

# Development of bicycle device to strengthen safety

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## 안전 강화를 위한 자전거 장치 개발

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**요약** 자전거를 이용하는 사람들의 수가 증가함에 따라 자전거 사고의 수도 증가하고 있습니다. LED 조명을 사용하면 자전거를 탈 때 자전거 사고를 최대 11% ~ 44%까지 줄일 수 있습니다. 자전거의 헤드라이트는 자전거 라이더의 반대쪽에 노출 효과를, 미등은 후면 자전거 라이더에 노출 효과를 제공하여 안전성을 향상시킵니다. 본 연구에서는 제어 버튼 신호에 응답하여 LED에 의한 방향 전환을 표시 할 수 있는 자전거 안전장치를 구현 하였다. 이 신호는 고정 된 시간 동안 자전거의 페달과 휠에 장착 된 LED 조명을 모듈 유형의 발광 또는 깜박임으로 만듭니다. 야간에 자전거를 타는 사람이 자전거를 타는 경우 LED를 사용하여 안전을 향상시킬 수 있는 페달의 자전거 보조 장치가 본 연구에서 개발되었습니다. 무선 통신 기술을 적용한 자전거 안전장치는 미래에 에너지, 환경 및 안전과 같은 사회적 문제를 해결하기 위한 대체 기술이 될 것으로 예상됩니다.

**키워드** : 자전거, 엘이다, 지그비, 자전거 악세서리, 자전거사고, 안전장치

**Abstract** With the growing number of people using bicycle, the number of bicycle accidents also has been increasing. It is said that bicycle accident can be reduced up to 11%~44% when riding a bicycle if LED light is used. The headlight of the bicycle makes exposure effect to the opposite side of bike rider while taillight makes exposure effect to the rear bike rider for improving safety. Bicycle safety device capable of displaying a change of direction by LED is implemented in this study in response to control button signal. This signal makes LED light which is installed in pedal and wheel of bicycle as a module type emitting or flickering during the fixed hour. Bicycle auxiliary device in pedal which is able to improve safety using LED when bikers are riding a bike at night is developed in this study. Bicycle safety device applying wireless communication technology will be expected alternative technology in the future to solve a social problem such as energy, environment, and safety.

**Key Words** : bike, LED, Zigbee, Bike Accessory, Bicycle accident, safety device

### 1. Introduction

As the number of bikers had surpassed 7,000,000 in Korea, there are more people commuting by bicycle these days. People who enjoy spending leisure time outdoors to keep in good shape after work at night has been

increased. Bicycle accident is likely to show relatively high fatality rate and therefore, bikers have to be very careful about safety during bike riding[1,2]. Nearly half of the number of cycling accidents nearly equivalent to 41.6% has been occurred during the evening rush hour and time

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to go home from school [3,4].

According to statistics, bicycle accident can be decreased by 11%~44% if used LED devices in bicycle. Headlamp makes it possible for bike riders not only to secure a clear view but to provide exposure effect with an opposite moving people while rear lamp can help to show bike to moving people[5-7]. LED pedal and wheel LED module to be installed in bike is developed to give a signal to direction change for safety at night bike riding according to response signal of control device for flickering as well as lighting time in LED. Bicycle auxiliary device in pedal using LED would make bicycle riders safer at night is developed in this study[8-10]

## 2. Related Work

Domestic market size of bicycle was about 1.93 million bikes in 2014 and since 2009, it had grown by an average annual growth of 5% during five years. Based on the total sales, it was about 513 billion Won with an average annual increase of 7.3% compared to the same period[11,12]. Domestic sales volume of bicycle in 2015 was two million bikes, four percent more over last year, the total sales were presumed to reach 550 billion Won, seven percent more over last year[13]. Domestic distribution rate of bicycle is about 29% while distribution rate of it has doubled or 3 compared to Korea. million bikes in 2014 and since 2009, it had grown by an average annual growth of 5% during five years. Based on the total sales, it was about 513 billion Won with an average annual increase of 7.3% compared to the same period. Domestic sales volume of bicycle in 2015 was two million bikes, four percent more over last year, the total sales were presumed to reach 550billion Won, seven percent more over last year[14,15].

## 3. Research and development

### 3.1 Design development of product controller

Product controller based on Zigbee is utilized a rechargeable module with box form. Its structure which is able to be installed in the part of bicycle handle is designed to be able to have removal function. Product design of controller is shown in Figure 1.



[Fig. 1] Controller design

### 3.2 Development of controller communication protocol

Controller communication protocol is linked with Zigbee communication module with 2.4Ghz bandwidth. Module specification of used Zigbee is shown in Table 1.

Table 1. Detailed specification of XBB

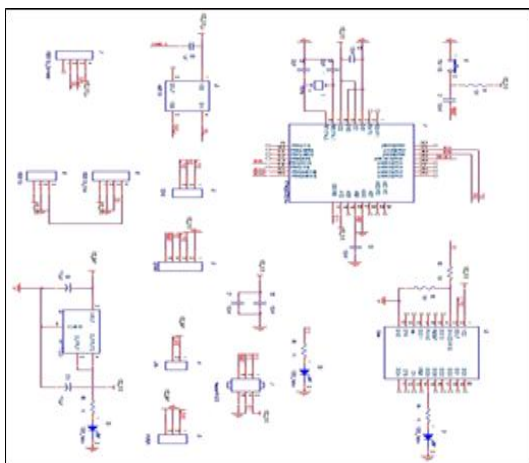
Specification	XBEE	XBEE-PRO
Performance		
indoor/urban range	up to 100ft(30m)	up to 300ft(90m)
outdoor RF Line-of sight range	up to 300ft(90m)	up to 1 mile(1600m)
Transmit Power output	1mW	63mW(18dBm)
RF Data Rate	250,000 bps	250,000bps
Power Requirements		
Supply Voltage	2.8~3.4V	2.8~3.4V
Idle/Receive Current	50mA(@3.3V)	55mA(@3.3V)
General		
Operating Frequency	ISM 2.4GHz	ISM 2.4GHz
Dimension	2.438cm x 2.76cm	2.438cm x 3.294cm
operating Temperature	-40 to 85 degree	-40 to 85 degree

### 3.3. Design of pedal PCB

RGB module test is conducted before circuit design and each module is tested after assembling PCB. Normal operation is confirmed under the condition of 3.7 voltage of WS2812B. The test result of RGB module is shown in Table 2 and PCB drawing of pedal is shown in Figure 2.

Table 2. RGB module test

Parameter	Symbol	Ratings	Unit
power supply voltage	V <sub>do</sub>	+3.5 ~ + 5.3	V
Input voltage	V <sub>I</sub>	-0.5 ~ VDD + 0.5	V
Operation junction temperature	T <sub>opt</sub>	-2.5 ~ +80	°C
Storage temperature range	T <sub>stg</sub>	-4.0 ~ + 105	°C



[Fig. 2] Pedal design drawing

### 3.4. PCB design of controller

RF module test of Zigbee is conducted before design and Pinmap is confirmed after selecting Zigbee module in consideration of review whether data are transmitted from main transmission data to sub. The result of Zigbee Pinmap is shown in Table 3.

Table 3. Zigbee RF Module PINmap

pin #	Name	Direction	Description
1	VCC	-	Power supply
2	DOUT	Output	UART Data Out
3	OIN / CONFIG	Input	UART Data In
4	DOS	Output	Digital Output 8
5	RESET	Input	module Reset(reset pulse must be at least 200 ns)
6	PWMO / RSS	Output	PWM output 0/RX Signal Strength Indicator
7	PWM1	Output	PWM Output1
8	[reserved]	-	Do not connect
9	OTR /SLEEP_RQ /DIS	Input	Pin Sleep Control Line or Digital Input 8
10	GNO	-	Ground
11	AD4 / DIO4	Either	Analog Input 4 or Digital I/O 4
12	CTS / DIO4	Either	Clear-to-Send Flow Control or Digital I/O 7
13	ON / SLEEP	Output	Module Status Indicator
14	VREF	Input	Voltage Reference for A/D Inputs
15	Associate / ADS / DIOS	Either	Associated Indicator, Analog Input 5 or Digital I/O 5
16	RTS / ADS / DIO	Either	Requests-to-Send flow control, Analog Input 6 or Digital I/O 6
17	AD3/DIO3S	Either	Analog Input 3 or Digital I/O 3
18	AD2/DIO2	Either	Analog Input 2 or Digital I/O 2
19	AD1/DIO1	Either	Analog Input 1 or Digital I/O 1
20	AD0/DIO0	Either	Analog Input 0 or Digital I/O 0

### 3.5. Resulting product

Resulting product of pedal is shown in Figure 3 and final product is shown in Figure 4.



[Fig. 3]Resulting product of pedal



[Fig. 4] Final product of pedal

LED pedal which is possible to display the desired direction of progress for left or right and wireless controller of the desired direction of bicycle are included in final product of pedal. The controller is composed of control button which generates signal for controlling LED pedal and wireless communications to transmit control button signal to LED pedal. To reply to pedal for delivering power to bicycle and control button signal, LED pedal is composed of LED module that is able to display the direction of bicycle progress for left or right by illuminating LED. LED module includes LED display for the desired direction of progress, wireless communications module capable of receiving control button signal, LED control part in response to received signal from control button, and battery for power supplying to control part. LED module having box form is inserted from outside towards pedal direction and LED module can be installed to illuminate light from the inside direction of pedal in order to appear to illuminate whole LED pedal.

#### 4. Conclusion

This study is related to bicycle pedal to strengthen safety for bike riding at night. LED pedal and wheel LED module to be installed in

bike is developed to give a signal to direction change for safety at night bike riding according to response signal of control device for flickering as well as lighting time in LED. The device will be expected not only to promote bikers' safety but to be able to apply the market of electric bicycles as well as leisure supplies.

Convergence of network technology will strengthen technological competitiveness in future bicycle market and it might be possible not only to develop but to extend smart technology field combined IT and IoT in the future. Setting and controls of wireless communications product through Zigbee network is also possible and creating higher value-added business based on technology convergence such as wireless communications technology and LED will be expected.

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