, then the motor rotates in anti-clockwise direction and latch moves backwards so the door gets unlocked.



In this module we can access the door from an biometric source were all the genuine people fingerprints are stored in the system if that person comes to the open door biometric scan if it is authenticated then door will be opened else a person image will be captured and stored .



The smart lock which we have designed above should be fixed with the present internal locks of the door were the latch of the interlock should be fixed with our smart lock .the input to the our system is given from the application were it sends the message to our gsm as an “lock or unlock” based on the message we have received the latched will be rotated clockwise or anti-clockwise respectively.



description

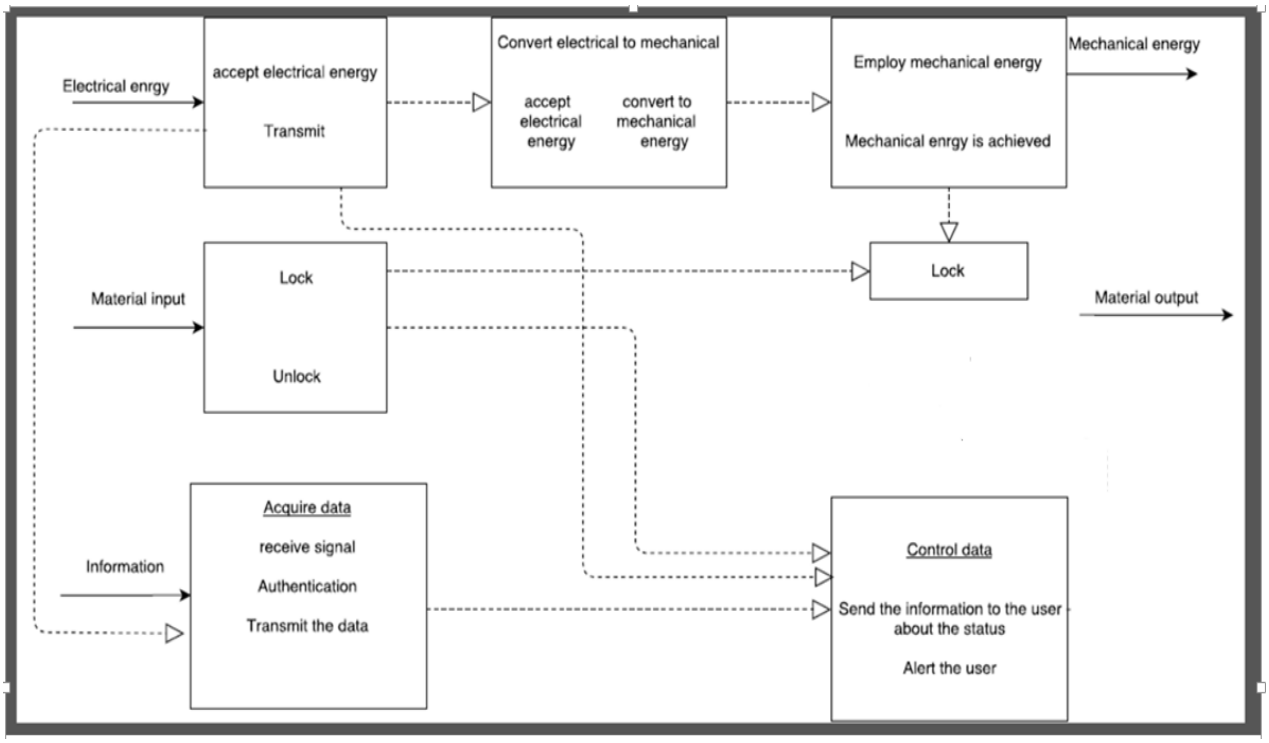
as the motor is controlled by signal conditioning element and the motor is powered by 12v battery, the shaft is attached with the worm gear and it meshes with worm wheel hence we can easily control the Movement of the latch of the lock with the help of above mechanism, just by controlling the motor shaft rotation. And the motor can controlled by any of the available logics such as wi fi, remote, voice controlled chip etc. So finally I can say that the lock can be worked automatically by the above mechanism.

3.5 Evaluation of best variant (Pugh Chart)

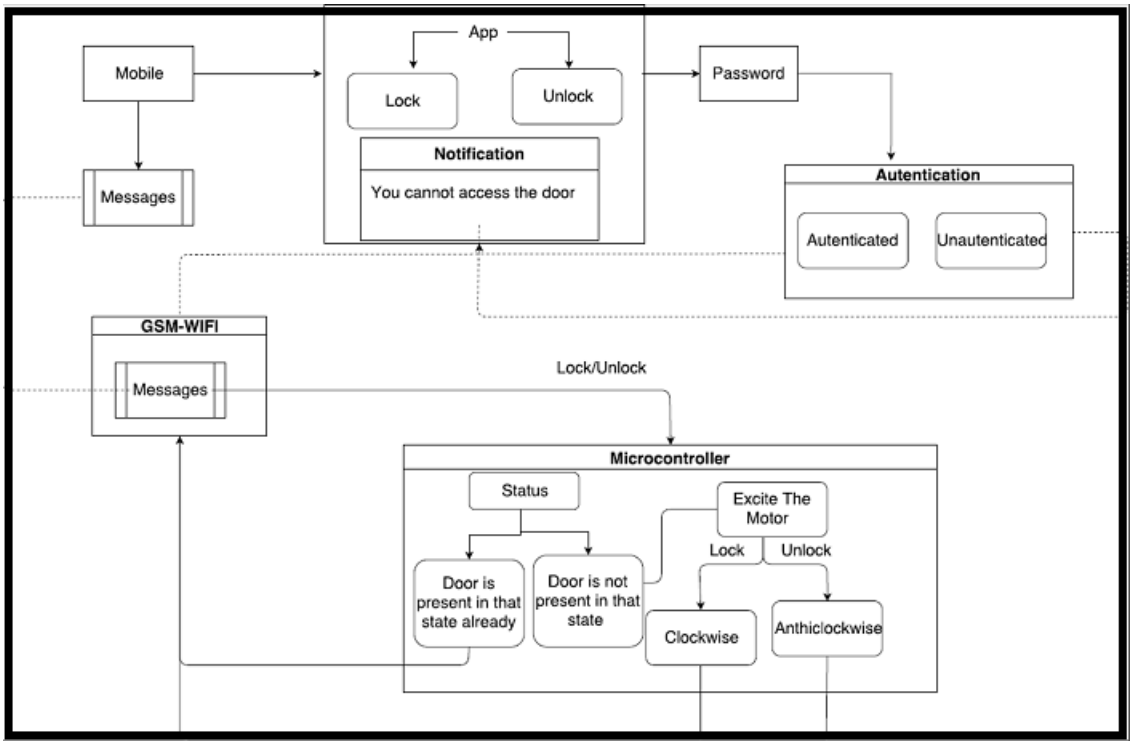
Requirement	Weight	D1	D2	D3	D4	D5	D6	D7	ref
Safety	10	0	+	-	+	+	+	+	0
Durable	8	+	0	-	-	+	-	+	0
User friendly	8	0	+	+	+	+	0	0	0
portable	10	+	+	+	-	+	-	0	0
Alert messages	10	+	+	0	+	+	+	+	0
cost	9	-	-	+	+	-	+	+	0
Time lapse	8	-	0	-	-	-	-	-	0
Ease of maintenance	7	-	0	+	0	+	-	0	0
Feasible distance	9	0	+	+	0	0	+	+	0
market	7	-	-	-	-	-	-	-	0
pluses		3	5	5	4	6	4	4	
same		3	3	1	2	1	1	4	
minuses		4	2	4	4	3	6	2	
Overall total		-1	3	1	0	3	-2	2	
Weighted total		2	31	10	4	29	-2	25	

4. System level Design

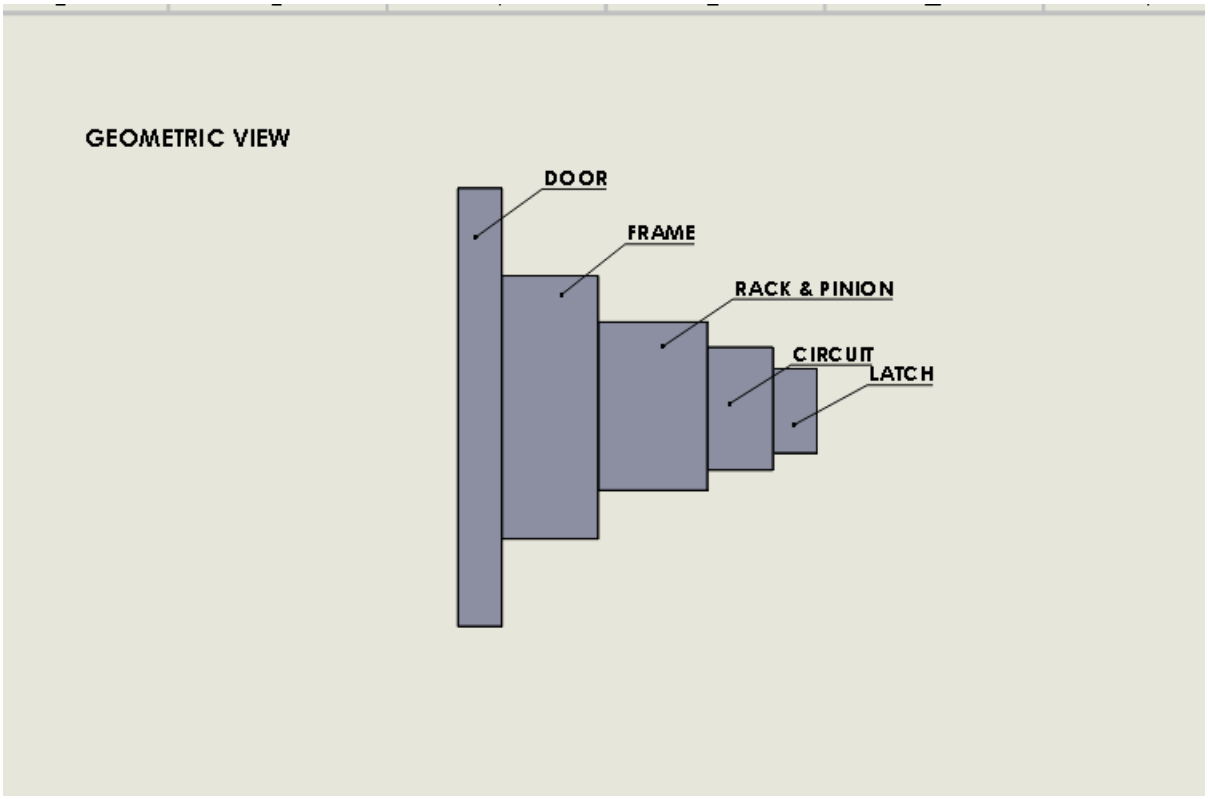
4.1 Schematic of the product



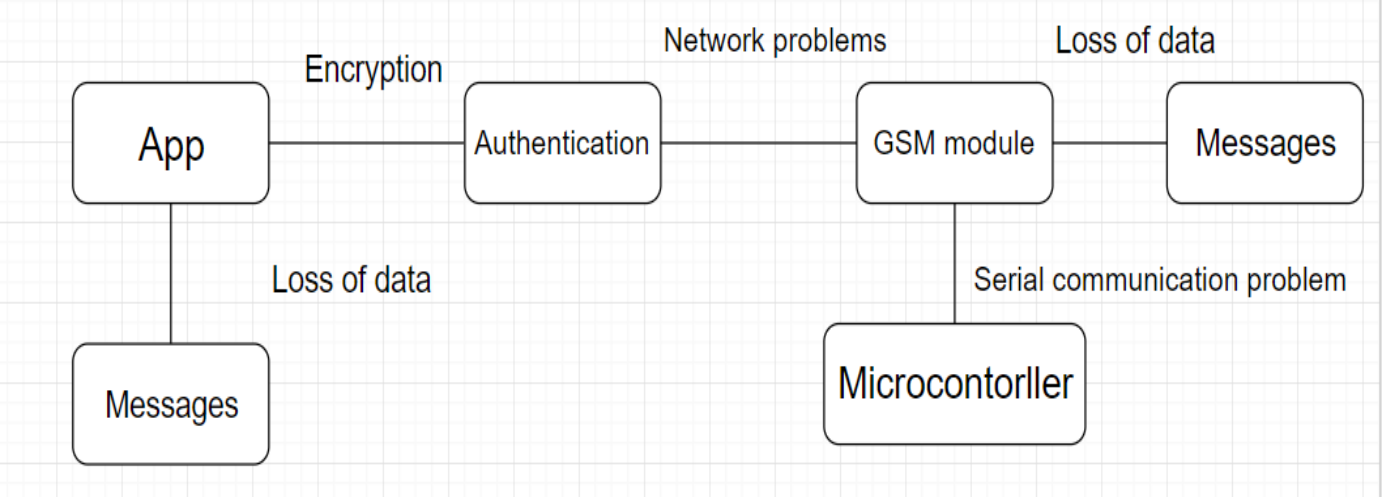
4.2 Clustering the elements of the schematic



4.3 Geometric layout



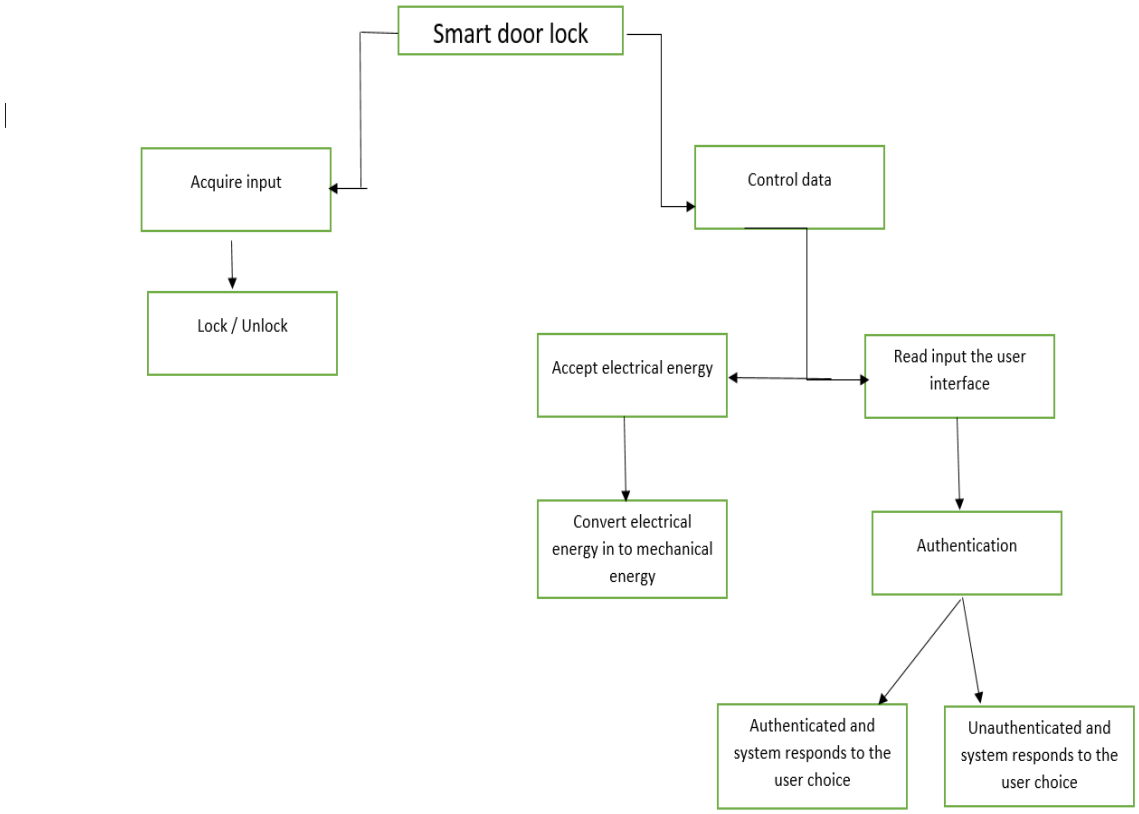
4.4 Fundamental and Incidental interactions



5. Detailed Design

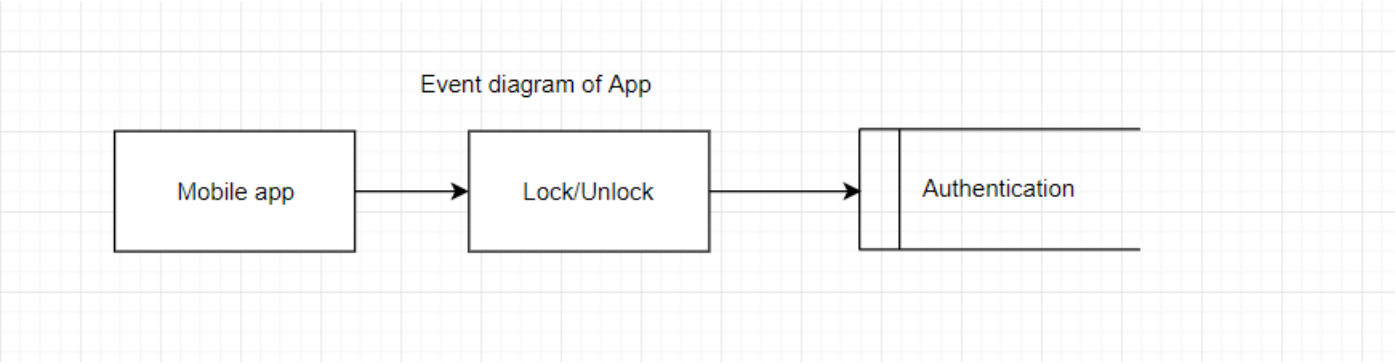
5.1 Software details

5.1.1 Behavioural Model

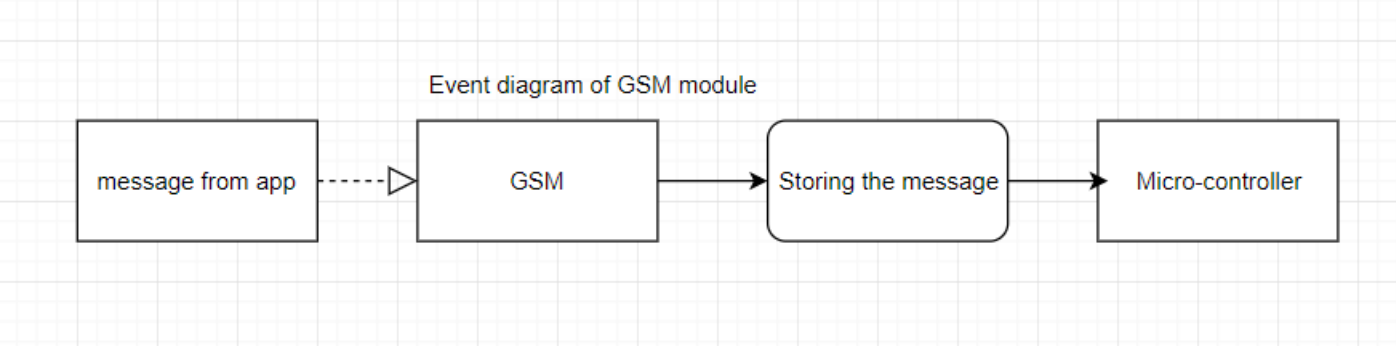


5.1.2 Event diagrams

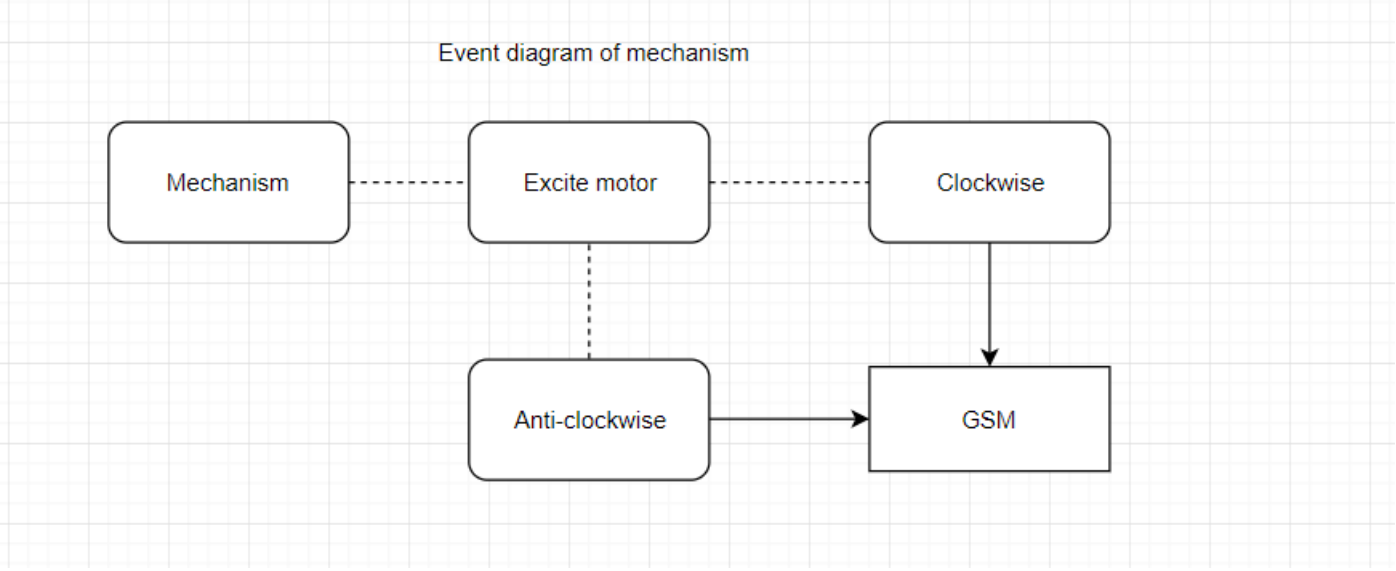
1) Event diagram of user interface



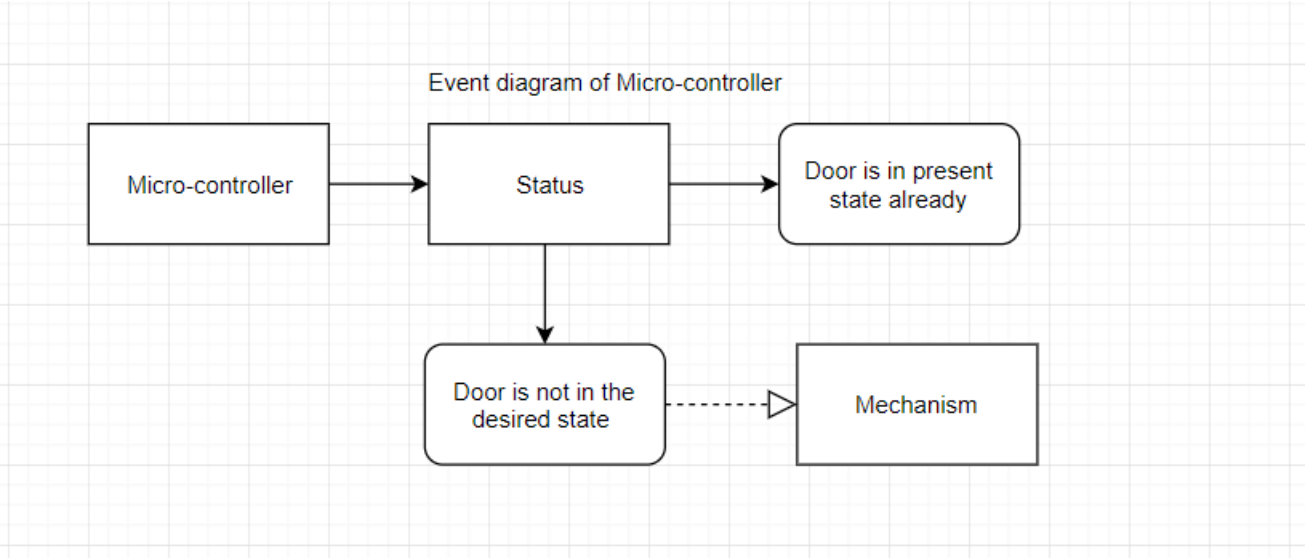
2) Event diagram of GSM module



3) Event diagram of Mechanism



4) Event diagram of micro controller



5.1.3 Pseudo code

MAIN FUNCTION

```
SET choice, name, admin pin <- XYZ, password, status <- UNLOCK
SET admin, otheruser, mainchoice
READ mainchoice
SWITCH mainchoice
   CASE admin
        SET details, changepin, adminchoice
        SWITCH adminchoice
            CASE details
                 DISPLAY a list of users in the database
            CASE changepin
                  Pinchange ()
               DEFAULT
                     Otheruser (choice)
        END SWITCH
   CASE otheruser
         Otheruser (choice)
   END SWITCH
```

Otheruser(choice)

```
SET login ,signup
READ user choice in choice
SWITCH choice
CASE LOGIN
    READ users registered name and password in name and password
    IF Authentication (name, password)
      SET otheruserchoice
    SWITCH otheruserchoice
        CASE EDITREGISTRATION
                Editregisteration ()
        CASE HELP?
                Help()
       CASE CHOICE
                mobileTOgsm (choice)
                mechanism (choice, status)
         DEFAULT
              DISPLAY Invalid choice
       END SWITCH
    ELSE
        DISPLAY unauthorized user
        Buzzer <-HIGH
      END IF
CASE SIGNUP
   Newregister ()
DEFAULT
```

DISPLAY Invalid choice

END SWITCH

AUTHENTICATION FUNCTION

BOOL Authentication (name, passw)

IF name present in the database & name [passw] =password

Return TRUE

ELSE

Return FALSE

END IF

SENDING MESSAGE FROM MOBILE TO GSM

mobileTOgsm (choice)

IF choice==LOCK

Send message as “lock” from mobile to the gsm

ELSE

Send message as “unlock” from mobile to the gsm

END IF

MECHANISM FUNCTION

Mechanism (choice, status)

IF status = choice

gsmTOmobile (choice)

ELSE

IF choice==LOCK

Actuate the motor in clockwise

Set status as LOCK

Return

ELSE

Actuate the motor in anticlockwise

Set status as UNLOCK

Return

END IF

ENDIF

SENDING MESSAGE FROM GSM TO MOBILE

gsmTOmobile (choice)

IF choice=LOCK

Send message as “door is already in locked state” from gsm to the mobile

ELSE

Send message as “door is already in unlocked state” from gsm to the mobile

END IF

NEW REGISTERATION OF THE USER FUNCTION

Newregister ()

READ name

WHILE name is present in the database

Display ERROR

READ name

END WHILE

READ mobile number

WHILE number of digits less than10 & first numbers is less than 6

DISPLAY ERROR

READ mobile number

END WHILE

READ relation with the admin

(*SEND AN MESSAGE TO ADMIN THAT SO AND SO PERSON IS REGISTRATING TO OPEN THE DOOR SO THAT ADMIN WILL SET ON TIME PIN)*

IF pin=admin pin (WHICH IS SET ON TIME)

Store all the details in the database

Return TRUE

ELSE

Return FALSE

END IF

EDIT REGISTERATION OF THE USER FUNCTION

Editregisteration()

READ name and password of the user

IF name present in the database & name [passw] =password

DISPLAY Enter the new password

READ newpassword

READ confirmpassword

WHILE newpassword! =confirmpassword

READ confirmpassword

END WHILE

DISPLAY new password is set successfully

UPDATE in the database

ELSE

DISPLAY invalid user

END IF

Help()

DISPLAY all questions (*IF HE CLLICK IN THE QUESTION HE WILL BE DIRECTED TO THE WEBPAGE*)

GOTO web page “SOURCE”

Pinchange ()

READ originalpin

IF originalpin=pin

READ newpin

READ confirmnewpin

WHILE newpin!=confirmnewpin

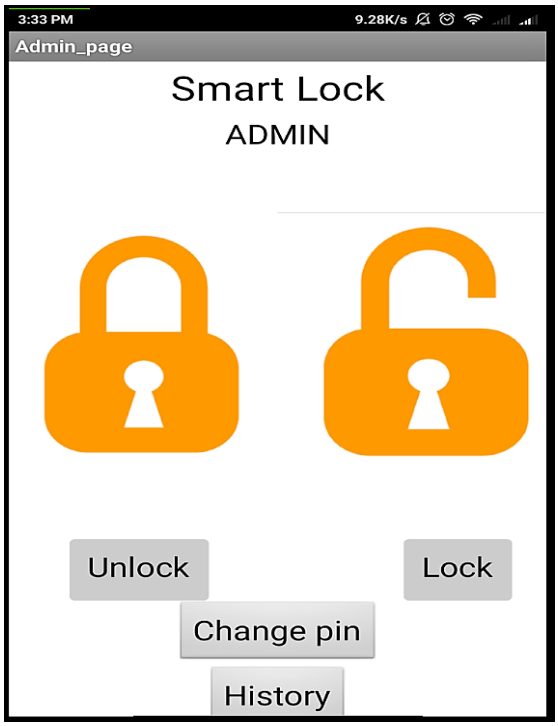
READ confirmnewpin

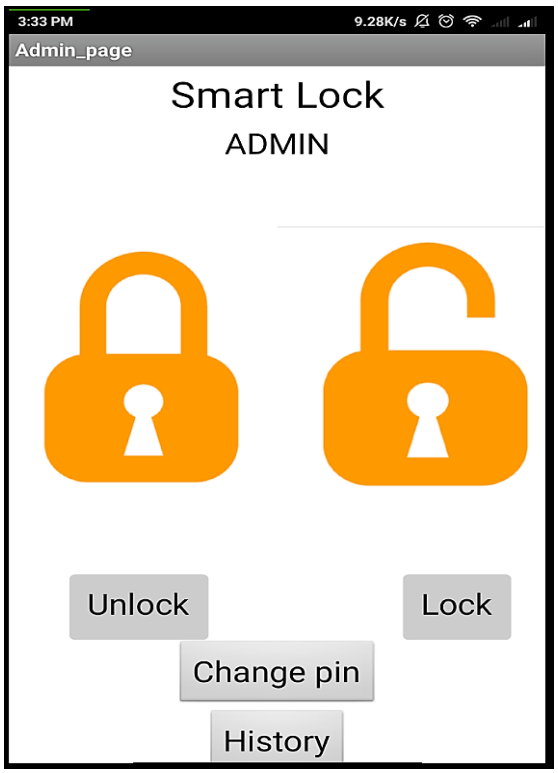
DISPLAY “A new pin is set successfully”

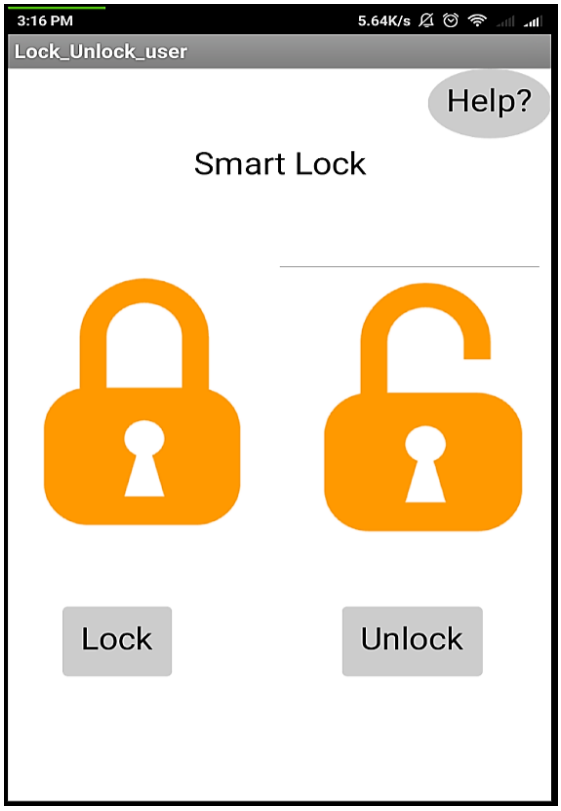
ELSE

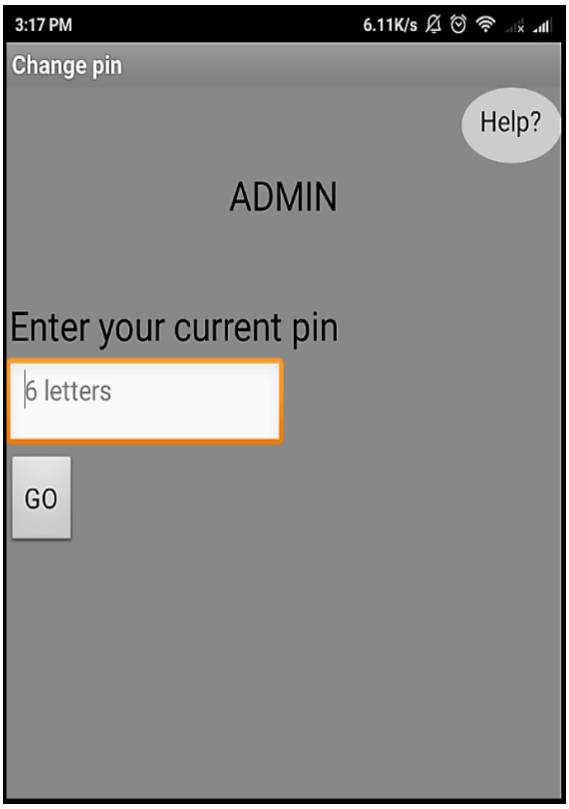
DISPLAY incorrect pin

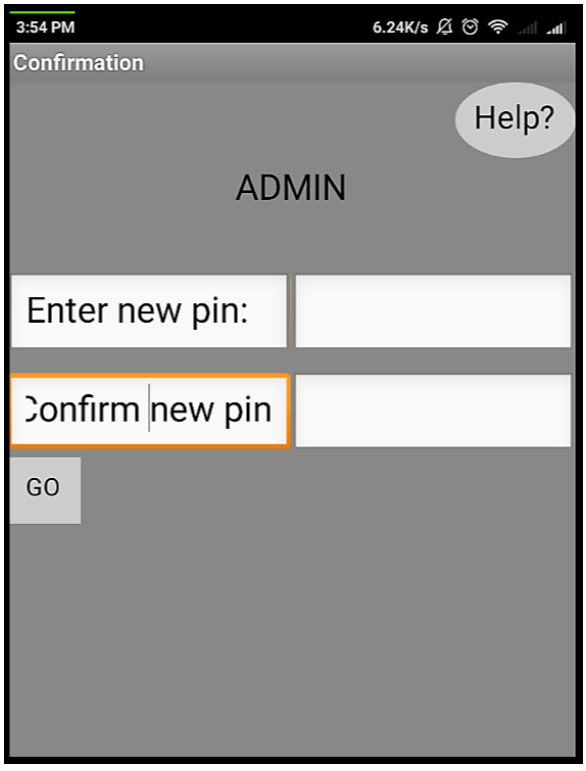
5.1.4 User Interface

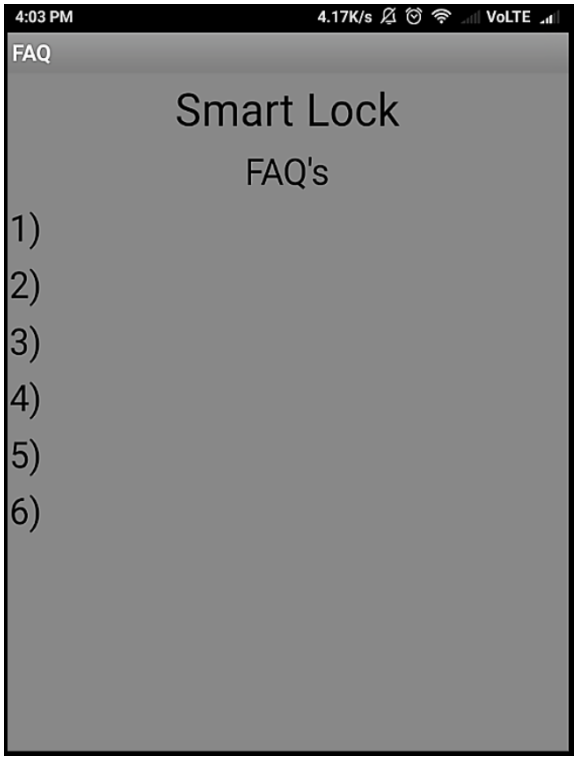


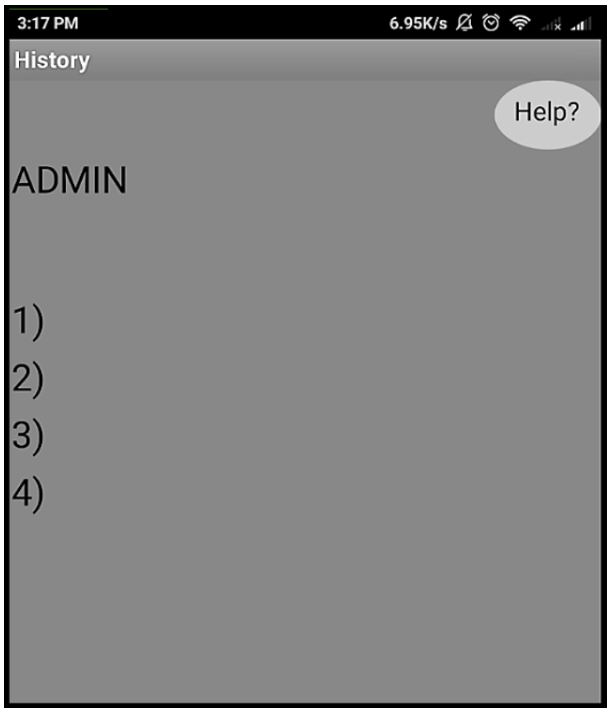



3:16 PM
5.64K/s
Lock_Unlock_user
Help?
Smart Lock
Lock
Unlock


3:17 PM
6.11K/s
Change pin
Help?
ADMIN
Enter your current pin
6 letters
GO

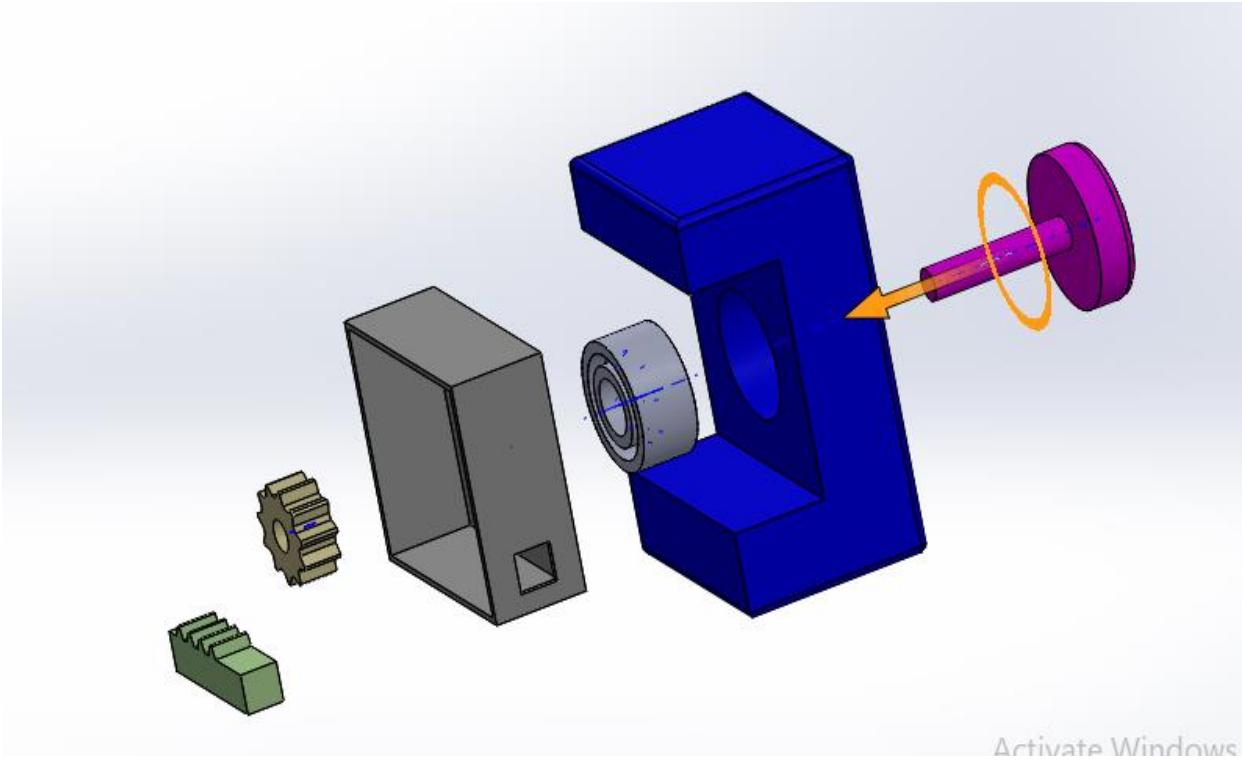

3:54 PM
6.24K/s
Confirmation
Help?
ADMIN
Enter new pin:
Confirm new pin
GO


4:03 PM
4.17K/s
VoLTE
FAQ
Smart Lock
FAQ's
1)
2)
3)
4)
5)
6)

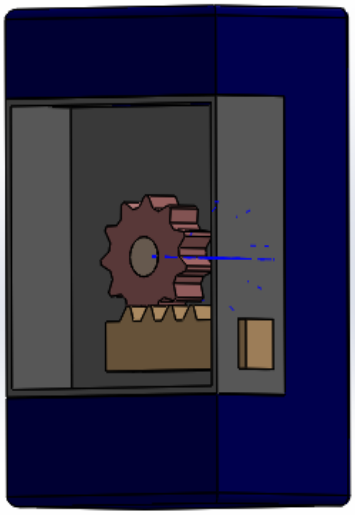

3:17 PM
6.95K/s
History
Help?
ADMIN
1)
2)
3)
4)

5.2 Mechanical Drawing

5.2.1 Exploded Assembly

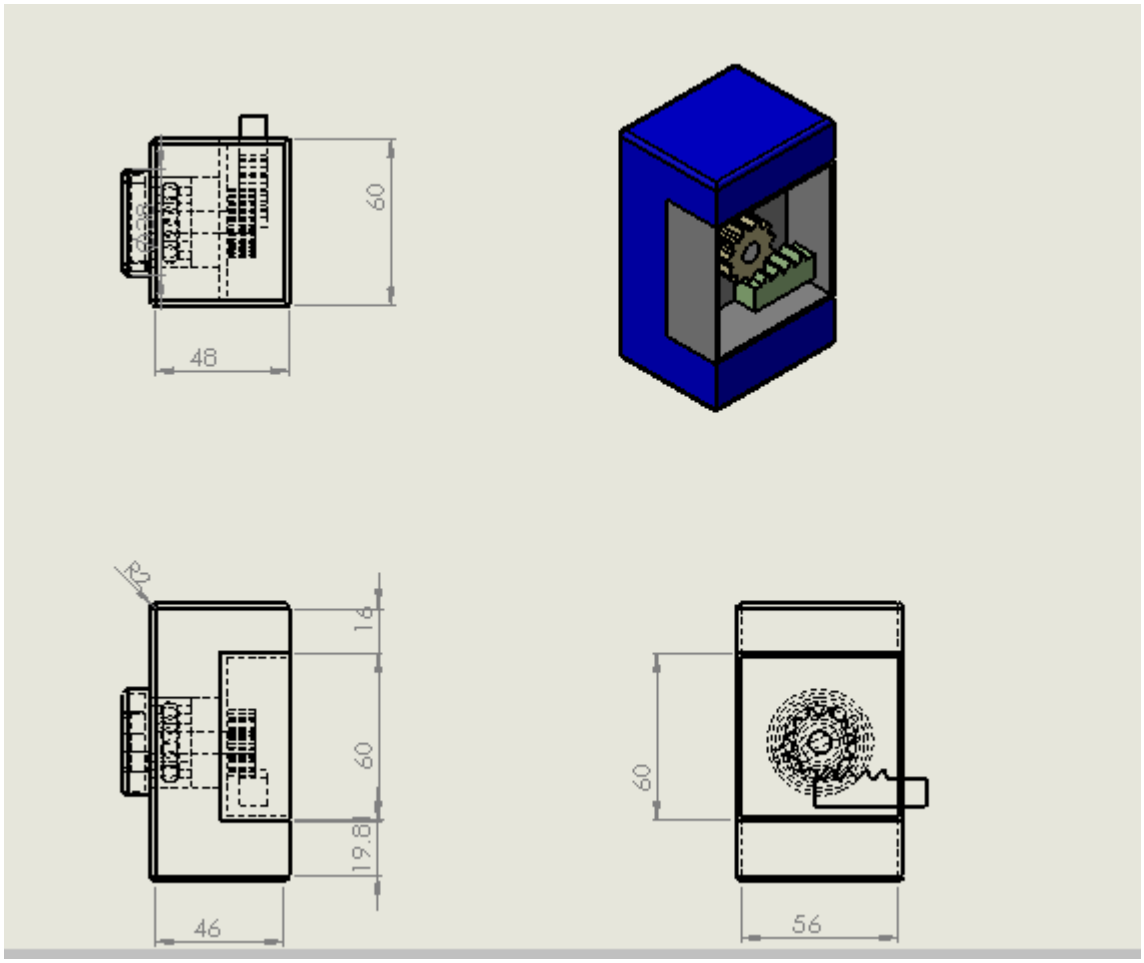


5.2.2 General Assembly



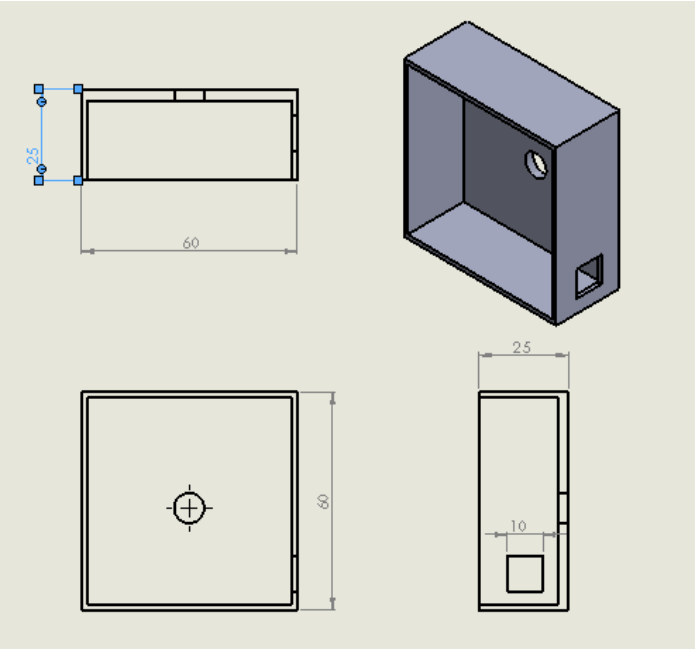
	A	B	C	D
1	ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
2	1	body	stainless steel	1
3	2	rack and pinion	high speed steel	1
4	3	stepper motor	42 byg torque=57gcm ,w=280gm,step angle 90	1
5	4	body 2	stainless steel	1

5.2.3 Detailed Assembly

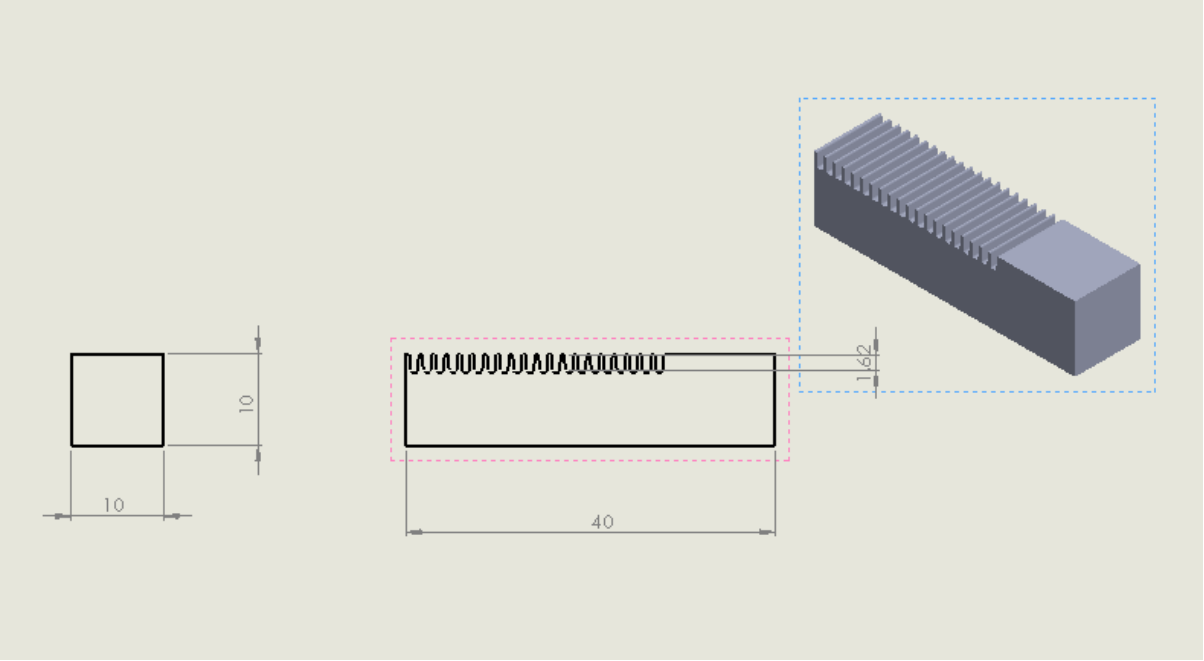


5.2.4 Detailed Component drawing

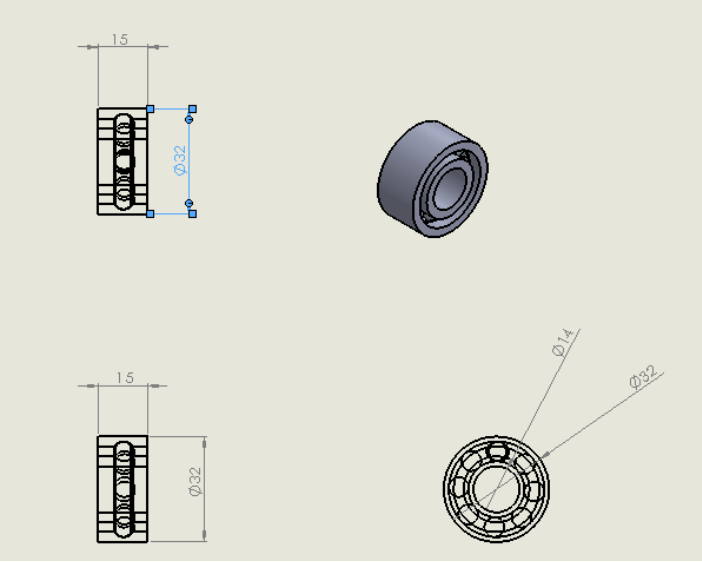
1) Internal Lock of the door:-



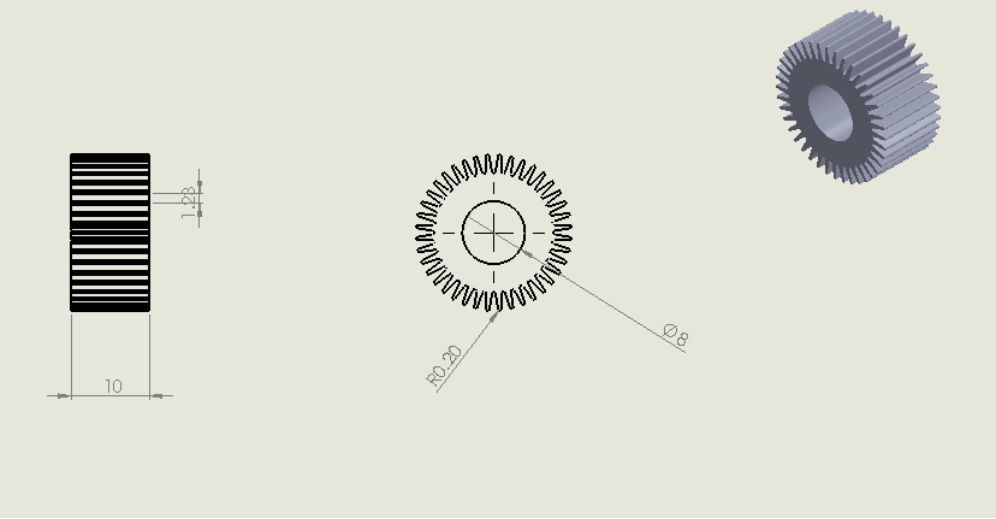
2) Gear used as latch:-



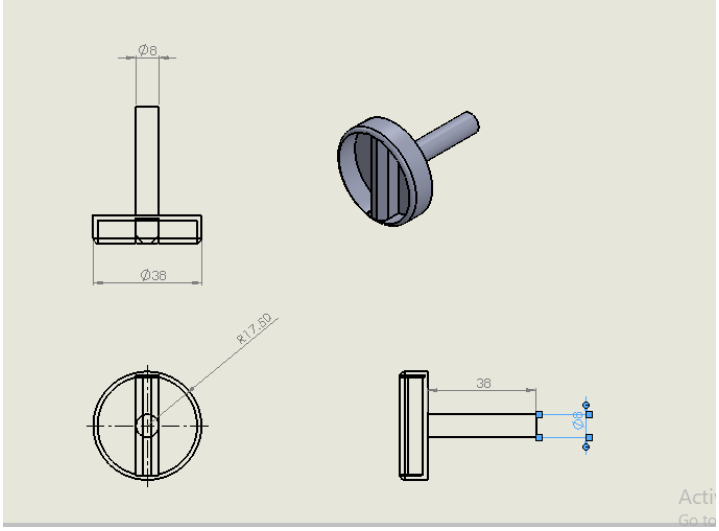
3) Ball bearings:-



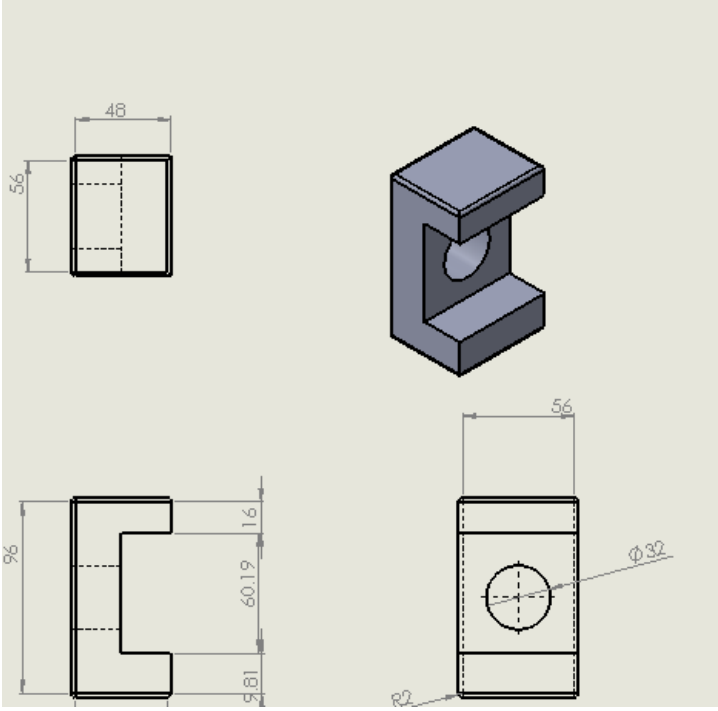
4) Pinion used to rotate latch:-



5) Rotating part:-

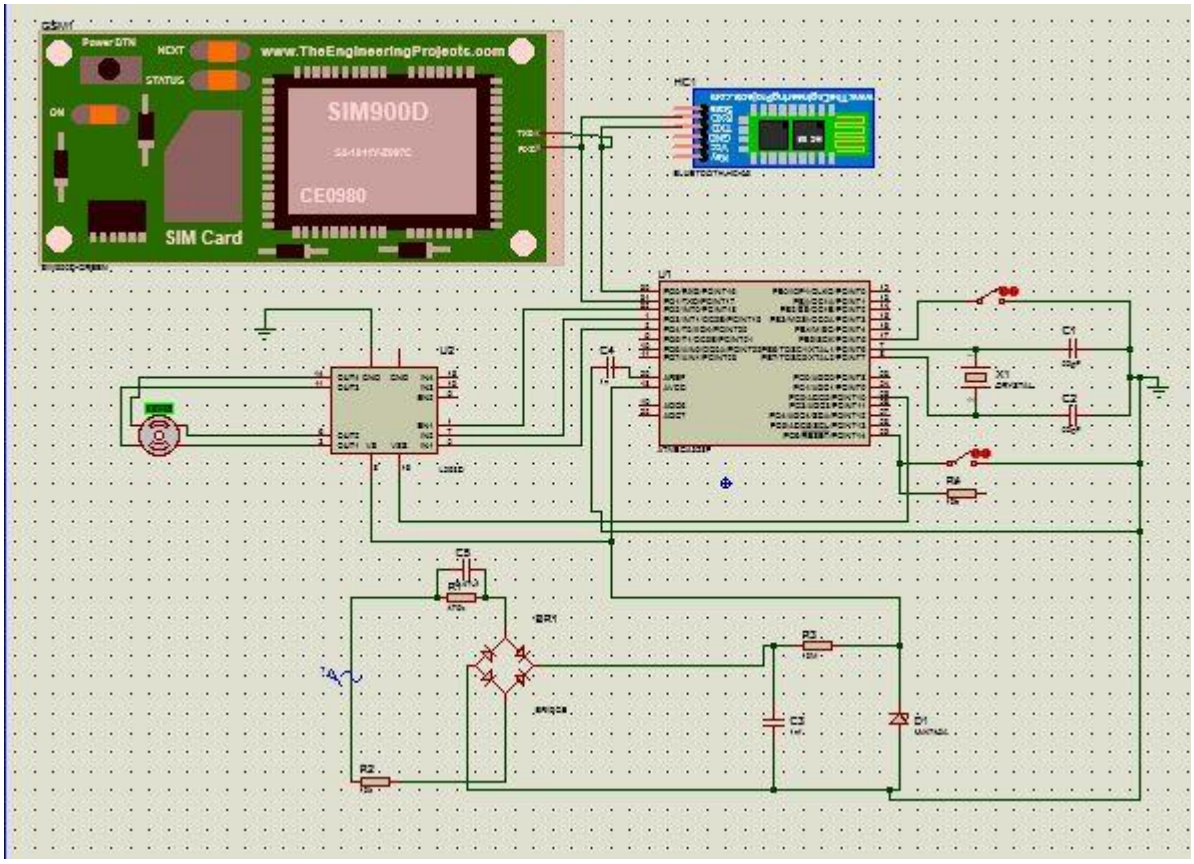


6) Outer casing of the smart lock:-

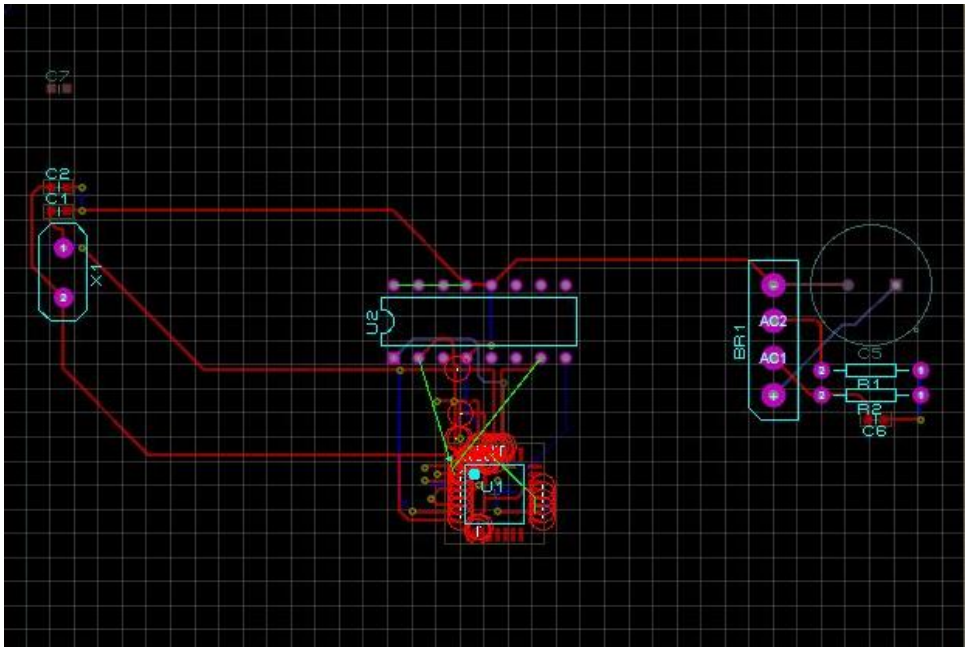


5.3 Electronic Detailed design

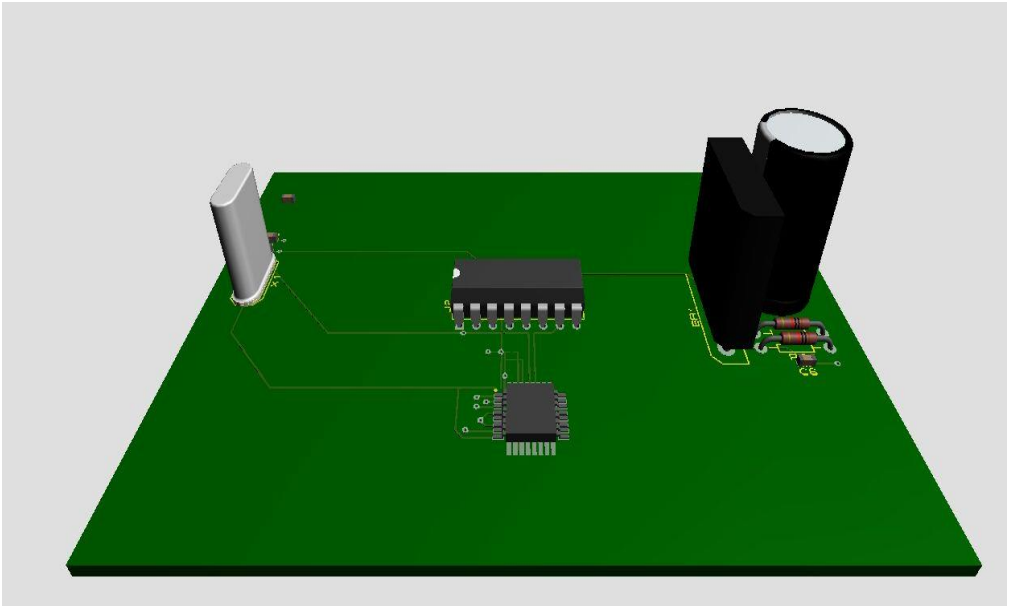
5.3.1 Circuit diagram



5.3.2 PCB layout



PCB 3D model



5.4 Bill of materials

Sl no	component	Material description	Quantity
1	42 byg stepper motor	Torque=57gcm Weight=280gm Step angle 120 deg	1
2	Ball bearing		1
3	Locking material(shaft)	-	1
4	Fiber	10cm*15cm*20cm	-

Bill Of Materials For

Design Title : SMART LOCK

Design Created	Tuesday, November 21, 2017
Design Last Modified	Tuesday, November 21, 2017
Total Parts In Design	17

5 Capacitors

Quantity	References	Value	Stock Code
5	C1-C4,C6	22pF	Digikey 311-1062-2-ND

Sub-totals:

3 Resistors

Quantity	References	Value	Stock Code
3	R1-R3	10k	

Sub-totals:

2 Integrated Circuits

Quantity	References	Value	Stock Code
1	U1	ATMEGA328P	
1	U2	L293D	

1 Diodes

Quantity	References	Value	Stock Code
1	D1	1M130ZS5	

Sub-totals:

3 Miscellaneous

Quantity	References	Value	Stock Code
1	BR1	BRIDGE	
1	GSM1	SIM900D-GREEN	
1	X1	CRYSTAL	

The estimated cost for the project is RS 6000.

Bibliography

1) https://en.wikipedia.org

2) https://www.google.co.in/search?q=patents+for+smart+door+lock&oq=patents+for+smart+door+lock&aqs=chrome..69i57.8725j0j7&sourceid=chrome&ie=UTF-8