Mobility and Green Infrastructure Laboratory for Energy Efficiency in Cities

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This paper presents a project that develops electrical technology for the implementation of solar charging public bicycle systems that are useful in mobility, tourism and transport of materials. It develops and implements planning strategies for sustainable mobility and green infrastructure. Also it shows a socialization strategy with a view to promoting sustainable mobility and energy efficiency.

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1. Introduction

In a modern city it is necessary the development and the implementation of planning strategies for sustainable mobility and green infrastructure, together with a socialization strategy with a view to promoting sustainable mobility and energy efficiency.

The transportation sector is the main consumer of energy in Mexico: It exceeds 45% of the total energy used in Mexico. As a sub-sector, motor transport uses more than 92%. The annual growth of vehicles is 5.3%, while the population increased 1.29%. An inhabitant of Mexico City loses 5 years of his life in traffic. 74% of mobility resources are allocated to road infrastructure, but 60% of households do not have a car. 40% of trips in metropolitan areas of the country have a length of less than 10 kilometers.

In Mexico and in the world, the paradigm of mobility is changing towards one that favors non-motorized means and public transport. One solution is the massive use of bicycles, there are more than 600 bicycle sharing systems in the world.

2. Electric Bicycles and Solar Recharging Stations

2.1 Electric Bicycles

There are many different considerations when developing an electric bicycle, some of the ones that we took into consideration are:

- That the energy used in the electric bicycle should be optimized to extend the time of the battery charge.
- That the batteries should be inside the bicycle's frame to be protected for the environment and also for someone that can steal them.
- That the electric motor of the bicycle only turns on when an automatic control system detects that it is necessary to assist the user, so she/he has to keep pedaling in a constant and comfortable manner, for example, when the bicycle is going uphill.

Figure 1 shows our design that took into consideration the previous aspects.

Figure 1: Design of an electric bicycle.

2.2 Public Solar bicycle recharging stations

There are many different considerations when developing public bicycle recharging stations, some of the ones that we took into consideration are:

- That the energy used to recharge the batteries of the electric bicycles parked in the stations should be environment friendly, thus solar panels are used as an energy source.
- That the bicycles need to be protected for the environment and also that someone can not steal them.
- That the lending of the bicycles to the public should be a straight and simple procedure using a mobile application.
- That the stations have an architectural design promoting the use of clean energy and visually friendly by putting flowers and plants in their design.

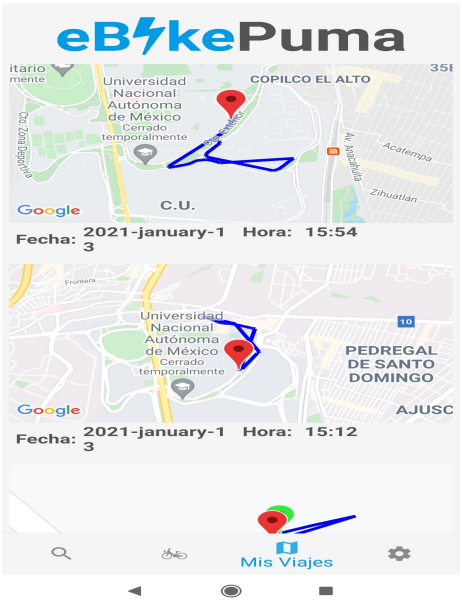
  Figure 2 shows our design for the recharging stations that took into consideration the previous aspects.

Figure 2: Self sufficient recharging bicycle stations.

3. Data visualization and processing tools

When a user takes an electric bicycle from our station, the data generated during the trip, such as velocities, its position, distance travel, battery charge, etc. is collected and then uploaded when the electric bicycle is parked in another station. This collected data later can be statistically analyzed to measured the use of the electric bicycles as well as the solar recharging stations and obtain usage patterns to improve the service and design.

(a) A bicycle user in our University Campus.



(b) Collected data of the user trip shown in an application.

4. Socialization strategy

An interactive module, inside a container, was developed for the promotion of alternative means of transport, green infrastructure and renewable energies, the iterative container it is shown in Figure 4.

Figure 4: Container with an iterative module to promote the use of clean energy.

In this module information regarding the previous topics are shown, as well as, an stationary bicycle with an electric generator generating energy while the user rides the bicycle, using a virtual reality helmet in a virtual trip as is shown in Figure 5.

Figure 5: A bicycle user in a virtual trips and at the same time generating electric energy.

This container can be transported to other locations to be shown to different types of audiences.

5. Conclusions

Fortunately, we have conjugated a group of researchers of different disciplines, engineering and architecture, to develop this project: electrical, mechanical and software engineers, as well as, industrial designers and architects for the successful completion of this project.

The participating institutions for this project of the National Autonomous University of Mexico (UNAM) are:

- School of Engineering, UNAM: development of electrical and electronic technology for the implementation of the electric bicycles, development of the software for the bicycles' lending process, development of applications and databases of the bicycles and users.
- School of Architecture, UNAM: development of the external and architectonic design of the electric bicycles and solar recharging stations. Generating policies of sustainable mobility and green infrastructure strategy, as well as the change and modal integration towards new modes of transportation.
- Engineering Institute, UNAM: manufacture of mechanical and electric elements as well as the development of manufacturing processes of the bicycles and recharging stations.