

---

# IC201P - Design Practicum 2018

## Project Design Report

### GROUP 15

# LibWalk

25<sup>th</sup> March 2018

## THE TEAM

Amrendra Singh	B16010
Sajal Boris	B16030
Paresh Agrawal	B16042
Tirupati Mishra	B16080
Abhijeet Rajput	B16083
Ajay Kumar	B16122

Mentor: Dr. Mahesh Reddy Gade

## OVERVIEW

LibWalk is a future-proof library concept. This relies on on face recognition based authorization and RFID technology to issue and return books without the need of any check-out counters. This is inspired by the latest concept of [Amazon Go](#) store. As a matter of fact library management coupled with face recognition as of today hasn't been implemented anywhere around the world.

The world is fast moving towards automation and human-less systems. Libraries have been the way they are for centuries. It's high time we give them a futuristic makeover.

LibWalk aims to build a check-out desk-less library. It targets to replace the manual issue and return system with a face recognition based technology, detecting what books a student is taking from the library and issuing it to his name. Additionally we have an

---

automatic book drop-box to return books without any manual interaction with the database.

## **PROBLEM**

Today's libraries rely heavily on manpower to issue and return books. This system is slow, less efficient and costly. There is no easy way to find a book if it has been misplaced to a different shelf in the library. Finding a misplaced book would be like replacing a faulty vacuum tube in Eniac!

If an automated system is developed to assist issue and return of books it would make any library a lot faster, more efficient and would save a lot of manpower and hence a lot of money. Even in a relatively small library there would be at least 2-3 people manning the check-out desks. An automated system can save their payroll.

For example, our IIT Mandi Central Library has 2 people manning the check-in-check-out desk. On an average these people are paid 20-40k per month. That is on an average 8-10 lacs per year! That's a lot of saving for a medium sized library.

## **SOLUTION**

Currently a user spends a lot of valuable time just to issue a book from the library. Also stealing of books is a big menace and returning books is a un-necessarily tedious task.

LibWalk is dedicated to optimize the present system. We came up with the idea of creating a system where a user directly gets his books issued bypassing the check-out counter. Cameras installed on the gate will capture the person's image. Then this image would be passed through a face Recognition algorithm to identify his identity and membership status. In case that the system is unable to recognise the person by face detection, he can get himself registered or use fingerprint based alternative. Each book will contain a passive RFID tag. As soon as the person walk through the gate RFID reader (attached on the sides of the gate) would interact with passive RFID tag and issue the book to the person carrying it.

Our System also offer features of library management. Sometimes books are mistakenly placed on other racks which gives library staff hard time finding the book in the pile of other books. That's where our Library assistant comes to help. RFID readers are attached on all racks of shelves. They are constantly in touch with RFID tags on the books. The

---

current position of any book can be monitored by our system. In case a book is being placed in a wrong rack or shelf a buzzer would buzz.

We want the user to be connected with us and get all the information they want in just a matter of click. For this we will create an app called LibGuide. It would give the information like no. of books issued, return date and notification regarding their return. It would update any fine pending. It would show the calendar of library, especially indicating the days when library would remain closed and notify the user accordingly.

Return of book is a bigger than needed task manually, taking an unnecessary time and hardwork in sorting and putting them back. We came up with an idea why not to do all this automatically. Instead of returning the book to check-out counter the user would drop those books into the drop-box. Here an RFID technology would again perform its magic and check which book has been returned and if it has been returned on time or not. If there is some delay in returning of the book then the system would calculate the fine and give a notification to the user on the app. From there a library employee will put the books on the appropriate rack (or maybe the robot of group 14 could do that).

This project is one of its kind. Face-recognition technology is growing rapidly. Currently no library system applies this kind of technology. It would save time of the user and money for library. Apart from this it would also strengthen the library security. This project is a glimpse of how present technology, Artificial Intelligence, computer vision is going to assist humans which seemed just science fiction just a few years back.

## **PRODUCT DESIGN**

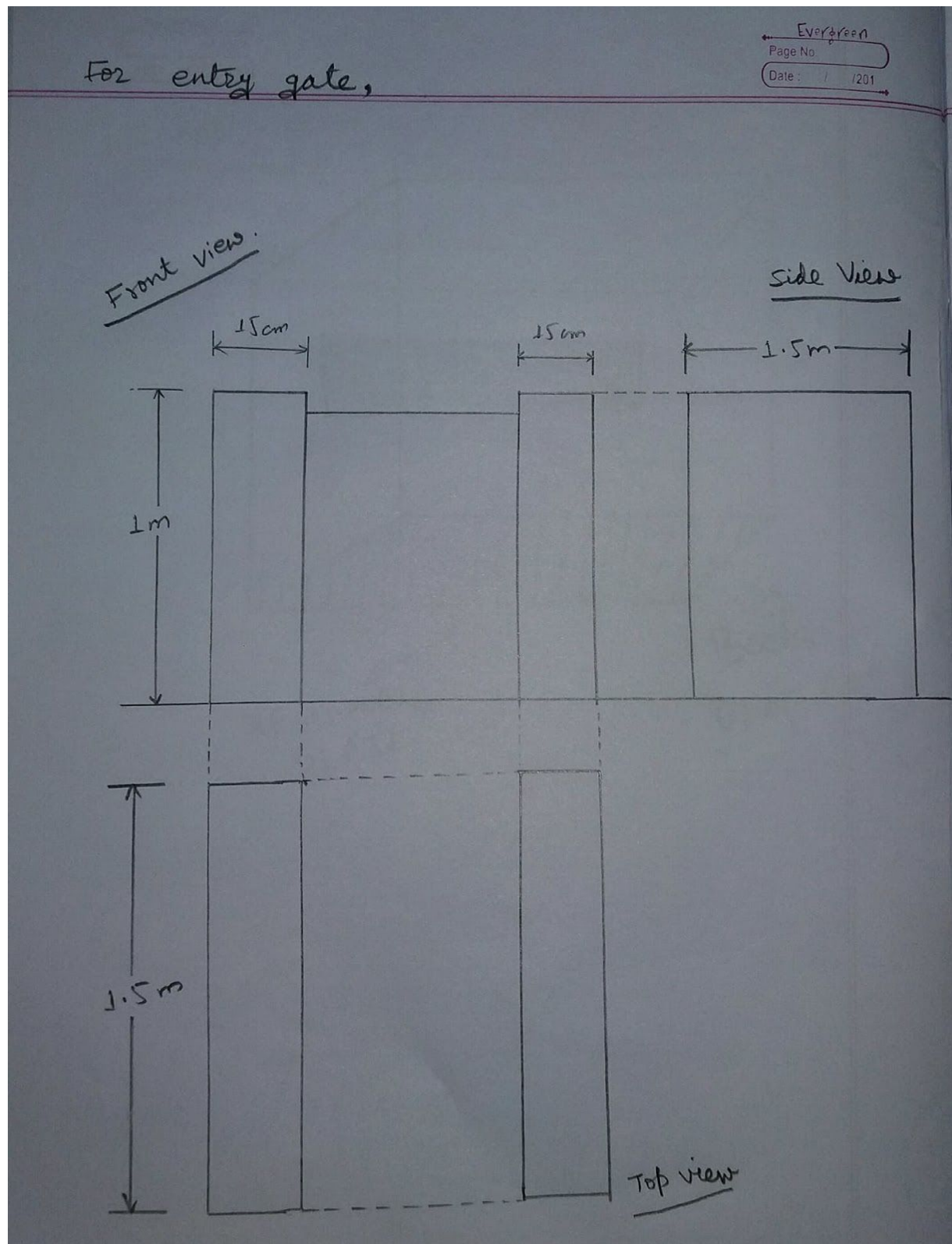
### **MECHANICAL ASPECTS**

In this project there are two parts of mechanical aspect, that is library entry or exit gate and book Drop-Box system.

#### **Gate**

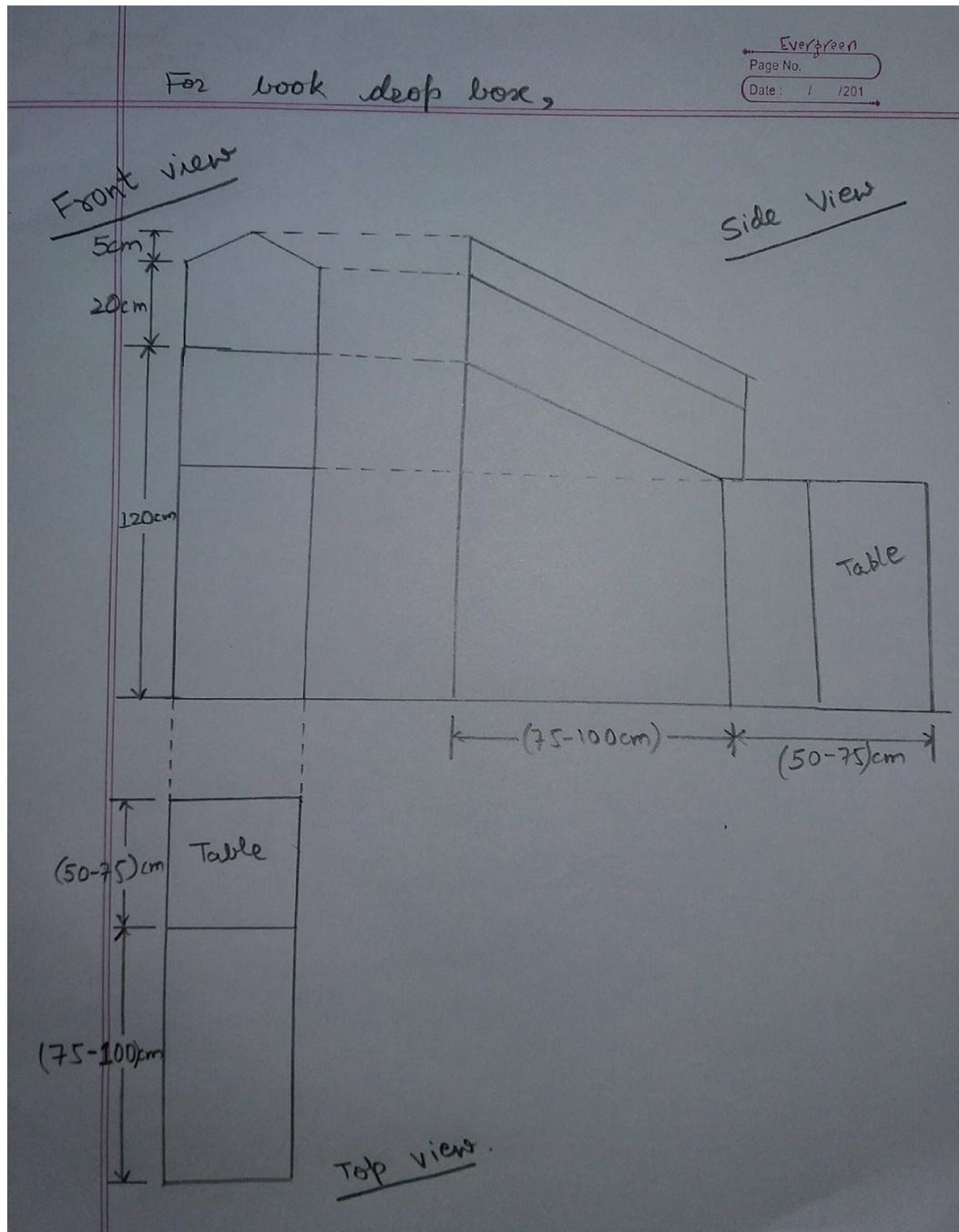
There are two gates, one at entry and the other at exit point. It's like the ones seen at metro stations. It's automatically shut because of its weight. When a person comes near to gate the camera will detect the person. If the person is found in database then the gate will open with the help of a stepper motor or hydraulic system. Otherwise, the user has to contact the library administration and register himself.

The gate is connected to a spring with motor, so whenever it gets the signal spring will pull it up and bar gets up and the person can go inside.



## Book Drop-Box

In figure top view, front view and side view are shown for the drop box system. When a person drops the book in drop box it will reach the roller by sliding, after that roller helps it to reach the table. Between our starting point of drop box and roller there will be RFID readers to know which book has been dropped and update it in the database.





---

## **ELECTRICAL ASPECTS**

LibWalk involves a lot of cameras and sensors. All these require a lot of electronics handling. A lot of connections between sensors, raspberry pi and arduinos are needed.

### **RFID tags and readers**

Every book will be associated with a RFID tag. We will be placing several RFID reader antennas which will be sending radio signals. The RFID tag will interact with the radio signals from the reader. Transmitted signals will be collected by RFID readers and RFID readers will be connected to raspberry pi which would handle the what to do with it. Every RFID tag will be unique signal so change in the signal will be detected and the information sent to the raspberry pi and processed.

### **Raspberry Pi and sensor/camera connections**

All the sensors and cameras will be connected to the mother Raspberry Pi. The sensors and Raspberry Pi would need a power supply from a 5V/12V battery.

### **Motors and driver circuits**

Motors in the dropbox and gate mechanism would need appropriate driver circuits, voltage and currents. DC adapter would be used to convert the 220V supply to 5V/12V DC supply for our system.

## **COMPUTER SCIENCE ASPECTS**

A major chunk of the project is computer science based. This includes setting up our own library management system and then connecting it with our face recognition authentication to issue books.

All these aspects require a high degree of computer science application in the form of image processing, networking and interfacing perl based koha with python based image processing modules.

### **Library Management Software Implementation**

We shall implement the most commonly used Integrated Library Management System [Koha \[Wikipedia\]](#). This is the same library management system as being used at IIT Mandi central library currently. We shall interface it with our face recognition to issue books.

---

Koha is developed in perl, uses MySQL database and runs on a Linux server. So this would require interfacing scripts of different programming languages in a single seamless product.

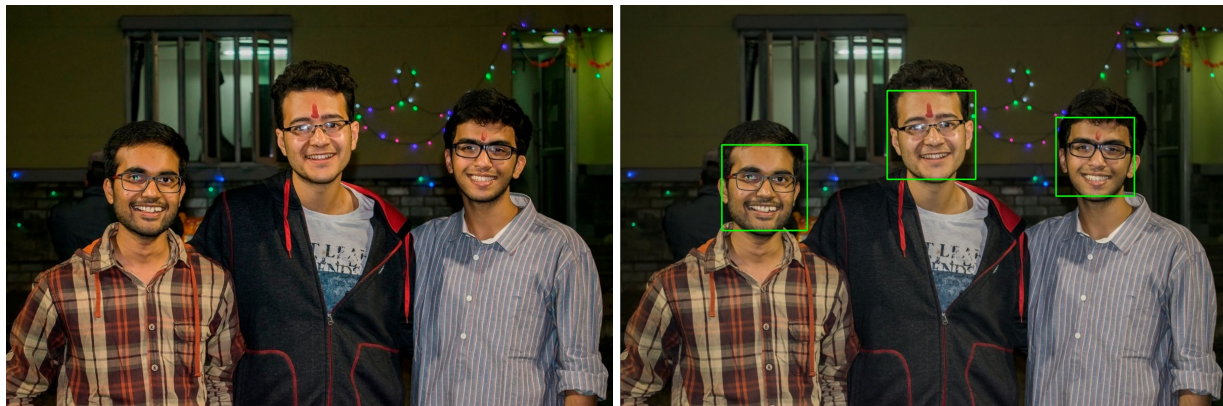
## Face Recognition based authentication

Our project's primary part is to issue books based on face recognition based authorization. To this end we shall maintain a database of the faces of all our users. We shall use the [ageitgey/face\\_recognition](#) open source library for this authentication purpose.

To this end we first capture the image of our subject, detect his face, isolate the face and then use it for recognition from our database.

An example run of our face detection:

Original Image vs Processed image



Now we need to isolate the faces and recognize them. On recognition we need to extract the persons ID number and other details from our database like what all books he has already issued. His identity combined with the ID's of the books he's taking through the door would be used to issue books under his name.

On returning the books in the drop-box, an RFID sensor will read and relay the book ID of the returned books. This id will be checked in our database and would be used to “return” the book from the issuers name. In case the book being returned is returned late, the system shall calculate the fine and add it to borrower's fee(in case of student) or bill him(in case of staff or faculty).

---

All of this would be done in real time and we'll try to do all tasks parallelly for greater efficiency and saving the user's valuable time.

## **App**

We plan to design an app which could tell which book is placed in which shelf and rack in the library as well as it could tell which of the books have been misplaced.

Further if time permits we can make the app so that the user can log in with his account and know which books are issued to him, when he has to return them and other miscellaneous notifications and updates about the library and his interaction with it.

## **COMPONENTS**

- Sensors and tags
  - RFID tags
  - RFID readers
    - Operated at 5V
    - Operating distance is 10 cm
- Microcontrollers
  - Raspberry Pi
  - Arduino Uno
- Battery
  - 12V Lipo battery
  - 220V AC power supply
- Rollers
- Buzzer
- Wi-Fi modules

## **MANUFACTURING & ASSEMBLY**

The major hardware components that we'll need to build will be the gate, drop-box and the shelves.

The gate would be made from plywood or metal sheets. We'll need to cut them according to specifications shown and join the different pieces. Drop-box and shelves would be primarily made up of plywood. Drop box would contain a few rollers.



---

There would be very less if any use of any operation other than cutting and joining. Although a bit of lathe may be required in shaping our rollers.

Most of the construction part would be assembling the different electronic components together. Sensors need to be installed on the gate, drop-box as well as the book shelves. A lot of wiring would need to be done to this end.

## CONCLUSION

LibWalk when complete has the potential to revolutionize the way we currently operate our libraries. As a lot of technical skills are needed for this project, it would be very helpful to the team.

The concept of no check-out counters isn't just for a library, this could be extended to various other businesses. Any business dealing with leasing articles can directly use a similar system.

RFID coupled with computer vision seems a very interesting and explorable concept. A lot of things can be unbelievably automatized with this. With long range high precision RFID units coming up faster and faster, we can expect this to be exploited for developing a lot of technologies and we hope this project is a part of this revolution.

## REFERENCES

1. Amazon Go
  - a. [http://en.wikipedia.org/wiki/Amazon\\_Go](http://en.wikipedia.org/wiki/Amazon_Go)
  - b. <https://www.youtube.com/watch?v=NrmMk1Myrxc>
2. Koha
  - a. [https://en.wikipedia.org/wiki/Koha\\_\(software\)](https://en.wikipedia.org/wiki/Koha_(software))
  - b. <https://koha-community.org>
3. Face Recognition Libraries
  - a. [https://github.com/ageitgey/face\\_recognition](https://github.com/ageitgey/face_recognition)
4. RFID library management
  - a. <https://www.youtube.com/watch?v=lfij-aic95w>