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by Morgan Jones

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Introduction

This report will cover a flowchart and circuit design of a rear bike light. There will also be research into similar products, what methods can be used to control the light and what components can be used.

Existing market products that perform similar functions.

Dracarys Smart Bike Tail Light



Figure 1 Dracarys Smart Bike Tail Light

The Dracarys light is designed to be a tail light on a bike.

It is resistant to water and has a rechargeable battery with LED sensor designed for many different bike models. It has an accelerometer, a high performing microcontroller with a three-level filter algorithm which helps the light act a specific way when braking. It has the ability to run a self-adaptive algorithm to help the light adjust to gravity when on a sloping road or when installed on the bike at an angle. There is also the ability to automatically turn the light on and off depending on the time of day; this is down to an ALS sensor. There is also a warning light that will come on signalling the light strength is going down; this happens after 30 seconds of high intensity light. The light is made from a COB LED and an EnSca lens; this gives good visibility at night and is designed not to dazzle. [1]

NEWBOLER Smart Bicycle Rear Light



Figure 2 NEWBOLER Smart Bicycle Rear Light

The light is designed to go on the seat post and is battery powered, it can be controlled automatically or manually, it weighs around 56 grams, it is waterproof and Usb chargeable. [2]

1 one enjoy Nkomax Smart Bike Tail Light



Figure 3 1 one enjoy Nkomax Smart Bike Tail Light

This bike light is waterproof, dustproof and is noticeable during night even in rain or fog. It has an auto on/off function this is determined by light intensity, braking and motion however, there is a manual mode. It has a compact and light design weighing 38g with a 400mAh Li-ion re-chargeable battery this can be done via a USB charger and can run for over 20 hours. This device also has slope adaptive technology, but this device can only be attached to the bike using a set of nylon cable ties. [3]

WQJifv Rear Bike Light



Figure 4 WQJifv Rear Bike Light

This light is suitable for different kinds of weather it has a 240-degree visibility range from a Cree Led it is also USB Rechargeable and can be charged from your computer or something with a USB port. USB Rechargeable Charges from your computer or any device with a USB port. It is also fitted with smart charging this allows the device to fully charge but automatically cut-off once fully charged. It can be adapted to be used on more than just bikes some examples are baby strollers wheelchairs, and backpacks. This light is also used as a warning light for example when changing tyres. [4]

Rear Bike Light USB Rechargeable by Apace



Figure 5 Rear Bike Light by Apace

This device is put in a impact-resistant polycarbonate plastic and an IPX5 waterproof casing, and uses 100 lumens and 7 lighting modes with 180-degree light visibility which people see in any terrain, weather or time of day and is Usb rechargeable with up to 48 hours battery life there is also a lighting mode designed for daytime visibility. It is also suitable for a variety of bike models. [5]

ENFITNIX Tail Light



Figure 6 ENFITNIX Tail Light

This device has is waterproof with an aluminium and plastic casing it has a Usb micro rechargeable battery which can run for 30 hours on flash mode, 14 hours on breath mode and 10 hours on constant mode the battery capacity is 400mAh. The brightness is 30lm and it weighs 31 – 36 grams depending on the mount. The is device is also able to automatically turn on and off, there is also the ability to sense what the brakes are doing so that the light can act accordingly. [6]

How to drive LEDs from a microcontroller

A LED uses one pin per LED. Using multiplexing the LED anodes are driven on an N pin and each cathode is driven via an M pin. With a processor with only 5 or fewer outputs which is most 8-pin microcontrollers this gives you an output similar to a direct drive. If the output pins are actually tristate enabled, it is also conceivable to share the drivers and control LEDs with just N pins. This is down to a pin being linked to a cathode and the LED which are driven low, and the other N pin is linked to an anode which can be driven high. Subsequently most of the board is taken up by the LED and room can be made for a microchip this can be done by using an LED as small as 3mm or using a board with two usable sides. [7]

Suitable PIC microcontrollers and their relevant internal modules

Suitable microcontrollers are:

12F675 with 8 pins and 1k flash memory, 16F88 18 pins and 8 flash memory, 16F877A with 40 pins and 8k flash memory [8]

Features

- Flash memory as it is used for Re-programmable program storage [8]
- RAM which is used to store variables. [8]
- EEPROM which is used as to store stable memory [8]
- I/O ports these are used as high current ports that can change pin direction [8]
- Timers/Counters there are usually three [8]
- USART which has built in RS232 protocol and uses a level translator chip. [8]
- CCP this is a Capture, Compare and PWM module. [8]
- SSP this contains the I2C and SPI Interfaces. [8]
- Analogue comparator which has an internal voltage reference. [8]
- ADC which is A to D converter [8]
- PSP which Parallel Slave Port that has an 8 bit microprocessor system. [8]
- LCD with interface [8]
- Special features -ICSP,WDT,BOR,POR,PWRT,OST,SLEEP [8]
- ICSP for Simple programming. [8]

PWM to perform power control.

Pulse width modulation (PWM) is a method for controlling analog circuits with digital outputs from microprocessors. PWM can be found in a wide variety of products, varying in use from measurements, communications or power control and conversion. [9]

Analog circuits

An analog signal has a constantly changing value, with unlimited resolution in both period and scale. A battery is an analog device this is down to the fact that the voltage given is not precisely the full amount stored in the battery it alters over a specific time period and can take any real-numbered value, also the amount of current drawn from a battery is not limited to a fixed values. [9]

The voltage and current from analog circuit can control objects for example volume from a radio in a car. In the radio a dial is attached to a variable resistor, as you turn the dial, the resistance changes up or down this means that the current going in to the resistor rises or falls this changes the current amount running the speakers which affects the rising or falling the volume.

As basic as an analog control may seem, it may not be always economic or practical. Analog circuits can also change over time making it a struggle to tune.

“Precision analog circuits, which solve that problem, can be very large, heavy (just think of older home stereo equipment), and expensive. Analog circuits can also get very hot; the power dissipated is proportional to the voltage across the active elements multiplied by the current through them. Analog circuitry can also be sensitive to noise. Because of its infinite resolution, any perturbation or noise on an analog signal necessarily changes the current value [9].”

Digital control

By managing analog circuits digitally the costs and power expenditure can be significantly decreased. [9]

“In essence it is encoding analog signal levels. Through the use of high-resolution counters, the duty cycle of a square wave is modulated to encode a specific analog signal level. This signal is still digital because, at any given instant of time, the full DC supply is either fully on or fully off. The voltage or current source is supplied to the analog load by means of a repeating series of on and off pulses. The on-time is the time during which the DC supply is applied to the load, and the off-time is the period during which that supply is switched off. Given a sufficient bandwidth, any analog value can be encoded with PWM [9].”

Figure 7 shows “three different PWM signals. Figure 1a shows a PWM output at a 10% duty cycle. That is, the signal is on for 10% of the period and off the other 90%. Figures 1b and 1c show PWM outputs at 50% and 90% duty cycles, respectively. These three PWM outputs encode three different analog signal values, at 10%, 50%, and 90% of the full strength. If, for example, the supply is 9V and the duty cycle is 10%, a 0.9V analog signal results [9].”

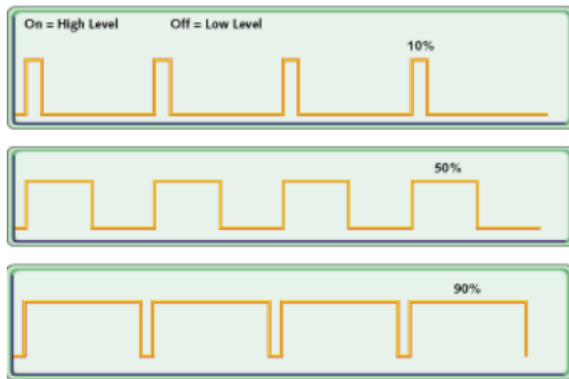


Figure 7 PWM signals of varying duty cycles [8]

Figure 8 shows “a simple circuit that could be driven using PWM. In the figure, a 9V battery powers an incandescent lightbulb. If we closed the switch connecting the battery and lamp for 50ms, the bulb would receive 9V during that interval. If we then opened the switch for the next 50ms, the bulb would receive 0V. If we repeat this cycle 10 times a second, the bulb will be lit as though it were connected to a 4.5V battery (50% of 9V). We say that the duty cycle is 50% and the modulating frequency is 10Hz [9].”



Figure 8 A simple circuit

“Most loads, inductive and capacitive alike, require a much higher modulating frequency than 10Hz. Imagine that our lamp was switched on for five seconds, then off for five seconds, then on again. The duty cycle would still be 50%, but the bulb would appear brightly lit for the first five seconds and off for the next. In order for the bulb to see a voltage of 4.5 volts, the cycle period must be short relative to the load's response time to a change in the switch state. To achieve the desired effect of a dimmer (but always lit) lamp, it is necessary to increase the modulating frequency. The same is true in other applications of PWM. Common modulating frequencies range from 1kHz to 200kHz [9].”

Commercial LED modules.

COB LED

COB LEDS can have 9 or more diodes. They have 1 circuit with 2 contacts. They are unable to change colour this is down to not having the correct requirements this makes it very efficient. They generate a large number of lumens with a small amount of energy . [10]



Figure 9 COB LED [11]

Cree LED

A Cree LED is a LED created by a company called Cree it these LEDS are deigned to have a high light quality, long usage life and also be energy efficient.

The Cree LED is developed for high performance with regards to quality of colour, output of the light and how the LED dims. It has been tested to last at least 30,000 hours of use. Its design makes it look like a normal light. This also delivers an 83 on the colour index which improves whatever is being lit up giving a larger area which gets light.

“The most recent Cree LED Bulb delivers 460 lumens for the 40-watt replacement and 815 lumens for the 60-watt replacement in soft white (2700K) and daylight (5000K) colour temperatures inside a durable, shatterproof housing and consumes up to 85 percent less energy* during its lifetime. As a better LED bulb, the new Cree LED bulb has once again achieved the trusted ENERGY STAR certification by meeting all the high-performance requirements [12].”

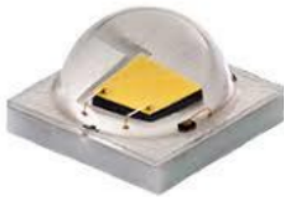


Figure 10 CREE LED [13]

Li-ion battery technology and USB charging methods.

What is a lithium-ion battery and how does it work?

A Li-ion battery is a sophisticated battery technology that uses lithium ions. During the discharge sequence the lithium particles in the anode are ionized and separated from their electrons. The lithium ions go from the anode and go through the electrolyte until they reach the cathode where they re-join with their electrons and electrically neutralize. These type of batteries can have a high voltage and high charge storage. [14]

“Li-ion batteries can use a number of different materials as electrodes. The most common combination is that of lithium cobalt oxide (cathode) and graphite (anode), which is most commonly found in portable electronic devices such as cell phones and laptops. Other cathode materials include lithium manganese oxide (used in hybrid electric and electric automobiles) and lithium iron phosphate. Li-ion batteries typically use ether (a class of organic compounds) as an electrolyte [14].”

USB charging methods

Smart Charge

Smart Charge is the term for smart charging technology. The charging current is from 1 to 2.4A this is dependent on the device it is connected to. This way you have a fast and safe charging process. These ports do not support data transfer and are only meant for charging devices and certain equipment. [15]

Quick Charge 2.0

It is designed to recharge a battery in a small amount of time. With QC2.0 the time it takes during charging to reach 75% percent will be reduced. This means that in about half an hour and you can have a battery charge of 60% when charging but this does depend on the device that is being charged. The QC2.0 can support 5V to 12V batteries with a capacity of up to 3A. [15]

“The intelligent IC in the charger recognizes which device you have connected and whether it supports QC2.0. If this is the case, then 1.5A will be delivered at 12V, 2A at 9V and 2A at 5V with a total maximum capacity of 36 Watt [15].”

Quick Charge 3.0

Quick Charge 3.0 is basically as strong as Quick Charge 2.0, but it is much smarter. The output can adapt to the requirements of the battery making the process of charging more efficient. The Quick Charge 3.0 can reduce the time it takes to charge a battery by up to 90% you can charge the battery 80% in roughly thirty-five minutes depending on your device. [15]

“Quick Charge 3.0 supports 5V, 9V and 12V with a charging capacity of up to 3A. The intelligent IC in the charger recognizes which device you have connected and whether it supports QC3.0. If this is the case, then 1.5A will be delivered at 12V, 2A at 9V and 2A at 5V with a total maximum power of 35 Watt [15].”

USB 3.1

The USB 3.1 has a C type connection which can give 2A but it can go to 5A / 20V, but this does depend on what method is used to deliver the power. [15]

Movement detection

An accelerometer can measure vibration, shock, tilt, and rotation. Vibration, shock, tilt are all effected by acceleration whereas rotation does not

linear rate motion

A MEMS accelerometer identifies tilt by measuring gravity when force is exerted at the axes of the accelerometer. For example, an accelerometer that has 3-axis this means there are three outputs which are taking measures at X, Y, and Z axes. Accelerometers can use differential capacitors to measure G-force, which is forwarded to a microprocessor to perform a specific function. There are two types of G force range one is the low range which is less than 20 gs which can be created by humans and the other range is high range which is higher than 20gs is this can be created by machines or vehicles. [16]

angular rate motion.

The rotation may take place without a change in acceleration. This works by having the X and Y axes parallel to the planet's surface and the Z axis toward the centre of the planet. The measurements for the Z axis is 1 g and the X and Y axes are 0 g. it is possible to turn the measuring device to move only about the Z axis. The X and Y just revolve measuring 0 g whilst the Z axis continues at 1 g. [16]

"Using MEMS Inertial Sensing to Transform Applications MEMS gyroscopes are used to sense this rotational motion. Because certain end products must measure rotation in addition to other forms of motion, gyroscopes may be integrated in an IMU (inertial measurement unit) that embeds a multiaxis gyroscope and multiaxis accelerometer [16]."



Figure 11 different types of motion [16]

Circuit design

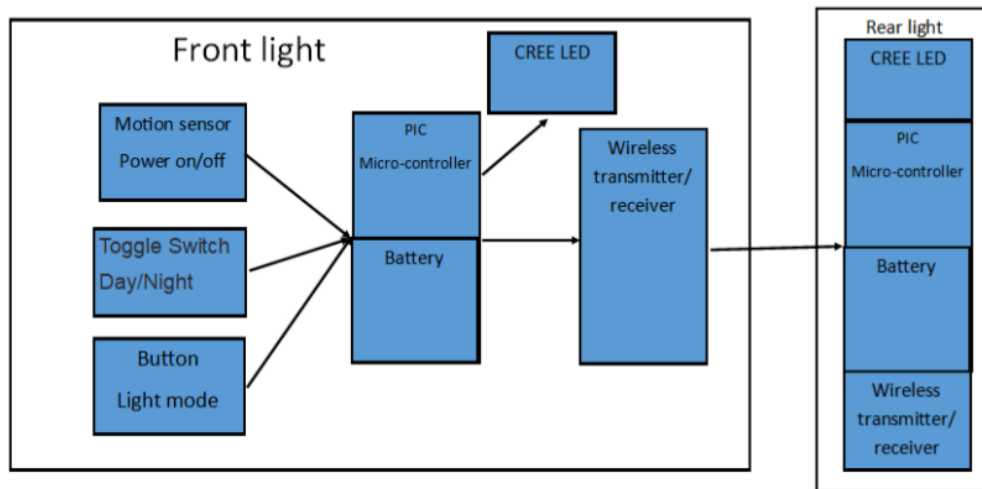


Figure 12 Front and Rear light design

The above design shows that the inputs for the front light send their signals to the pic in the front light which then activates the Cree LED which is powered by a battery and transmits the data via a wireless transmitter to a wireless receiver connected to the pic in the rear light. The inputs which are sent to the pic control how the Cree LED acts for example whether it flash or how bright the light intensity is.

Flowchart

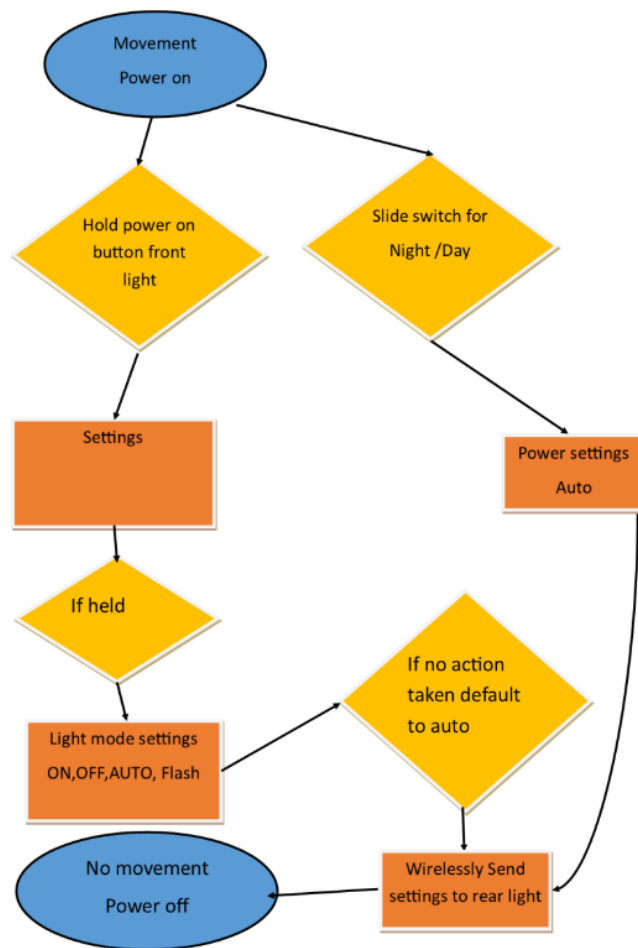


Figure 13 flowchart of how the circuit will work

The above figure 1 outlines the basic operation of the software.

1. The power is automatically turned on when a sensor on the front and rear light picks up movement, there is also a manual function to turn on the power
2. Slide switch for night or day to determine power intensity
3. Power intensity runs on automatic
4. Hold the power button to the settings
5. Hold the button for the light mode settings
6. If there is no light mode chosen then will default to automatic
7. Once the settings for the power and light modes are chosen, they will be wirelessly transmitted to the rear light
8. The power is automatically turned off when a sensor on the front and rear light picks no movement, there is a manual function to turn off the power

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FINAL GRADE

GENERAL COMMENTS

Instructor

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**MORGAN
JONES****244****ENGAGEMENT WITH LITERATURE**

Reasonable and relevant research performed. Note that while you have provided citations and put text into quotes, its not good practice to have such large sections directly quoted all the time.

65**KNOWLEDGE AND UNDERSTANDING**

Reasonable knowledge demonstrated via the research. Less so on the actual implementation.

54**COGNITIVE AND INTELLECTUAL**

The research does identify some reasonable components or technologies, but as there is no final detailed circuit or parts list, its difficult to see the final justification for choices etc.

35

PRACTICAL APPLICATION



Some thought given to what sections the hardware and software will require, however the flowchart structure and flow isn't logical if you tried to actually implement it. Block diagram of the circuit produced, but much more detail (as in a proper circuit diagram) should have also been produced (even if hand drawn).

30

TRANSFERABLE SKILLS



Reasonably well laid out and presented.

60