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Cycling Management Using IoT – Keeping Track of Fitness Regime And Fall Detection

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ABSTRACT- *Cycles are part of everyone's life, could be either for travelling or for exercising. But on a regular basis we have no idea about the fitness routine we have been carrying out. Hence, through this paper a system is presented by which using IoT based on our smartphone sensors as well as some other hardware equipments, we are able to get essential details about our cycling routine. This paper also involves fall detection using accelerometer of our smartphone which could provide necessary help during accidents.*

Keywords **: Cycles, Event recorder, Internet of Things, Fall detection, Accelerometer.**

1. INTRODUCTION

Bicycles has emerged out to be a very convenient and pollution free mode for travelling. In fact people are using bicycles more for exercising as a fitness regime which is scientifically proved to be one of the best way leading to fitness. But it could rather be futile and monotonous if we have no idea about how much we travelled or getting into same and casual routes every day, and what if we don't even have a bit of idea about how much calories we burnt while cycling because in case of exercising, the best part is to know how much calories we have possibly burnt. We could simply combine all these information's in our smartphone screen and moreover can share the data online with other cycle riders. All this is done using the sensors in our smartphone which forms first part of our module and using real time feedback which forms the second part.

Smartphones have been involved for many applications in our daily life. Smartphones even helps in fitness related purposes and tracking users using gps, preventing fall of people and objects, other such activity recognitions of our daily routines. Mixing up these technologies with IoT could be all the more very much efficient since IoT turned out to be a milestone in technical development [2] [3].

Recording events in cycles [1] presented an embedded approach. Cycling management even involved anti-theft and certifications using RFID. Such approaches leads to the this system of cycling recording using IoT.

The system in this paper uses smartphone sensor modules as - accelerometer to determine acceleration direction, gyroscope to determine orientation, electric compass to determine direction of travel, gps to determine route taken during whole ride and system integration module to combine all data and display them in our smartphone screen. It also involves some feedback system modules as – reed switch for speed and distance calculation, bluetooth module to transfer data to smartphone, Wifi module for cloud storage and a real time display.

If we consider the instance of accelerometer in a laptop, when a laptop tends to fall, the accelerometer senses the fall and turns off the hard drive so as to prevent its complete detection. Such an accelerometer of our smartphone can be used to alert predetermined person about a fall during an accident faced by the rider with the rider's GPS location. Hence, using the concepts [12] [14], fall detection using 3D accelerometer is also a feature of this system to prevent accidents while riding. Thus, to a quite good extent helps to provide the after care dealing with accidents as it alerts a pre determined person about the fall.

2. RELATED WORKS

In recent years, the IoT has become a topic of wide global concern, which provides a new direction to the intelligent fall detection and cycling event recording system. At present, by using the embedded technology combination of wireless sensor network of our smartphone to construct Internet of Things has become the development trend and research focus. And many scholars has great contributions to the development of bicycles by employing embedded system.

Relaying upon the electrical power on e-bikes, numerous innovations have started exploring the implementation of sensing devices on e-bikes, e.g., [4] the copenhagen wheel, which includes the development of a regenerative braking

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system and innovative motor control and uses real-time sensing and the powers of crowd sourcing to improve the cycling experience.

Currently, cyclists' experiences are typically converted into numerical data, which are collected for dietary, health and fitness measurements as proposed by Eisenman and team [5] introduced BikeNet which represents a multifaceted sensing system and explores personal, bicycle, and environmental sensing.

Embedded system in bicycles had been proposed by many other scholars. Ming Chiu and team [6] proposed embedded real time vision system for car counting, this was for parking lot management. Lin and team proposed a bicycle management system including anti-theft and certification by using RFID[7], which is a position trajectory management. VR bike system given by Yun Kim and team [8], is embedded with the dynamic geometry generation method, multi-thread method and portal generation method, for bicycle based rehabilition. And as in case of this approach the cycling events are recorded using IoT and embedded system [1].

Moreover, because of growing demand and usage of smartphones, smartphones have also increasingly used sensors and been presented in many systems. Such as tracking user coordinates through GPS as presented by Lei Zhang [9] SensTrack that selectively executes a GPS sampling using the information from the acceleration and orientation sensors. Thammasat and team proposed a fall-detection using accelerometers on a smartphone [12] focusing on elderly people and a similar case in [13] and [14] which provide further efficient function by wearable sensors.

Furthermore, activity recognition using sensors of our smartphone put forward by Anjum and Ilyas[10], developed a smartphone app that performs activity recognition that does not require any user intervention. Smartphone application even tend to calorie burning like Mobile Exergames which helps in burn calories while playing games on a smartphone [11] coined by Buddharaju and Pamidi. It combines exercising with gaming by requiring users to do some kind of exercises in order to score points in the game.

3. PROPOSED SYSTEM

3.1. Riding Data Recorder

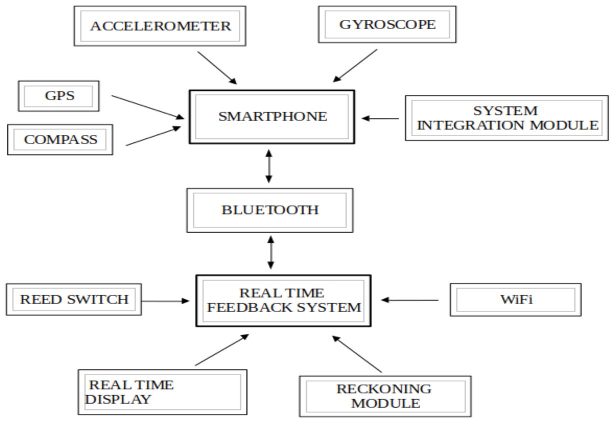

Fig - 1 : Block diagram to represent event recording for fitness regime

The information relating to riding and exercise for the cyclist is recorded using smartphone modules as well as real time feedback modules. Let us first consider the following smartphone modules based on different sensors and their implementations.

i) *Accelerometer*

It is used to examine acceleration direction. When an object accelerates in a direction, it creates disturbances in heat conduction, creating differences in the temperature of thermoelectric voltages measured from four directions which is directly proportional to acceleration direction.

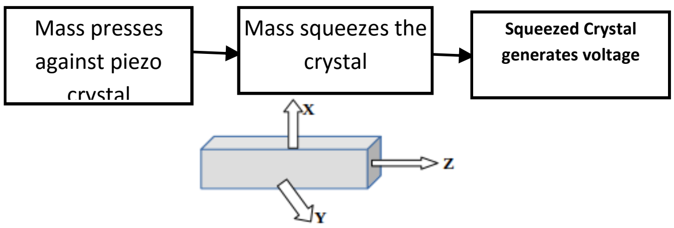

Fig - 2 : Working and orientation of accelerometer

ii) *Gyroscope*

It used to used to determine cyclist's angles of rota- tion. Electronic gyroscopes, also called microelectromech- anical system (MEMS) gyroscopes are used. When gyro is rotated, small resonating mass is shifted as angular velocity changes. This movement is converted to electrical signals which are then recorded.

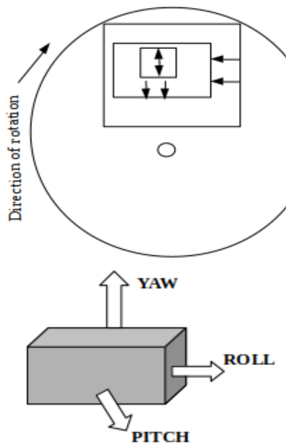

Fig. - 3 : Working and orientation of MEMS gyroscope

iii) ***Electric Compass***

It determines cycling direction. It helps to know whether cyclists are going through the correct routes. Electric compasses, similar to traditional compasses, distinguish the North and South poles by sensing the Earth's magnetic fields. Electric compasses apply the principle of Hall effect to sense direction, using the direction of electron deviation in electric currents to calculate changes in voltage from which the directions are known.

iv) ***GPS (Global Positioning System)***

It helps to determine cyclist coordinates. Cyclists can also share route maps generated from recorded data with other cyclists through the Internet which helps other cyclist to travel through routes they haven't traveled yet.

v) ***System Integration Module***

The system integration module read, analyse and combine the information provided by the above modules. The informations are displayed as well as stored in smartphones' memory. It also uses the Bluetooth of smartphone to connect to Bluetooth module of the real time information feedback system to collect other informations like average speed, total distance traveled and calories burned. Hence, data displayed are listed as : routes taken in the form of google maps, state of connection between the smartphone and Bluetooth module of feedback system, direction indicated on compass, speed, total distance traveled, weight of the cyclists (to calculate calories burned) and total time taken while cycling. Now, we take account of the real time feedback components.

vi) ***Reckoning Module***

The module reads information obtained from the reed switch module and display related cycling information on the real-time information display module. It also sends real-time cycling information to smartphones through the Bluetooth transmission module.

vii) ***Reed Switch***

Reed switch main principle is to convert mechanical energy into electrical energy. When magnets approach the magnetic switches, reed switches senses changes in the magnetic field. The reed switch contact point closes, thus completing the electric circuit each time wheel completes one rotation.

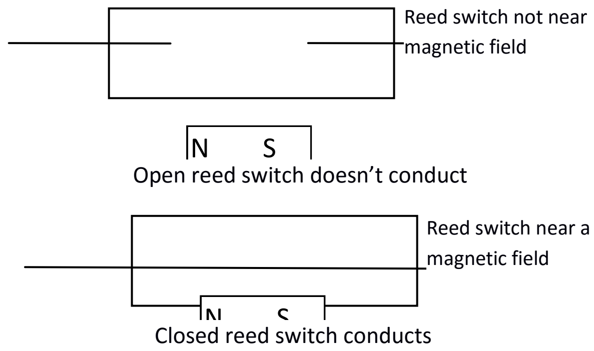

Fig - 4 : Working of a Reed Switch

It used to measure the number of wheel rotations and time required for wheels to complete one rotation which hence helps to calculate speed and distance of cycling.

speed = 3600 * (length/time)
distance = (count*length)/1000

Table – 1 : Description of terms for speed and distance calculation

Terms	Description	Unit
speed	Real time speed	km/hr
length	Wheel circumference	m
time	Time interval between each wheel rotation	ms
distance	Total distance travelled	km
count	No. of wheel rotations	-

viii) ***Real-Time Information Display***

Information computed from the reed switch was displayed using the real-time information display module which conveniently displays the speed, distance and time of cycling.

ix) *Bluetooth*

It develops connection with the Bluetooth in the smartphone to transmit the real time information calculated by reed switch.

x) *Wi-Fi*

It connects to the network connection of the smartphone, to transfer the real-time informations to cloud storage. Moreover, the informations computed in smartphone is also given up to cloud storage.

3.2 Fall Detection Using Triaxial Accelerometer

The developing technology of smartphones in case of sensors has led to developed algorithms for accelerometers on any smartphone. Using a smartphone for fall detection is comfortably and widely used and the cost is affordable. Thus, while we are cycling, our smartphones record the events as well as it helps in fall detection and alert a person with predetermined number and the location via GPS. We can observe an acceleration pattern during a fall is as a decrease in acceleration and then an increase, as shown in Fig 5. Accelerometer at rest is at 1 g (Earth's gravity, g = 9.8 m/s^2) and during free fall 0 g. When a person starts falling, the acceleration decreases from 1 g to around 0.5 g. Due to the impact with the ground, an increase in the acceleration is observed. The minimum and maximum acceleration within a one-second window is measured. If the difference between maximum and minimum exceeds 1 g and the maximum came after the minimum, thus we come to know fall had occurred.

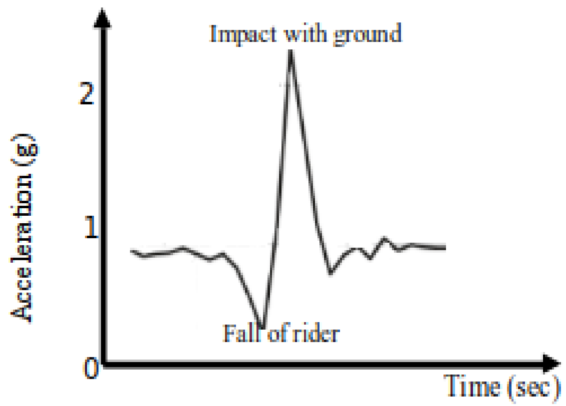

Fig – 5 : Acceleration pattern during a fall

Assume that the acceleration vector a = [ax, ay, az], which consists of the accelerations along the three axes of the accelerometer, basically pointing downwards. Let z be the axis pointing downwards when the person is standing upright. The angle *r* between the acceleration vector and the z axis thus indicates the person's orientation, is computed as

$$\cos r = \frac{az}{\sqrt{ax^2+ay^2+az^2}}$$

The average orientation while cycling is measured as r_0. Consequently, when a new orientation r was measured, it was normalized as : $r_{norm} = r - r_0$. A person is considered to be riding properly oriented, if $30° < r_{norm} < 30°$. This algorithm is used for fall detection. If an acceleration was detected that exceeded the threshold as described previously, we can conclude that a fall had occurred. Now, this could be a fatal fall, hence, no sooner does accelerometer detects fall, it informs the person of predetermined number with an alert and gps route. Thus, it helps in avoiding delays after accidents occur.

4. CONCLUSION

This paper has put forward a reliable and user friendly manner to record cycling related data for a cyclist using the components which are handy like the smartphone and a real time system all relating to IoT as the basic side. Combining these components we get to know our information relating to cycling in a real time basis and can also share it online with other users in various parts of the world. Getting into exercise point of view cycling could become vigorous or could be other reasons leading to accidents. This problem is also sorted out yet again in a handy manner by using triaxial accelerometer in the smartphone to detect fall and simultaneously alert a predetermined person with the location. Thus, our system provides a complete database of exercise relating information and preventing riders from delay to care after a fall.

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