UniCycle: An Android Application of Bike Sharing System in the Digital Campus

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Abstract. Bike Sharing System (BSS) has been on a rapid rise to provide healthy lifestyle and a sustainable environment to the world. However, the concept of BSS has a multiple flaws such as in managing of bike’s usage and maintenance. BSS that is currently used in Universiti Malaysia Perlis (UniMAP) is based on rental concept which reduces time efficiency and is inconvenient to users due to its lack of maintenance management. Thus, this work has been innovated to monitor the bike’s maintenance by designing the concept of dock free system and design of mobile application to monitor bike’s usage, payment and location of the bike based on Internet of Thing (IoT) platform. UniCycle provides services that are useful as neither there will be wastage nor shortage of parking dock. The dock free system provides a service where users need not worry about finding the parking dock and they can place the bicycle at anywhere and anytime within the campus’ compound. Therefore, UniCycle provides dock-free smart bike sharing services which is a more convenient alternative to students to navigate around the campus. Furthermore, the maintenance team can also monitor the condition of the bicycles.

1. Introduction

Transportation is considerably important to allow users to move from one location to another. There are different modes of transport used by students daily around the campus. Unfortunately, not all students possess car or motorbike to navigate around the campus. Bus services is provided in the campus, but the time schedule may not be ideal to the students. Thus, students may prefer different modes of transport if they have a choice. In conjunction, bike sharing services becomes an alternative which is convenient yet affordable to move around the campus.

Smart Bike Sharing System (SBSS) in a digital campus is a service that are made available to the public especially to students and staff to use the bicycle for a short period of time for a price. According to Ruckus, digital campus helps to link application, devices, and people to provide new experience to people and to improve the efficiency in daily activities. In a digital campus, bike sharing service is to provide a convenient yet affordable way for students to navigate around the campus. Smart Bike Sharing System is developed using Bluetooth, GSM/GPRS module, Android application, microcontroller, and solenoid. The Internet of Things (IoT) is a system that relates to computer devices and hardware where unique identifier is provided so human-to-human and human-to-computer is not needed during the transfer of data over a network. The system is IoT based for the application
where users is required to sign up / sign in to use the application. Besides that, maintenance is crucial to help to improve and maintain the services for good user’s experience.

2. Background Review

Bike Sharing Systems (BBSs) have been installed in many cities around the world and are increasing in popularity, whereby allowing people to have ready access to these public bikes rather than rely on their own bikes. It is one of the key elements of sustainable transport systems. A major operational cost driver in these systems in rebalancing the bikes over time such that the appropriate number of bikes and open docks are available for users. According to [1], BBSs should offer services such as cycle availability, reservation and safety to both biker users and Bike Sharing Service Operators (BSSOs).

The literature review shows that work on BBSs has become a strong interest to researchers, especially in the urban area. There have been numerous studies to investigate how to turn conditional bike into a ‘smart’ one where it can communicate and sense the surrounding area. A work from [2] proposed a campus distributed BBSs based on Internet of Thing (IoT) System in providing flexibility to borrow and return the bike by using Message Queue Telemetry Transport (MQTT). Meanwhile, [3] proposed ‘smart’ BBSs in which bikes have sensing and communication capabilities. Their focus on networking protocols that could support efficiently the collection of the date sensed by the bikes using Delay Tolerant Networking (DTN) as an alternative to Wireless Sensor Networks (WSN). On the other hand, [4] designed an efficient mobile system for bike sharing on campus that includes client and server. Client is designed based on Android system and server is designed based on Openstack cloud computing system that have login, lessor, lessee, and administrator module.

Then, [5] presented a novel phone app for use in the collecting the flow of data pertaining to users approaching and leaving a station before and after using a shared bike. Two main functions in this work is “Bike Sharing Querying” and “Staged Route Planning” which indicate the location of nearby rental stations and the current availability of bikes and a route planning based on when the user would like to pick up and park the bike. Meanwhile, the method introduced by [6] has the advantage that of reminding users to place bikes properly, in term of location and posture by judging the location and position of the bike through nine-axis attitude sensors and give a reminder through a voice warning. While [7] used a machine learning model to predict the number of available bikes at each station. Some authors have also suggested that BBSs can be used to understand the pattern of social dynamics and human mobility in the city by looking into the bike trip pattern [8, 9, 10].

3. System Description

UniCycle is introduced in this paper based on the block diagram as shown in Fig. 1. The work is involved with two parts which is the software and the hardware. Based on the diagram, the hardware consists of microcontroller Arduino Mega which is picked for its smaller in size and convenient to be portable with GPS (NEO 6M) and GSM/GPRS(SIM900A). Solenoid is being used as the lock for the bicycle as it is strong and Bluetooth (HC-05) is used to communicate between QR code, the application and the hardware to lock/unlock the bicycle. The relay used is to step up the voltage to 12V. A 12V solenoid is used to provide extra security to prevent theft. Bluetooth is used to lock and unlock the bicycle as it is more directly to prevent loss of connection when unlocking the bicycle. Arduino Mega is used as the microcontroller as it more compact and it is easier to be moved around.

On the other hand, software part involves the development of Android application using Appy Builder. The development of application is to ease the process of lock or unlock the bicycle, sign up or sign in, top up payment using e-wallet and location of the bicycle which is made available to the user. The application is used as a platform to allow user in hiring a bicycle which would save time in going through registration and payment. The application allows user to hire the bike whenever they want to and doing payment via e-wallet would ease the old payment method. The data that is stored into
firebase is used by maintenance team into monitoring the condition of the bicycle. This would allow the maintenance to maintain their bicycle as well as reducing poor experience for user to prevent this service for becoming a liability.

When GPS is initialized, the Arduino will receive the location, and it will send it to the host by using GPRS. The host will pass the data into the firebase. The firebase will finally store the longitude and latitude that came from the GPS. The App will retrieve the data from firebase and show the location of the bike on its screen. From there, user can choose any bike inside the campus via the App as shown in Fig. 2.

Fig. 1. Block diagram for bike sharing system for digital campus

Fig. 2. Flowchart of the system.
Fig. 3 shows that when a user scans the QR code on the bike using his/her mobile, the mobile will send a string to the Arduino via Bluetooth. The Arduino will check either the string is correct or not. If it is correct (yes) the lock of the bike will open, and the person can start to ride the bike. If the String is not correct the lock will not open and APP (Android) will ask the user to scan the QR code again.

![Flowchart for open lock](image_url)

Fig. 3. Flowchart for open lock.

Fig. 4. shows, when we push the stop button on the application, the mobile will send a signal via Bluetooth. This is done when the user wish to stop using the bike. If the Arduino receive the signal (yes) the timer will stop, and the bike will be locked. After that the App will calculate the charge and display it on the App’s screen with remainder, simultaneously the App will store the cost and the remainder on the firebase. If the Arduino does not receive the signal the timer will keep working and the user must push the stop button again.
Fig. 5 shows the prototype of the bicycle where it is dock free and does not require a docking station. As shown in the figure, it is mostly focus on the back of the bicycle which the docking lock will lock in between the bicycle. The only way to unlock the bike is through the app where scanning of the QR code is required. The application will be discussed further later in this paper. The bike is unlock/lock by scanning the QR code which communicates via Bluetooth HC-05 and the application. Meanwhile, Fig 6 shows a complete circuit of the dock-free lock behind the bicycle. Arduino connects with the application via Bluetooth by comparing the string and if it’s equal then the bike will unlock. When the application sends a ‘0’ string to the microcontroller and if it is true then if will lock the bicycle.

Fig. 5 shows the prototype of the bicycle where it is dock free and does not require a docking station. As shown in the figure, it is mostly focus on the back of the bicycle which the docking lock will lock in between the bicycle. The only way to unlock the bike is through the app where scanning of the QR code is required. The application will be discussed further later in this paper. The bike is unlock/lock by scanning the QR code which communicates via Bluetooth HC-05 and the application. Meanwhile, Fig 6 shows a complete circuit of the dock-free lock behind the bicycle. Arduino connects with the application via Bluetooth by comparing the string and if it’s equal then the bike will unlock. When the application sends a ‘0’ string to the microcontroller and if it is true then if will lock the bicycle.

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For the Android apps development, Fig 7 shows an approach to retrieve the specific user data from the Firebase such as account balance. On this screen it will get value from other screen such as from TOPUP and UNLOCK screen which the adding and subtracting arithmetic involve between the Firebase value, desired user value which is from TOPUP screen and counted timer value from UNLOCK screen. After that, the result from the arithmetic solution will be stored again in the same directory. All the value stated above is assuming to be a valuable currency.

Fig.7. Retrieving data from Firebase.

Fig 8 shows coding for the unlock page, where after the user unlock the bicycle the timer will start running. After user lock the bicycle, the timer will stop and it will calculate it by one second equal to 0.00028 sen where one hour of riding equal to one ringgit.

Fig. 8. Trip Count Coding.
4. Results and Discussion
The Android application that was developed is called UniCycle. The Graphical User Interface (GUI) on the application is shown in Fig. 9(a). Meanwhile Fig. 9(b) and Fig. 9(c) shows the GUI of sign up and sign in, respectively.

![GUI front page of UniCycle, (b) new user GUI and (c) home page of user](image)

A new user would have to use the sign-up page where details such as username, password and credit/debit card is needed. Credit/debit card is used because commonly all student currently has matric card as their debit card. The data would be saved into cloud database which firebase was chosen. Once that is done existing users could use the sign in page where only the password is needed to retrieve the profile. This would bring us to the Home page which is Fig 10. On the top right corner shows current balance. The current balance is RM0 because it is newly signed up. The logo is to Unlock the bicycle via Bluetooth. The small icon on the bottom left corner allow users to find a bicycle. The middle icon is the check out their personal profile of the user. The right corner icon is for top up.

![Front page of UniCycle after sign-in.](image)

Fig 11(a) shows what comes after selecting the top up button. Users were made available to select the range from RM5, RM10, RM30 and RM50. The concept is based on e-wallet. When RM50 is selected, a confirmation shown in Fig 11(b) is asked to prevent accidental selection. Once ‘yes’ is selected, the money is top up into the user’s account (Fig 11(b and c)). These are the extra feature used to solve the issues.
Figure 11 (a) The concept of e-wallet to top-up the UniCycle, (b) Warning for accidental top-up process,

A reminder pops up to remind the users to open their phone Bluetooth to communicate with the lock. Once they are paired, barcode scanner would appear on the screen to allow user to scan the barcode. Once the barcode is correct, the lock will unlock, and the time begins Fig. 12(a). The first minute is free for user to get used to the bike and a head start for the user Fig. 12(b). It is then counted 1 hour for RM1 Fig. 12(c).

Fig. 12(a) GUI of starting the bike, (b) GUI if bike been used less than one minutes and (c) Time of bike been used.

Once the user has arrived at his/her destination, user can click on the lock button. A gentle notification shown in Fig. 13(a) is given to prevent accidental clicking as that would be dangerous to user. Once it is lock, the amount used appeared on the page and the amount will then be deducted as shown in Fig. 13(b).
Fig. 13 (a) Notification to stop the riding and (b) The cost of the riding.

Fig. 14 shows the date, time and bicycle that is used to analyze how frequent the bicycle is used daily. The data is clock in using Realtime basis. When users scan the QR code to unlock the bicycle, the date, time, and bicycle which is being used will be clocked into the data. The maintenance team will use the data to generate a graph to provide convenient ways for user to get the bicycle. Additionally, the real cloud time allowed the maintenance team will analyses the frequency of the data given to further understand the number of users for each bicycle as shown in Fig. 15.

Fig. 14. Frequency of Bicycle been used by user.

Fig. 15. Maintenance Analysis
5. Conclusion
This work is designed to provide a convenient way for users to navigate around the campus. Bike sharing service could become a daily mode of transport for student in an affordable and convenient way. On the other hand, using bicycle does not just help to preserve the environment but it helps to encourage user to stay healthy by exercising. Living in a world that is moving so fast may lead to hectic lifestyle and this is one of the ways to release stress from those hours of sitting in lecture halls and offices. Existence of bike sharing system can change the perception of students in UniMap towards exercise and follow a healthy lifestyle.

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