BikeEge - Bicycle Sharing System for Ege University Students

Nese BAZ [1], Bahadir AKTAS [1], Nail AKCURA[2], Radosveta SOKULLU,[1] Erol UYAR[3]

Abstract – **In the last decade Bike Sharing systems have become very popular all over the world. There are numerous examples bike sharing systems designed for big metropolitan cities which help reduce both traffic and CO2 emissions. More recently similar systems have become popular for universities campuses. In this paper we present the architecture and details of the free bicycle sharing system designed for Ege University students.**

Keywords – **bike sharing systems, system architecture, user inferface**

I. INTRODUCTION

A Bicycle Sharing System (BSS) is an alternative type of transportation system that allows bicycles, belonging to a certain organization to be used in a shared manner by a group of designated users, mainly for short-term short-distance transportation. Until the end of 2014 there were over 200 cities in the world that had registered bike sharing systems, with the number of bicycles varying from 50 (Dumfries, UK) to 65000 (Hangzhou, China) and stations from 10-15 to several thousand. Supported by a sophisticated software and network database, including an hourly based payment subsystem such BSS relieve the users from transporting and keeping a bike, while at the same time allow them to benefit from all the advantages that biking in cities can provide. In the last decade similar systems have been started in a number of universities all over the world. Most interesting examples in this respect are ZotWheels. (University of California, Irvine automated bike share program, inaugurated in 2009), viaCycle@GT, (Georgia Institute of Technology, Atlanta, Georgia), Reggie Ride (Illinois State University, Illinois), Crimson Bikes (Harvard University, Cambridge, MA), NYU Bike Share (New York University, New York) and Bike Emory, (Emory University, Atlanta, Georgia) to mention just a few. Generally these are not-for-profit enterprises, and city programs are usually sponsored by large banks or city municipalities, while university bike sharing is usually installed, operated and backed up by university funding.

[1]Nese Baz, Bahadir Aktas and Radosveta Sokullu are with the Department of EEE, Faculty of Engineering, Ege University, Izmir, Turkey: corresponding author email: radosveta.sokull@ege.edu.tr

[2]Nail Akcura is with the Dept. of EEE, at Katip Celebi University, Izmir Turkey

[3] Erol Uyar is with the Mechatronic Department, Institute of Natural Sciences, Ege University, Izmir, Turkey

In this paper we will present the details of such a prototype systems that is currently being developed in Ege University, Izmir, Turkey. The project, led by Prof. Dr. Fazil Apaydin, includes participants from different departments from the Faculty of Engineering, the EU Student Biking Society and it is also supported by Accell, the largest bike manufacturing company in Turkey.

II. BIKE SHARING SYSTEM ARCHITECTURE

A. Operational principles of a BSS

A bike sharing system in general consists of a number of stations, where bicycles are located, one main terminal at each station, which is used for carrying out the renting and returning operations and a main server located somewhere else. Docking stations are usually fixed mounted and bicycles are locked/unlocked to them. The terminal (kiosk) consists of a user interface part, storage, operating unit, power unit and a LAN or WAN network connection, which provides connection to a central server. A sample view of a bike sharing system is given in Fig. 1

Fig.1 An example of a bike sharing station

The process of renting and using a bike has the following 4 major steps:

a) User Registration
b) Renting
c) Usage
d) Return

In most cases there is a small fee for renting the bike, which is based on the duration and either pre-paid cards or credit cards can be used. Most of the systems require user registration in

terms of name, address and contact information. Once a bicycle is rented from the terminal, the lock on the bicycle stand is opened and the user can take the bicycle. Payment is usually per hour and is charged on the return. Bicycles can be returned at any station which has available bicycle stands.

B. University BSS

Different from the city BSS, university systems usually do

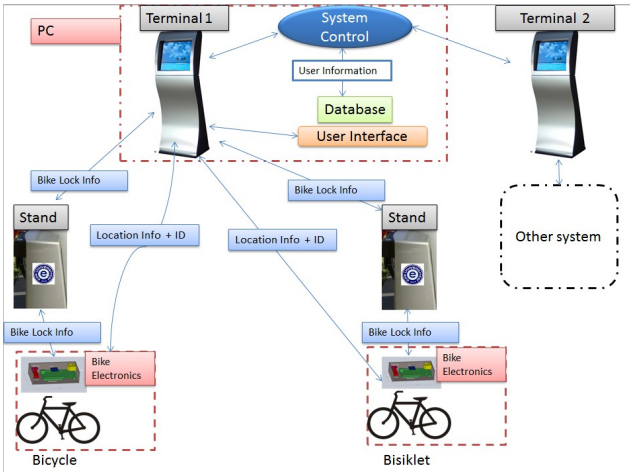

Fig.2 BikeEge Architecture

not require credit card payment but instead need initial user registration over the internet and a valid student ID card. Some of the systems provide also SMS notifications, location information as well as additional user related information. The architecture of the proposed system is given in Fig.2.

The proposed BikeEge system has the following main features:

a) It is free of charge for university students
b) Works directly with student ID cards
c) Integrated GPS service for bicycle location tracking
d) Location mapping of rented and free bicycles

III. Main Components of BikeEge

As can be seen in Fig. 2 the proposed system comprises the following modules: a Bike Module, a Station Module and System Control Module. The bike module consists of the electronics on the bike itself as well as the lock and the stand. The station module includes the terminal and the related user interfaces and databases. The system control module is connected to all terminals and contains the system management interface and all the user related databases.

List of the components used in the Bike Module is provided in Fig.3 below:

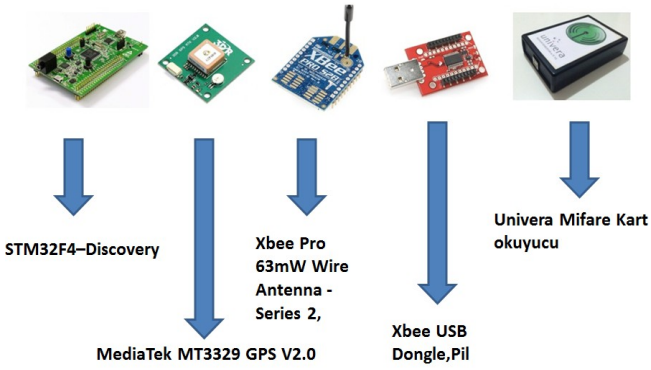

Fig.3 Hardware for the Bike Module

The Bike Module contains an ARM based STM32f4 processor, [13] [14], MT3329 GPS unit [9] and XBee 63mW wireless module which provides the connection between the docking stations and the terminal. [7], [9], [10], [13], [14]. Location information from the GPS and bike ID data is processed and transferred wirelessly to the terminal. The Station Module is responsible for connecting to the main System Control Module and database for verifying the user information. Through the designed user interface the operations of registration, password change, renting and return can be carried out at the terminal. System registration of a user can either be realized remotely (over the internet by using the student ID number) or directly at the terminal. Once the user is registered it is prompt for a password, which will be used later in all renting and return operations. The Station Module includes software and hardware for collecting the user information – in our case this is a MiFare card reader, compatible with the student card system used in Ege University [11] as well as processing unit and storage. All the data is stored and controlled by a database, which at this stage is a limited copy of the university one and is not linked to it in real time. The system control module is running on a server, which physically holds the whole user database, the bicycles, stands and terminals inventory and is implemented using SQL SERVER 2012. [12]

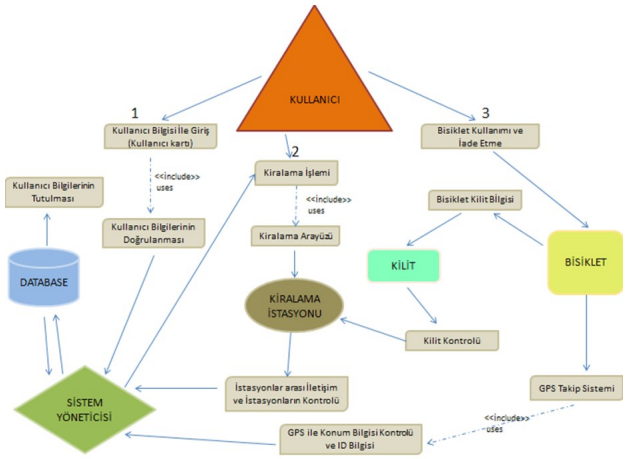

Fig.3 BikeEge Algorithm Flowchart

IV. BikeEge Interfaces and Operation

The designed system provides and easy to use interface. The interface is backed by the software system given in Fig.3. The communication is user-centered. After the initial welcoming screen (see Fig.4), the user action selection screen

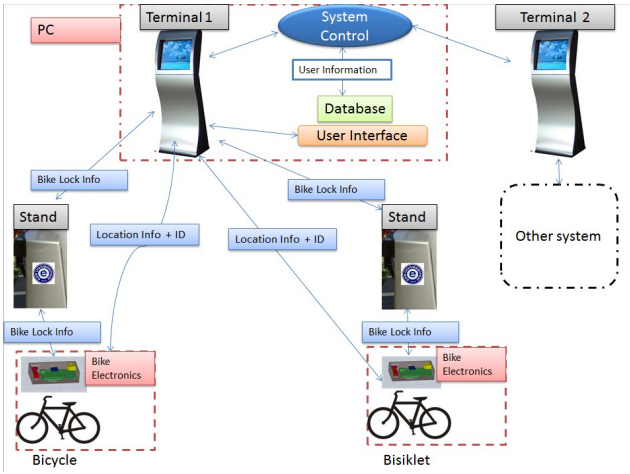

Fig.2 BikeEge Architecture

Fig.4 Welcome screen

Fig.5 User Action Selection screen

pops up that gives information about the available bicycles in terms of stations and number of bicycles available at each station. The user is requested to select an option to proceed. In order to rent a bike the user is prompted for his ID card and is directed to the renting window shown in Fig. 7. which requires user password.

Fig.6 User ID card request

At this stage the designed system accommodates both initial registration over the internet, based on the student email and registration at the terminal, when again the user is prompted for student ID number and email address. The information is checked against the existing EU student database.

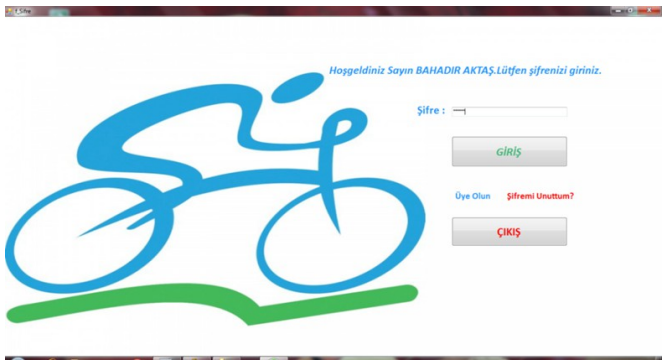

Fig.7 User registration screen

Once the registration process is completed, the user selects a bike number from the available pool. The numbers of the bikes are paired with the locks and the check is used for releasing the bicycle. An additional feature which is provided is a Google map, which shows the number of available bicycles at each station in the university campus. The terminals and docking stations are only within the limits of the university campus (which however is the largest in Izmir).

Since the service is provided free of charge to the students, there is no time limit to the renting period. However, the operator is notified if a bike is not returned within 24 hours. In that case the student should be contacted based on the information available in the database. In the future we plan to provide additional SMS service for return reminders, out of campus notifications and delayed returns notifications.

The return process is very similar to the renting process. It starts with the same Action Selection screen (given in Fig. 5) and upon selecting the return option, the student is prompt for his identity information and the ID number of the bicycle he wants to return. The data is used to match up the lock at the stand and it is also recorded in the management database together with a time stamp.

As part of the System Control Module a separate management interface developed for the administrator. It is shown in Fig. 8

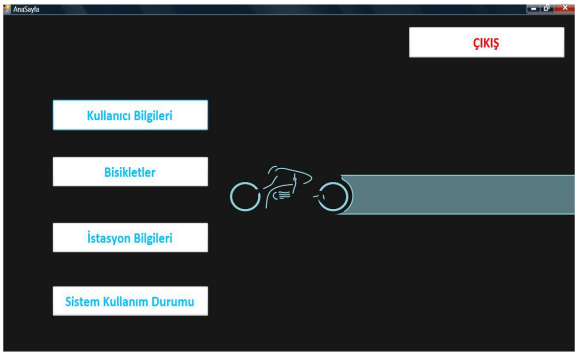

Fig.8 Administrator Screen

The administrator screen allows an authorized user to display and check the information in the different databases: user information, bike information, station information and system usage information. At any time the administrator can audit which users are renting which bikes and for how long they have been rented; he can view the number and ID of the bikes found at each station as well as the information about the occupied and free stands at each station. It also provides a notification if there is a damaged bicycle/lock, which can be used for timely intervention of the maintenance team.

V. The BikeEge Project

The work described in this paper is part of a much large project carried out currently in Ege University. Bike Ege is a large organizational project which requires the cooperation of very different units both in the university and outside the university. Besides the Department of Electrical and Electronics Engineering, which is responsible for the electronic part of the system and its supporting software there are several other departments participating. The Department of Machine Engineering is responsible for the docking systems (the stands, the locks and the terminals design); the Civil engineering Department is responsible for designing, establishing and maintain the bicycle tracks that will run through the campus and connect the two major parts (the Hospital Part and the Main Campus Part); the International Computer Institute will provide the final overall system software. As for the bikes themselves, for the first prototypes Accell has provided a limited number of all-purpose bikes. However, once the final bike and docking station design is determined, the manufacturing will be carried out by Accell. Finally, to have the system up and running, the active participation of the EU student Biking Society as well as the Faculty of Business will be required.

VI. Conclusion

In this paper we have presented details about an ongoing project for providing alternative “green” transportation to the nearly 45 00 students in Ege University – Bike Ege. The scope of this paper is the design of the electronic sub-system that will be located on the bikes and will allow renting, tracking and return of the bikes to their docking stations. The operational principle, the hardware, software and the designed user interfaces are described in detail. The paper is concluded with future work goals and a brief overview of the aims of the project as a whole

References

[1] Alta Planning + Design: Bike Sharing/Public Bikes: An Overview of Programs, Vendors and Technologies. Portland, 2009
[2] Schneider, R. Krizek, K. J., and E. W. Ston, TCRP Synthesis of Practice 62: Integration of Bicycles and Transit, Transportation Research Board of the National Academies, Washington, D.C., 2005
[3] DeMaio, P., Smart bikes: Public transportation for the 21st century, Transportation Quarterly 57(1): 9–11, 2003
[4] New York City Department of City Planning, Bike-Share Opportunities in New York City, NY, 2009
[5] ViaCycle@GT, Georgia Tech, http://www.viacycle.com/
[6] Bixi Bike, Toronto, https://toronto.bixi.com/ride-with-bixi/station)
[7] http://en.wikipedia.org/wiki/Zigbee (accessed 03.2015)
[8] http://www.jennic.com/elearning/zigbee/index.htm (accessed 05.2015)
[9] MediaTek, MT3329 DataSheet, Rev, A03, 2010/04/30, 2010
[10] http://en.wikipedia.org/wiki/Global_Positioning_System (accessed 03.2015)
[11] http://www.sonmicro.com/trx/downloads/Mifare/ds_SM130 pdf
[12] Database Fundamentals, First Edition, Neeraj Sharma, Liviu Perniu.
[13] http://stm32f4-discovery.com/stm32f4-links/ (accessed 03.2015)
[14] http://www.st.com/st-web-ui/static/active/en/resource/technical/document/reference_manual/DM00031020.pdf (accessed 03.2015)