**DESIGN:**

**Microcontroller : Arduino UNO**  
The microcontroller unit acts as one of the processing units for the system. It controls the turning lights, counts the revolutions made by the wheel and communicates to PC or Android applications via Bluetooth. It is powered by the energy harvesting circuit.  
  
**Turning Lights:**   
  
Initial design: Initially the turning lights were implemented using polling where the loop constantly polled the state of the push buttons (left and right) to check for user input.  
  
Improved design: The former design was then improved by implementing interrupt service routines (ISR). In this current design, each push button is attached to an ISR that toggles a flag. The flag then triggers a blinking method for the LEDs. So, when a push button is pressed, the respective light starts blinking and turns off at a second push of the button. Each LED has a 47kΩ resistor in series with it and is powered by the 5V pin from the microcontroller. The same circuitry and code was implemented for both turning lights.

**Revolution Count:**

The hall-effect sensor is placed in close proximity to the spokes of the back wheel. It is powered by the 5V source drawn from the microcontroller with a resistor of 47kΩ in parallel to it. A magnet is attached to one of the spokes and an interrupt service routine is implemented to detect the crossing of the two. Every time the magnet crosses the hall-effect sensor, an interrupt is triggered and the service routine increments a counter.  
  
  
**Bluetooth:**

The communication to PC or Android application is maintained via a Bluetooth connection by the Arduino. A Bluetooth module is attached as a peripheral to the board. This peripheral will send any serial data printed out by the Arduino code out over the Bluetooth connection. The code used waits for a request from the connected device and sends the elapsed counts i.e the number of revolutions made by the rear tire since the last request and time elapsed since last request. Data is only sent when a request is made. Every time the Bluetooth receives a ‘1’, it sends the data out over the Bluetooth connection.

**IMPLEMENTATION:**  
Devices  
Microcontroller : Arduino UNO  
Hall Effect Sensor: IC Sensor Hall Effect 3SIP  
Magnets:  
Push Buttons: [enter specific name]  
LEDs : [enter specific name]  
Bluetooth : Sunfounder HC-06  
  
*Micrcontroller : Arduino UNO*  
Initially, while deciding which microcontroller to use for the microcontroller component of the project, various requirements were considered such as price, power consumption, and suitability for the projects needs. Some of the initial requirements were for wireless connectivity and for storage. For wireless connectivity, WiFi and Bluetooth were examined. For storage, SD or microSD technology were examined. After an analysis of Bluetooth and Wifi, Bluetooth was decided upon due to lower power draw and simplicity in connection with Android applications. MicroSD proved to be not necessary considering the quantity of data that needed to be stored.  
  
*Hall Effect Sensor: IC Sensor Hall Effect*  
In deciding upon which hall effect sensor to use, the size of the sensor itself was a vital point to consider since it needed to fit onto the frame of the bike right beside the wheel. It was important that the sensor was small enough in size to place without interfering with the operation of the bike. Although soldering the sensor pins onto wires proved to be a challenge initially due to the heat produced by the iron, it was later on installed using a header socket to prevent heat issues.

*Magnets:*  
The magnets were decided based on the strength. Four ¼” inch magnets were attached onto a spoke of the wheel. It had a magnetic range of approximately a centimeter.   
  
*Push Buttons:*Two simple one pole push buttons were used in order to take inputs for navigation from the user. A 3.9kΩ resistor and a 10nF capacitor were used to implement debouncing for each of the push buttons and a 5V line was drawn from the microcontroller’s 5V pin to power the buttons.   
  
*LEDs:*Since the target was to make a prototype of the device, a simple LED was chosen for this project. These LEDs drew power from the microcontroller in series with 47kΩ resistors and were grounded on the bike frame.  
  
*Bluetooth : Sunfounder HC-06*  
The Bluetooth module was decided based on the popularity and availability in the seller’s site. Good reviews on the sellers site, as well as price point and speed in delivery, were also factors in choosing the module.  
  
*The Code:*In order to code the functionalities of the microcontroller, different new fucntions were defined (as given in the source code) which were then plugged into the main loop in the code. All the interrupts were attached in the setup and all the variables and pin assingments were declared outside the setup. Also a arduino library *PinChangeInterrupt.h* was introduced in order to broaden the number of pins that could be used as interrupts.

If the SmartBike retrofit kit was to be produced as a product, it could potentially produce several sustainable effects and have a measurable social impact. It would encourage biking both recreationally and as an alternative to driving while commuting.   
  
It would also work to improve engagement in the local community through targeted advertisements for local businesses. Big chains or corporations do not need such small level targeted advertisement mediums. It’s the local stores that could use this opportunity to the fullest. Targeted to an audience who is conscious about their carbon foot print and effortful towards a more sustainable society, local businesses will be able to cater the advertisements of their promotions and services more effectively. Such first-hand communication between the customers and local businesses will generate growth and encourage more ideas.  
  
In addition, it would encourage longer distance biking, as the phone charging capability allows users to maintain charge to their phone throughout the ride. Long hours of operation drains a lot of battery from phones or any assistive gadgets. Often times these prove to be discouraging for riders to go for long distances at a time. This problem also discourages frequent use of such assistance. With SmartBike Retrofit Kit’s built-in power generation system, bikers will not need to worry about draining their gadget battery like before. Instead, they can recharge the battery while they are riding it. It will also be take out worries of battery drainage in daily commuting routines which will encourage more people to commute with bicycle , eventually reducing their carbon footprint .

Additionally, it would improve bike-car interactions, as the turning signals, and other potential future improvements, would make the bike appear as a more familiar vehicle to the car driver, and make the bike user more visible and safe while biking at night.

  
