CS684 Project
Report

iPool

In-campus Smart Bicycle Sharing

Submitted by

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Abstract

IIT Bombay campus is spread across 550+ acres. Within campus everyone try to use environment friendly way of transportation and bicycles seems to be not only by IIT but a globally accepted solution for short distance transportation. But still not everybody living in campus can afford to have a cycle of their own and if still everybody buys a cycle maintaining it could be a "hectic?" job. We are proposing a solution and a technology implementation which will help campus residents to travel easily in campus.

Contents

Chapter 1

Introduction

Our main goal for this project was to design a digital hardware lock with all the mandatory functionalities such as authorization and authentication of users, creating the lock tamper-proof, robust for different environment conditions and many more. What we could observe in campus is students use to travel from hostel to department vie Tum-Tum bus service provided by the institute, but tum-tum gets overloaded at the pick time when most of the students have classes. Student have to wait till next bus comes which many time result in going late to the class and get scolded by prof. or if prof. is strict he might not let you in for the class. On the other hand the students who own cycles, take those to the department area and park them there. Which will not be used next 4-5 hours. What we are proposing in our solution is that we designed IOT lock which a student can attach to their bicycles and add it into the iPool system. Not anyone in need of quick transportation can easily use the cycle through the mobile application that we have crafted.

Bicycle sharing is just one application of the IOT lock that we have designed. The lock technology that have built essence of which is light based data transfer is very easy to use, and compared with any other communication technologies works faster. This technological framework that we have built, includes encryption of important data with symmetric key encryption algorithms, hashing algorithms to check the truthfulness of the received data. These methods are used to validate IOT lock through app, validate user. Then we have designed very innovative physical layer data transfer technique which is much faster than conventional blue-tooth or Zig-Bee was of data transfer.

Chapter 2

Problem Definition

We aim to implement a digital lock for in-campus bicycle sharing and a platform through which system users can access any bicycle which is part of our system, iPool. Once user registers for a bicycle, he can use it for short distance commute within the campus and can drop it anywhere. We aim to develop a common framework which can be extended for other type of sharing systems as well, for example: bike sharing, car sharing etc. We aim to provide offline sharing system which allows users to start and end trip without internet access.

Chapter 3

System-Design

In this section we are going explain architecture of our IOT platform and integration with iPool bicycle lock. Figure 3.1 shows the block diagram of system. As any other IOT system iPool also communicate

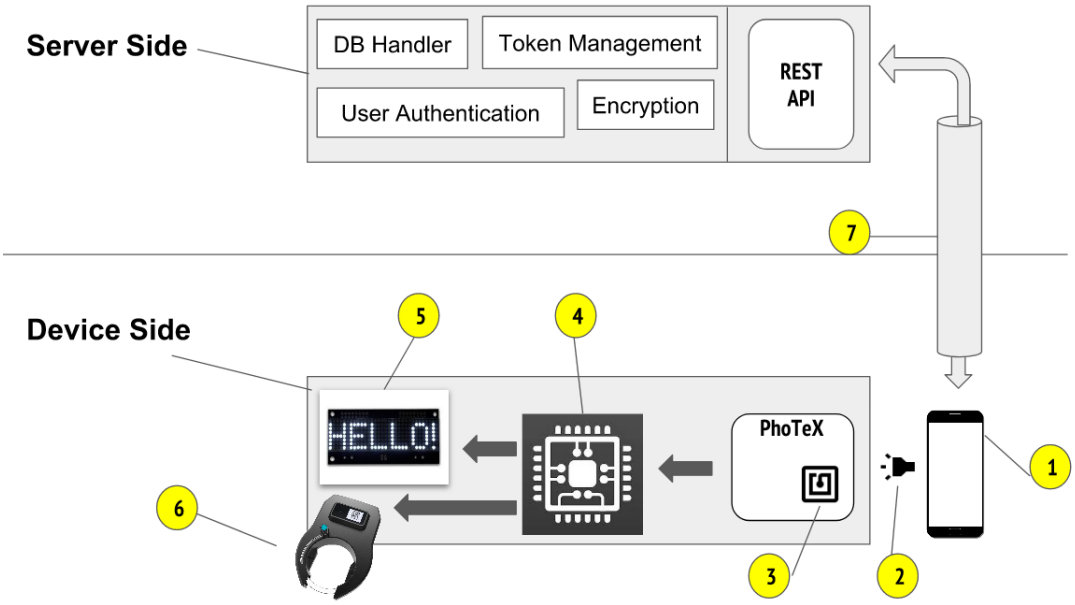

Figure 3.1: Architecture Of System

3.1 Description of architecture

Lets understand about each module shown in Figure 3.1. and overall working of the system will be explained in next chapter.

3.1.1 Mobile Phone Application

We have developed Android mobile application which communicate with server side REST API's to authorizes and authenticates the user, receive data related to trip, send GPS location of bicycle.

3.1.2 Mobile Flash Light

Now a days every mobile phone comes with camera and flash light. We are using that to transfer data from mobile to iPool lock.

3.1.3 Light sensor

We have tested system with LDR (Light Dependent Resistor), photo transistor as receiving end of data transmitted from mobile flash light. Ideal characteristics of the sensor that we observed is that it should be trigger able for the higher frequency input data.

3.1.4 Processing Unit

Processing unit is needed to decrypt the the data send by server. and take the appropriate action of locking/ unlocking of lock. Displaying proper information on display

3.1.5 Output Display

We have used led display to give feed back to user about the status of the lock.

3.1.6 Hardware Lock

This mechanism is made up of hardware motor and gears and shaft. Purpose of this is when motor will trigger from processing unit, it will rotate the gear and push the shaft to locking state.

3.1.7 Secure Connection between device and server

Communication between mobile phone and out IOT server is made using API level SSL based encryption technique.

Chapter 4

System working and Test results

Steps to follow for proper working of the system:-

- Open the iPool android app Figure 4.1 in mobile:

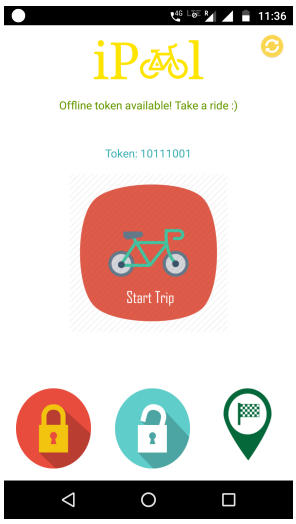

Figure 4.1: iPool Android app

In app we have given option to "start trip" which is first step to start your bicycle ride.
Next button is with symbol of "closed lock" which gives the functionality of locking the system temporarily.
Next button is with the symbol of "open lock", as you might have guessed by now, to open the lock after temporarily locking it user will use this functionally.

And finally button with the "flag" symbol on it, gives functionality of ending the trip. The place where you will end trip that location from mobile GPS will be sent to our server as a record where the bicycle is.

- Prototype of iPool lock Figure 4.2 :

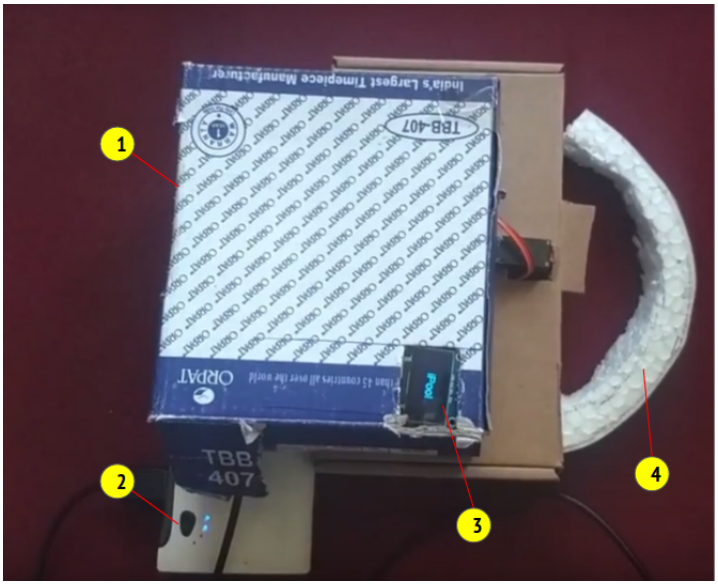

Figure 4.2: iPool lock

Description of each part of above figure

1. Gap to slide mobile halfway into the lock
2. Battery for power supply
3. Display to show feedback
4. Circular mechanical shaft attached with motor

- To open the lock first time Figure 4.3 :

1. Slide mobile halfway into the lock
2. Press "Start trip button"
3. Lock will go into open state as shown in Figure 4.4
4. Scan QR code displayed on device display as shown in Figure 4.4

- End the trip Figure 4.5 :

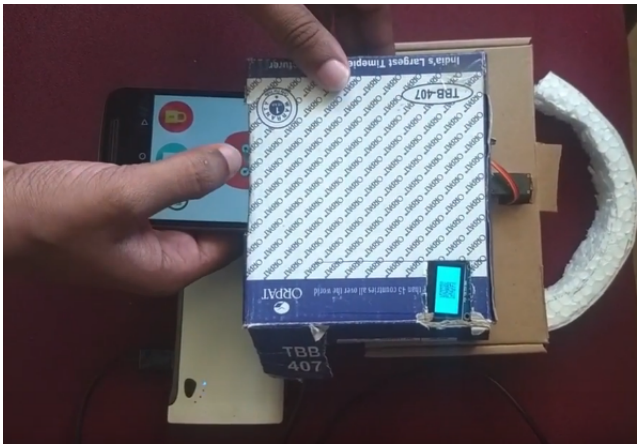

Figure 4.3: Lock closed

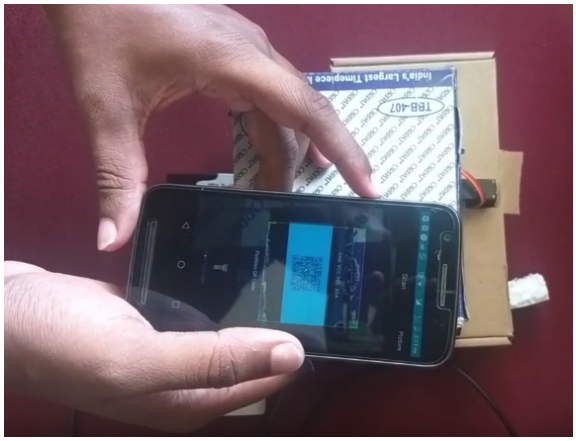

Figure 4.4: Lock open

1. Slide mobile halfway into the lock
2. Press "End trip" button
3. Lock will go into closed state as shown in Figure 4.2
4. Message will be displayed on mobile screen as Figure 4.5

- About PhoTeX data transfer technique:
  To transfer data from mobile to iPool lock, we have implemented very novel technique of sending data from mobile flash light.

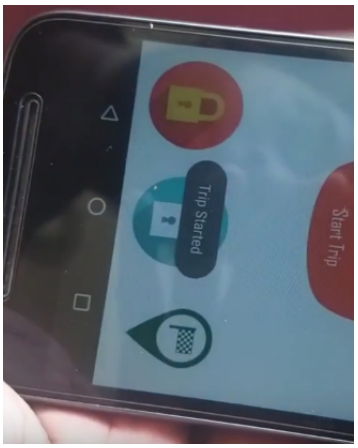

Figure 4.5: End trip

Chapter 5

Future Work

1. Current implementation of PhoTeX allows 32 bps rate of data transfer, in future we would like to test the system with high frequency receiver to achieve better transfer rate.
2. With increased data transfer rate, we can implement better security techniques to validate user, device and transactions (that a user is making with device).
3. Designing compact device for electronics and hardware used in current lock.
4. Making lock tamper-proof & water resistant.
5. Making the iPool mobile app more user friendly & provide a smooth flow of events.
6. Providing proper instructions on the lock which would give info to user how to use the lock.
7. Make the electronics system battery efficient, by making proper use of sleep cycles. That means putting the device on low power consuming sleep mode when not in use.
8. Adding alert mechanism if someone tries to steal the bike when it is locked.
9. Add battery indicator on the lock as well as show battery level on android app.

Chapter 6

Conclusion

We have presented a prototype of our bicycle sharing system using a digital lock and an android app which communicate using Photo Transmission technique (PhoTx). Our system's USP is the concept of keeping offline track of bicycle rides and data transmission technique using PhoTx. Since PhoTx is a novel approach and a research area, we can explore this field to make our system more foolproof and secure.

The concept of transmission of data using light can be extended to many new research problems. As well as keeping offline track using token sharing protocol that we used in our system can be used for solving many other real life problems like offline authentication, offline money transfer and many more. Because of this offline feature, our system can be used in such places where internet connectivity is not consistent all the time. Although we have presented a prototype for bicycle sharing but it can be extended to a generic framework which can be used for any type of sharing systems like bike sharing, bike pooling, car sharing, car pooling, room rent system etc.

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