Instrumented Bike

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Abstract

Purpose: This project will build on the concept that the cars use a variety of sensors, but will instead focus on instrumenting a bicycle to report trail conditions.

Method: This paper presents a method using accelerometers and GPS chip with Internet of Things (IoT) devices to detect pavement condition displaying the real-time data on the mobile application and storing the data to cloud. The main purpose of this research is to help the government evaluate the severity of road condition making a strategic decision about maintaining or retreading the damaged area, as well as, to notify other bikers to avoid bumps. The author puts forward an algorithm, which sets up a window range to process the raw accelerometer value(in Z-direction), to accurately filter out bumps. Additionally, this algorithm is implemented in the mobile application to identify locations of bumps. Furthermore, by connecting the smart phone to Cloud, the data can be shared by all users of this mobile application realizing the notification of bumps among users.

Concept of IoT

Concept: The idea of Internet of Things(IoT) is applied in the Instrumented Bike. All the device including the microcontroller, mobile application, and the cloud are connected. Based on this technology, this device is not just presented about how to detect the bumps, but also achieve a series of service including the mobile application and cloud storage. Furthermore, two or more bikes realize communication with each other, the data could be transmitted in real-time, it means drivers could share the information about the road condition and remain others avoid barriers.

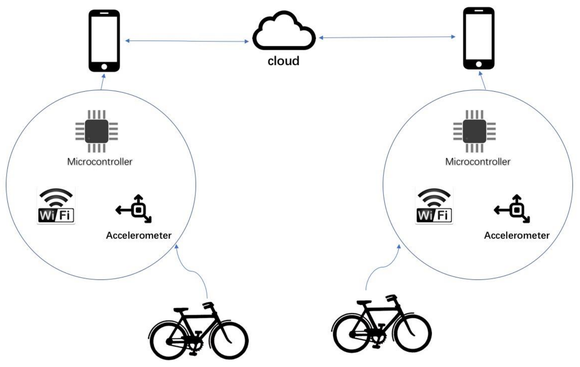

Figure 1: Concept of Internet of Things

Charts and Graphs

Figure 2: Data processing is the process of extracting valuable information from massive raw data, that is, data is transformed into information. Here is our original data.(accelerometer 1 on the front of bike and accelerometer 2 on the back of bike)

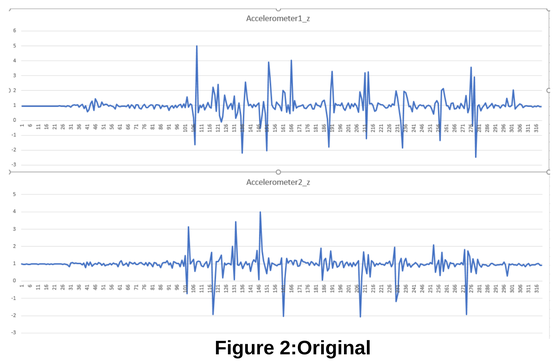

Figure 2:Original

Figure 3: This method is that dividing line chart into so many pieces with same range called windows. This is how this method identify pavement problem locations. There must be a consistent one-to-one match between every point on x-axis and latitude and longitude for a location. Finally, the points that fit into our standard will be showed on mobile application.

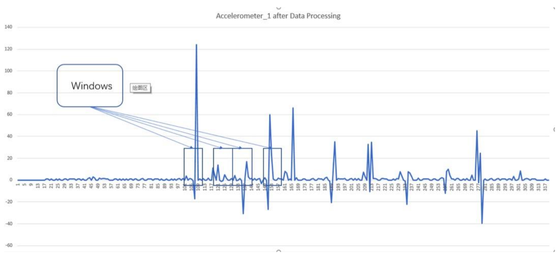

Figure 3: Data Processing Method

Test Results

Figure 4(a): In this test, ten artificial bumps are used to test accuracy of this application.The distance between first five bumps is almost 1meter, while distance between the last five bumps is 3 meters. The mapping appeared on the google map matches the number of bumps, locations of bumps, as well as the distance between bumps.

Figure 4(a): Preliminary Test

Figure 4(b)(c): Before applying the vibration model, mobile apps, signal processing, and GIS platformin roadway condition assessments, a preliminary road test was conduct on NorthernArizona University's campus to validate the applicability of the mobile sensing technology and mapping in real world application. A road displaying rough and smoothsurface was selected.

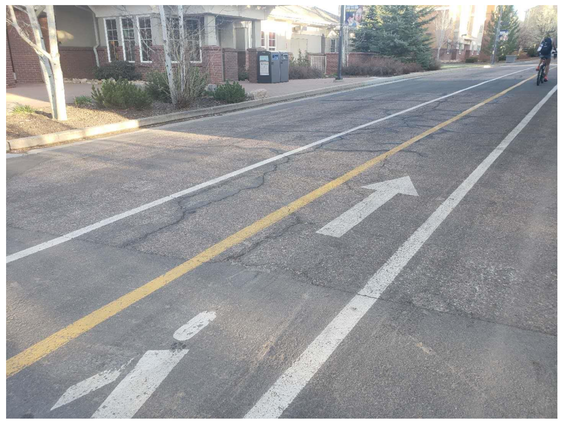

Figure 4(b): Road Test

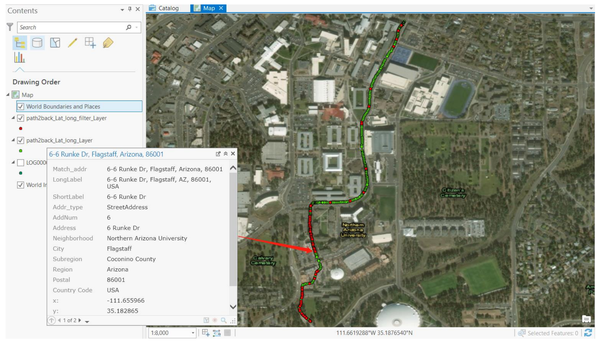

Figure 4(c): Geographic Information System

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