

PROJECT PROPOSAL

AUTOMATED BIKE SHARING SYSTEM FOR UNIVERSITIES



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1.0 PROJECT BACKGROUND

Bike-share has taken many forms over the course of its development, from free bikes left for a community to use at will to more technologically advanced and secure systems. In every iteration, the essence of bike-share remains simple: anyone can pick up a bike in one place and return it to another, making point-to-point, human powered transportation feasible. Today, more than 600 cities and more than 200 universities around the globe have their own bike-share systems, and more programs are starting every year. The largest systems are in China, in cities such as Hangzhou and Shanghai. In Paris, London, and Washington, D.C. highly successful systems have helped to promote cycling as a viable and valued transport option.

As the most of the universities have wide area of land, transportation within the university causes time waste, accidents, congestion because of using the private vehicles, parking problems and the energy consumption related to the mobility of workers and students of the universities. The bicycle sharing programs have received increasing attention in recent years with initiatives to increase bike usage, better meet the demand of a more mobile public and lessen the environmental impacts of our transportation activities. So the project aims to introduce automated bike sharing system to minimize above impacts while evaluating the mobility patterns of academic campuses and assessing the energy consumption and pollutant emissions produced by the universities. This system provides the users to unlock the chosen bicycle in the substations via a mobile app and start riding, check the availability of bicycles and authorized people to track the path of rides of all users.

1.1 OBJECTIVES

As the most of the universities have wide area of land, transportation within the university causes time waste, accidents, congestion because of using the private vehicles, parking problems and the energy consumption related to the mobility of workers and students of the universities.

- **Mobility** for employees – providing transportation options that assist University employees to conduct their duties and responsibilities in an efficient, environmentally-friendly manner
- **Safety** through reduced motor vehicle traffic – reducing the amount of motor vehicle traffic in areas with complicated infrastructure or high pedestrian volumes
- **Health** through increased physical activity – providing methods for employees and students to add more movement into their daily routine, thus impacting alertness, health, longevity, and more
- **Environmental** benefits of reduced motor vehicle traffic – reducing greenhouse-gas emissions, decreasing impervious surfaces for parking lots, decreasing need for road maintenance
- **Social** benefits through enhancement of bicycling culture – supporting a culture that sees cycling as a preferred transportation mode choice, and a community that respects and works with the different transportation options
- **Convenience** factor – providing efficient transportation choices to aid users in arriving at destinations quickly and safely by reducing the need to always be in search of a bicycle or car parking area as well as the need to have to do own maintenance on bicycles
- **Economically** self-sustaining – implement a system that will pay for itself and reduce transportation costs for the campus community

- **Research** opportunities – provide the potential for research in urban planning, kinesiology and community health, marketing, environment, engineering, and more, with opportunities to publicize findings internationally
- **Education** campaign – participate with the campus-wide bicycle education campaign, by creating a platform for information sharing
- **Enhanced Image** of the Campus – Implementing a bicycle sharing program would improve the campus' standing as a preferred employer and be an attractive feature for prospective students. This could positively impact recruitment and retention.

2.0 EMBEDDED SYSTEM DESIGNING

1. Measuring and Controlling

- RFID reader and tags/stickers - To identify each bicycle is in the exact position and to identify the bicycle when returning to the dock station.
- Electric lock - To lock the bicycle

2. Embedded Platform

- Arduino

Arduino is an open source computer hardware and software platform which is very easy to use. There are enough libraries and compatible modules which can connect to the arduino board. For serial communication we can have hardware serial ports or software serial ports. To control the locking mechanism there are digital I/O pins and ICSP pins.

3. Connecting the system to the network

- Whole locking system will connect to internet using a GSM module
- Users will connect to the system using a Mobile App

4. Peripheral devices

- RFID reader

RFID reader use to read the RFID stickers in the bicycle. These stickers have a unique id which we use as the identification of bicycle. It is a 5V device, so you don't need a external power source. ICSP pins are going to use for the communication between the reader and the arduino board.

- GSM module

A GSM module will use to connect with central server. TTL pins in GSM module will use to connect the module to Arduino board.

- A linear actuator

A linear actuator is use in locking mechanism of the bikes. Digital I/O pins will be used to send control signals to the actuator.

5. Limitations of peripheral devices

- There are various security problems with locking mechanism. Additional sensors have to use in order to make more secure.

2.1 WEB AND NETWORK APPLICATION DESIGNING

1. Protocols and Middle-ware

- HTTP

HTTP protocol will be use to maintain the communication between dock stations and central server.

- I2C protocol

This protocol will be use to communicate between locks and the relay node.

- A central server

Central server is use to control the locks. A user scan the QR code in the lock and send the information with his login details to the server. Then the server will unlock the relevant lock and start to track the bicycle using the GPS system of the mobile using the given mobile app. It maintains a database of users and bicycles.

- MQTT Protocol

MQTT protocol is a Machine to Machine (M2M) protocol widely used in Internet of things. The MQTT protocol is a message based protocol, extremely light-weight and for this reason, it is adopted in IoT ecosystem. Almost all IoT platforms support MQTT protocol to send and receive data from smart objects. There are several implementations for different IoT boards like Arduino, Raspberry and so on

2. Back End and Front End

- Back end

Will use Node.js as the server side language

Mongodb / postgres as database management system

Heroku cloud application platform

- Front end

- Web interface for administrative usage

- HTML, CSS, Javascript

- Mobile Application

- Android studio

3. Connecting components through APIs

- REST API

Use to exchange information among components (lock and mobile app)

- Google Maps API

Will use to show to location of the bicycle

- Bar-code API

Will use to parse the QR code with different format

2.2 NETWORK SECURITY

- Sensitive data

Detail of users are stored in central server. Mobile app is used to login to the system. These login requests need to be secure.

Passwords of users need to be stored in hash representation.

Controlling responses from server should be secured

- Security features

Encrypting the requests and responses.

Encouraging users to use a strong password.

- Making MQTT secure with SSL

MQTT brokers may require username and password authentication from clients to connect. To ensure privacy, the TCP connection may be encrypted with SSL. SSL (Secure Socket Layer) is the accepted standard for encrypted communication between a server and a client ensuring that all data passed between the server and client remain private and integral.

3.0 INTRODUCTION

This chapter describes the method which will be used to implement this project.

3.1 NETWORK AND WEB APPLICATION DESIGN

For the riders' side, an mobile application is going to be implemented using Android studio. The client can check the map of the dock stations around the University and he/she can unlock by reading the QR code via this mobile application at the desired dock station.

A web application will be developed for the administrative purposes such as to register the riders and monitor the bike usage. HTML, CSS, Javascript will be used as the front end technologies.

3.2 HARDWARE DESIGN

Implementation of smart locks for bike dock stations is the main task under hardware design. Smart lock is going to be designed using a linear actuator (solenenoid) which triggered when the current flows. The smart lock unlocks when the rider reads the QR code and locks when the rider returns the bike, RFID reader reads the RFID tag in the bike and then the smart lock works.

Each lock in dock station contains RFID reader and lock components which are connected to an Arduino nano board. Those Arduino nano boards are connected to an Arduino mega board using I2C communication bus. GSM/GPRS module is used for the wireless communication between the hardware components and the server. In between the server and the hardware components, there is a MQTT broker which is primarily responsible for receiving all messages, filtering them, decide who is interested in it and then sending the message to all subscribed clients.



Figure 3.1.0 - RFID Reader

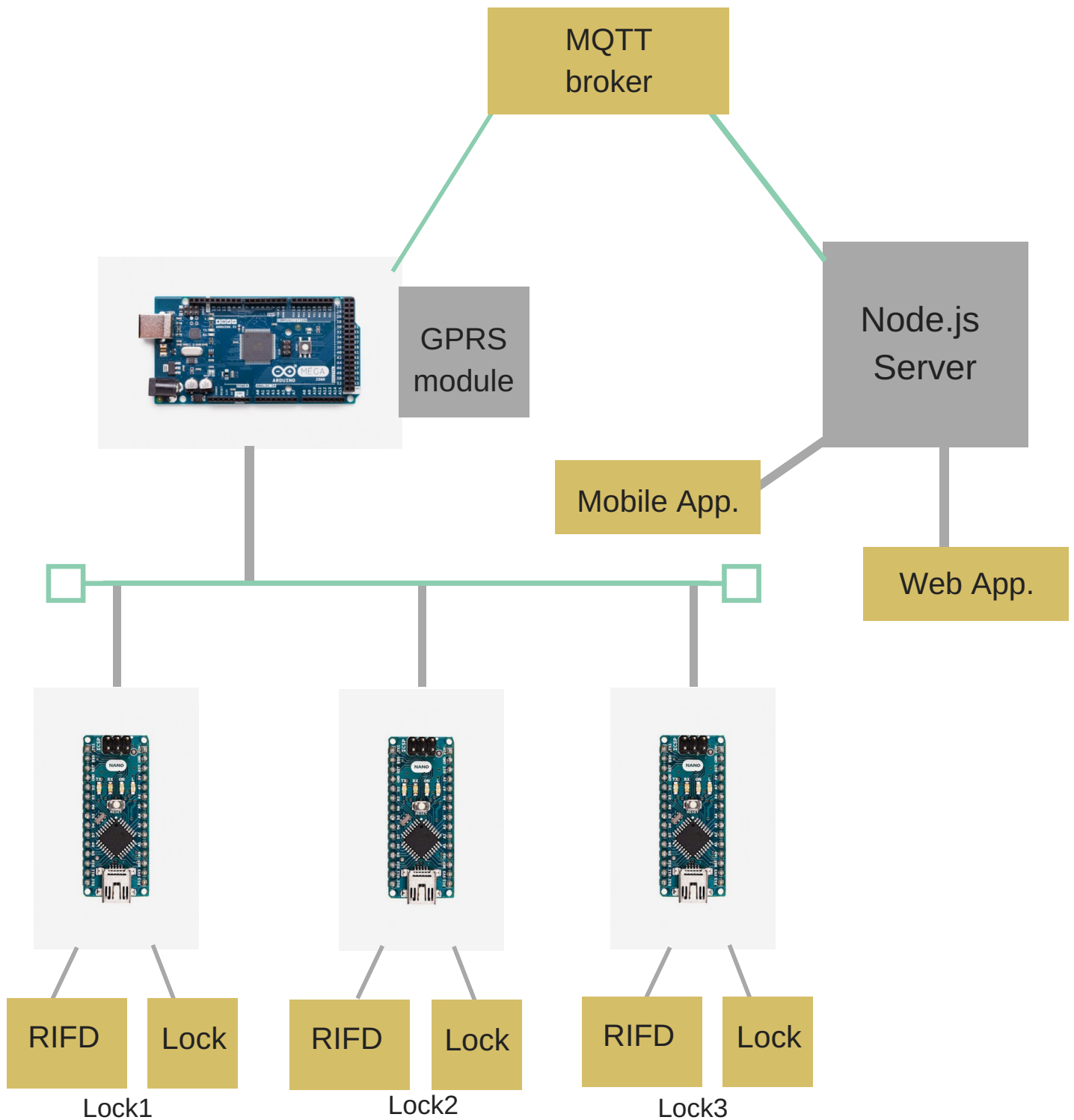


Figure 3.1.1 - GSM/GPRS module



Figure 3.1.2 - Linear actuator

3.3 OVERALL SYSTEM DESIGN



MILESTONE PLAN

Chapter 4

Tasks	Feb				Mar				Apr				May
	1	2	3	4	1	2	3	4	1	2	3	4	1
Milestone 1													
Finishing the design of the lock													
Setting up the GSM module with the Arduino													
Checking the RFID reader													
Creating the Server													
Creating a suitable API													
Database designing													
Milestone 2													
Implementing the locking system													
Checking the communication with the server													
Setting up the database and connecting it with the server													
Creating a user interface in Mobile app													
Creating a login system													
Milestone 3													
Implementing the locking system and connecting with the Arduino													
Controlling the lock using Arduino													
Getting the data from the server													
Identifying the bicycle and update the database accordingly													
Getting the QR code and other user information and send them to server.													
Milestone 4													
Connecting all components together and checking													
Overall testing and finishing													

