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Article

Design of Bicycle Power Generation Distribution Control System

Ming-Feng Wang [1,*], Hsing-Meng Wang [2], Chao-Yuan Zheng [2], Sheng-Chin Lin [2], Hong-Bin Zhang [2], Yuan-Chin Hsu [3], and Yao-Yu Tsai [2]

[1] Development of Wood Science and Design, National Pingtung University of Science and Technology, Pingtung 912301, Taiwan;
[2] Research General Center, National Pingtung University of Science and Technology, Pingtung 912301, Taiwan; wangxingmeng@mail.npust.edu.tw (H.-M. Wang); cyzheng@mail.npust.edu.tw (C.Y. Zheng); fivebird62@mail.npust.edu.tw (S.-C. Lin); changhb@mail.npust.edu.tw (H.-B. Zhang); og73230153@mail.npust.edu.tw (Y.-Y. Tsai)
[3] Department of Applied Digital Media, Wu Feng University, Chiayi 621303, Taiwan; yuanchin888@gmail.com
* Correspondence: wmf1981@gmail.com; Tel.: +886-87703202#7137

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Abstract: We designed a bicycle power generation distribution control system that consisted of the front and rear mudguards, wheel frames, fans and coils, and wheel frames with magnets. The bicycle generated wind and magnetic power while riding. The control system generated electrical energy from wind and magnetic power and stored it in the mudguard battery. The light sensor in the mudguard was used for the bicycle to generate power and charge the battery during the day while at night, power was supplied from the battery for lighting charging and storing power. This bicycle showed industrial usability with the basic configuration and cost-effective way to maintain the power generation and the battery.

Keywords: Bicycle, Wind power generation, Magneto, Distribution control system, Product design

1. Introduction

For environmental protection, sharing bicycles has become one of the travel modes chosen by most people in recent years [1,2]. In general, it is difficult for people to ride bicycles at night due to dark conditions [4]. To solve this issue, wind power and magnetic force are used to generate electrical energy to save it to the battery [3]. During the night, LED lights were powered by the battery along with a global positioning system (GPS) locator through the USB interface with smartphones and computers [5]. The data about riding the bicycle could be shared with friends through social networks and competitions, encouraging people to ride bicycles for environmental protection and carbon reduction which corresponds to the Sustainable Development Goals (SDGs) 2030 [6]. The bicycle was characterized as follows.

(1) The developed self-powered bicycle with a distribution control system contributed to the use of affordable and clean energy for sustainable development.
(2) The bicycle met safety standards and cost affordably, which allowed for mass production and subsequent commercial success to promote economic growth.
(3) The bicycle was aligned with sustainability as it was reusable, non-polluting, and environmentally friendly, addressing the climate change impacts.
(4) The bicycle coincided with Sustainable Development Goals, including affordable and clean energy, decent work and economic growth, and climate action.

2. Materials and Methods

For the bicycle, the battery life of electronic products is a problem [7]. Using wind and magnetic power, electricity was generated while cycling on the mudguards and stored in the battery in the mudguard. The battery was used to light LEDs on the front and rear mudguards to enhance safety. A GPS locator was powered to record trips through a USB interface with smartphones and computers [8]. With the continuous development of the green economy, the emergence of shared bicycles promotes environmental protection and brings new designs for green products. The bicycle was composed of four parts: LED lights, a power conversion device, a wind-power generation device, and a magnetic power generation device. For energy-saving and environmentally friendliness, wind and magnetic energy were converted into electrical energy and stored in the battery.

In the bicycle, wind and magnetic power generation devices were installed in the front and rear mudguards and wheel frames of bicycles. Coils were attached with magnets to the wheel frames to generate electricity through magnetic power generation. Fans and coils were installed into the front and rear mudguards to generate electricity from wind energy. The generated power was stored in the mudguard battery. In the dark, bidirectional energy storage of the generated power was conducted to light LEDs and generate and store power in the main battery. The sensors in the front and rear mudguards of the bicycle were used to light LEDs in the dark still generating electricity from wind and magnets.

3. Results

On the bicycle, a wind and a magnetic power generation device were used for generating electricity. The electricity generated by the bicycle was stored to emit light and operated sensors and a GPS locator. A control device was used to detect the remaining power of the battery and determine if it was greater than a preset power level. The power level was used to decide whether to charge the battery or not. Figs. 1 and 2 show the illustration of the developed bicycle.

(a) **(b)**

Fig. 1. Illustration of front and rear mudguards for bicycle power generation and distribution control module (**a**) Side view of the product; (**b**) 3D view of the product.

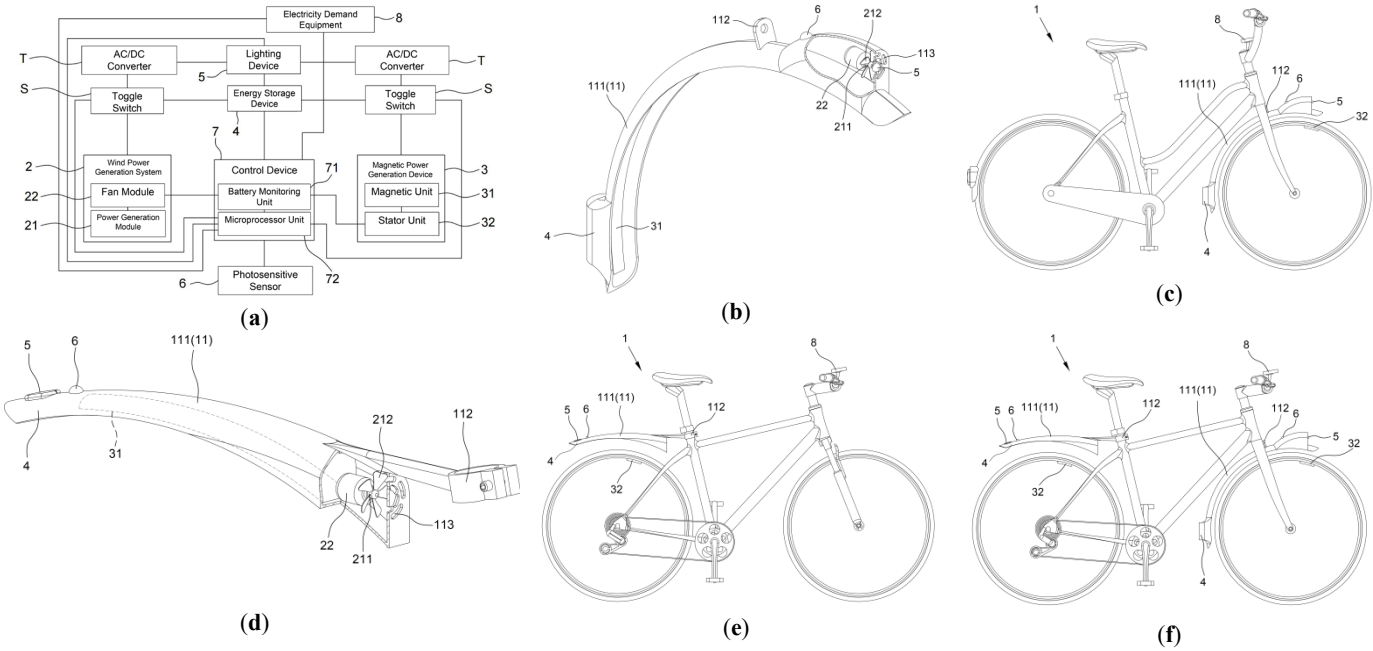

Fig. 2. Function diagram of bicycle power generation and distribution control module for front and rear mudguards. (**a**) System diagram of power generation and distribution control module; (**b**) Functional diagram of front mudguard product; (**c**) Functional assembly diagram of bicycle front mudguard product; (**d**) Functional diagram of rear mudguard product; (**e**) Functional assembly diagram of bicycle rear mudguard product; (**f**) Integrated functional diagram of bicycle front and rear mudguard products. (1: Bicycle, 11: Mudguard, 111: Hollow body, 112: Fastener, 113: Air inlet, 2: Wind power generator, 21: Fan module, 211: Shaft unit, 212: Blade unit,22: Generator module, 3: Magnetic power generator, 31: Magnetic unit, 32: Stator unit, 4: Energy storage device, 5: Lighting device, 6: Photosensitive sensor, 7: Control device, 71: Power detection unit, 72: Microprocessor unit, 8: Electrical demand equipment, S: Switch, T: AC/DC converter).

4. Discussion

To generate electricity in riding a bicycle, a combination of wind turbine and magnetic rotation was used to convert wind and magnetic forces into electrical energy which was stored in the battery. This energy-saving approach was proposed to conserve the battery's internal power. These features were integrated into the front and rear mudguard products. Sensors were installed on the bicycle's front and rear mudguards to allow LEDs to light in the dark. During the night, the control system initiated bidirectional energy storage to generate and store electricity while lighting the LEDs and operating the GPS locator and USB interface. The data of riding was used to calculate the amount of reduced carbon and foster data sharing. Users could be encouraged to ride the bicycle to reduce their carbon footprint and share the data. The bicycle's front and rear mudguards consisted of LED lights, a power conversion device, a wind-power generation device, and a magnetic power generation device. Leveraging the energy-efficient and environmentally friendly nature of cycling, the rotation of the fan blades and magnets while riding the bicycle generated electrical power which was stored in the battery.

5. Conclusions

We designed a bicycle with specialized features in terms of appearance, color, material, and functions for environmental protection. It provides fitness and cycling effects while satisfying the green economy. As the bicycle is simple and convenient to ride, it can be commercialized as a competitive product in the market to enhance the recognition of environmental protection and the green economy.

6. Patents

Ming-Feng Wang, Hsing-Meng Wang, Chao-Yuan Zheng , Sheng-Chin Lin, Hong-Bin Zhang, Yuan-Chin Hsu, and Yao-Yu Tsai. Bicycle Power Generation and Distribution. Taiwan Patent, application number 112117042, date of application.

Author Contributions: Original concept and product design, M.-F. Wang; market trend and marketing strategy, Y.-Y. Tsai and H.-B. Zhang; product organization and design, S.-C. Lin and Y.-C. Hsu; application of product materials and programming, C.-Y. Cheng; product technology and integration, H.-M. Wang. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest: The authors declare no conflict of interest.

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