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Design and Development of Gyroscope Based Vehicle Movement Pattern Recognition System

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Abstract: ***In today's life, everyone is in hurry to reach their destination as quickly as possible. So people intentionally or unintentionally take harsh driving events such as aggressive turnings, digs and speed breaking, which further lead them to accidents or even loss of their lives. To monitor driver behavior various sensors are being used either deployed inside the car, roadside or inbuilt in Smartphone. This paper provides analysis of vehicle movement patterns for normal and aggressive events. This paper also provides some research directions which various researchers can explore.***

Keywords: gyroscope sensor, MSP430G2553 controller, X-bee, Vehicle movement patterns.

1. Introduction

According to the study conducted by the Ministry of Transport and Highways, 60 percent of the driver-caused road accidents were attributed to over speeding, 16.7 percent of these were due to alcohol or drug consumption and lastly 23.6 percent were caused due to driver fatigue or overcrowding of vehicles. These clearly bring to light the gravity of the situation and the enormous responsibility of vehicle drivers towards causing road accidents. A life lost in a road accident is unforeseen and absolutely unnecessary; making the addressing of the situation a complete must [1].During the year 2010, there were close to 5 lakhs road accidents in India, which resulted in more than 1.3 lakh deaths and inflicted injuries on 5.2 lakh person these numbers translate into one road accident every minute and one road accident deaths every 4 minutes unfortunately more than half the victims are in the economically active age group of 25-65 years.

2. System Design

Figure 1 shows the Hardware Architecture of Vehicle Mount Unit (VMU). The hardware system includes Microcontroller, Gyroscope sensor and X-bee module. In this paper MSP430G2553 Microcontroller is chosen for complete core control; MPU-6050 Gyroscope sensor is used to measure angular momentum of vehicle; X-bee module for transmitting Gyroscope sensor data to Monitoring system.

Figure 2 shows the Hardware Architecture of Monitoring System (MS). The hardware of MS includes X-bee and Personal computer or Laptop. X-bee for receiving data from VMU; Personal computer for plotting and analyzing patterns of vehicle for various turnings under normal and aggressive turnings, speed breakers and digs.

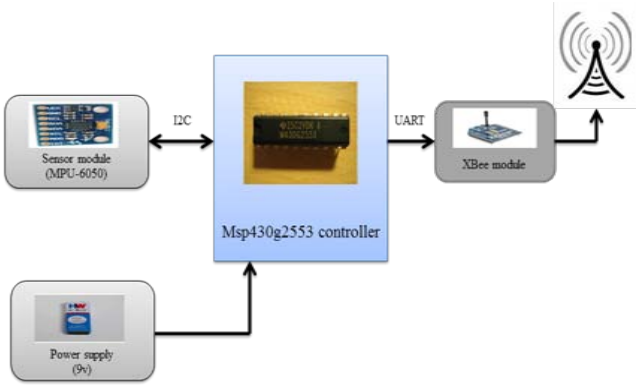


Figure 1: Hardware Architecture of Vehicle Mount Unit

The VMU is mounted on Dash board of car, initially when the setup is powered starts capturing heading information of vehicle and captured information is processed through Microcontroller, those values are send to Monitoring System via X-bee module.

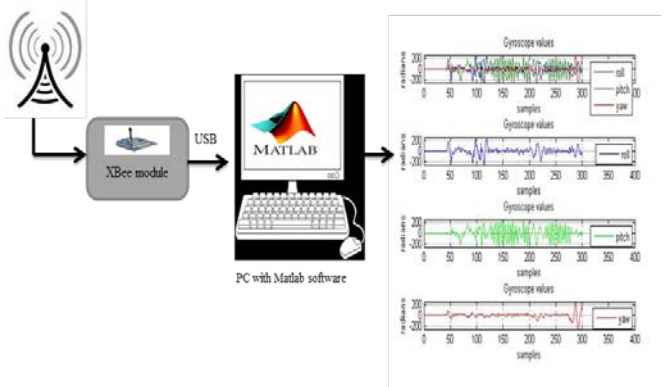


Figure 2: Hardware Architecture of Monitoring System

The Monitoring system receives the captured heading information of vehicle through X-bee; values are plotted and analyzed on personal computer or laptop.

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2.1 MSP430G2553

MSP430G2553 is used as the processor of this Vehicle Movement Pattern Recognition System. The processor was chosen because of its good features and integrated peripherals. Its portability and low-power consumption design can satisfy prolonged outdoor work. MSP430G2553 Microcontrollers (MCU) from Texas Instruments (TI) is a 16-bit, RISC-based, mixed-signal processor designed specifically for ultra-low-power. It is combined with a flexible clock system by using a Von-Neumann common memory address bus (MAB) and a memory data bus (MDB) [2] [3]. Figure 3, shows block diagram of this microcontroller. MSP430G2553 has on-chip Emulation Logic with spy-bi-wire, serial onboard programming, ease-of-usage, low cost, and the lowest power consumption for thousands of applications.

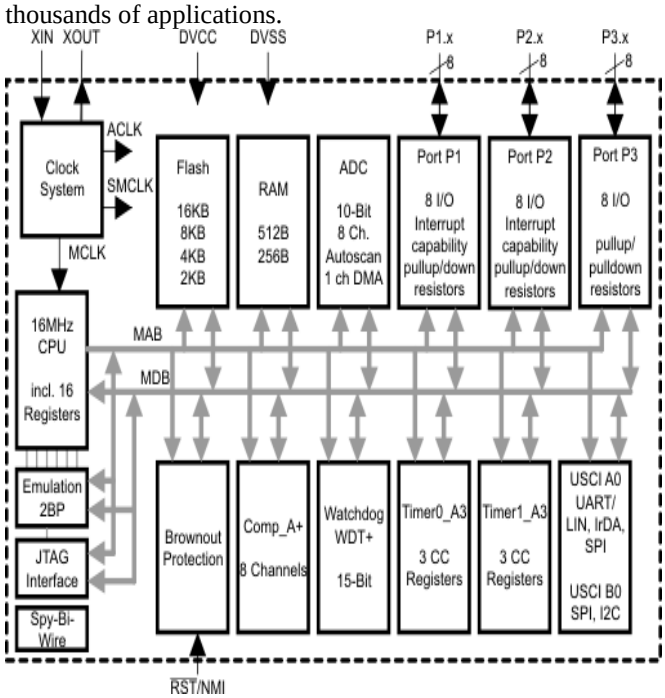


Figure 3: Block Diagram of Microcontroller

Its flexible clocking system, multiple low-power modes, instant wakeup, and intelligent autonomous peripherals enable true ultra-low-power optimization, dramatically extending battery life. Its power modes are shown in Table 1. The system is running in Active Mode. If the process is finished, the system will be in Standby Mode.

Table 1: MSP430G2553 Power Modes.

Mode	Current
Active Mode (AM)	230 µA at 1 MHz, 2.2 V
Standby Mode	0.5 µA
Off Mode (RAM Retention)	0.1 µA

2.2 Gyroscope

A Gyroscope is an electromechanical device for measuring or maintaining orientation, based on the principles of angular momentum. The gyroscope is used to find the angular momentum of a vehicle. It continuously monitors the how driver is taking turns, crossing speed breakers and digs at various instances. Those are analyzed at monitoring system.

2.3 Zigbee

Zigbee module is used for communication between VMU and MU. Zigbee is a recently developed two-way wireless communications protocol designed to meet very low power consumption (6 months-2yrs on 2 AA) and low cost (half that of Bluetooth) requirements. The higher protocol layers are being defined by the Zigbee Alliance group while interests in the lower layers of the stack (MAC, PHY) are being defined by the IEEE 802.15 working group 4 (802.15.4) which is aimed at achieving data throughput of 250kbps in the 2.4GHz band.

3. Algorithm

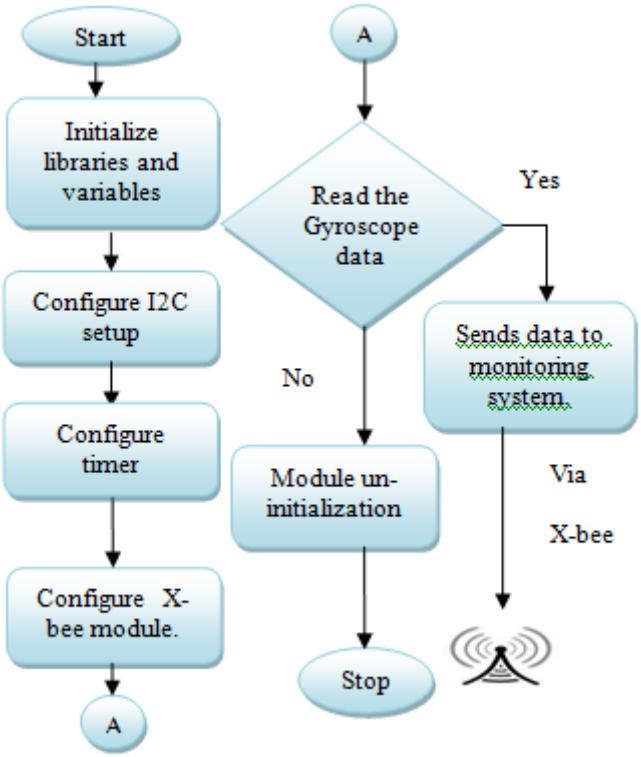
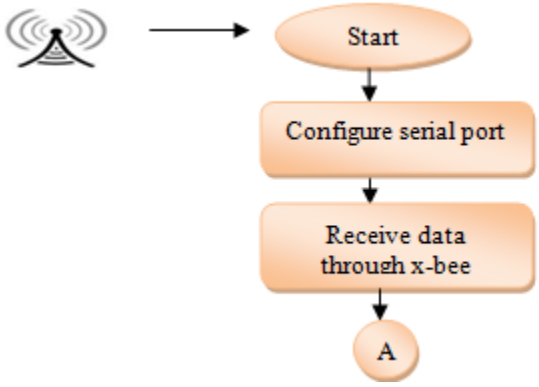


Figure 4: Flow Chart of Vmu.



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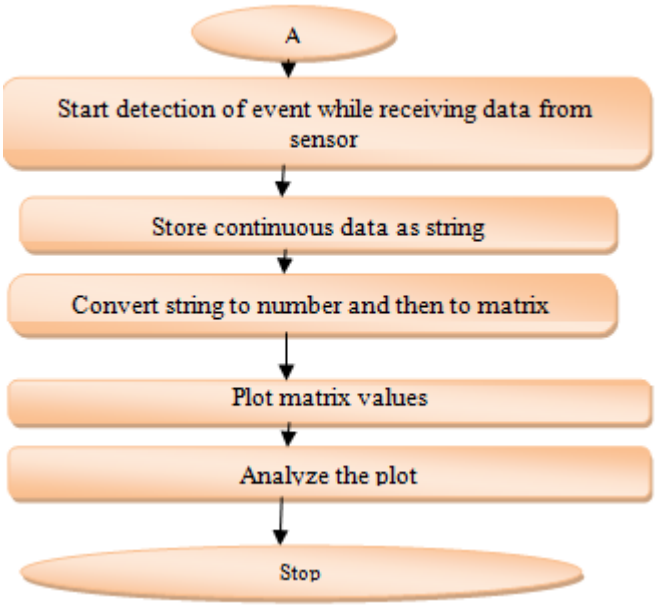


Figure5: Flow Chart of Monitoring System

4. Experimental Results

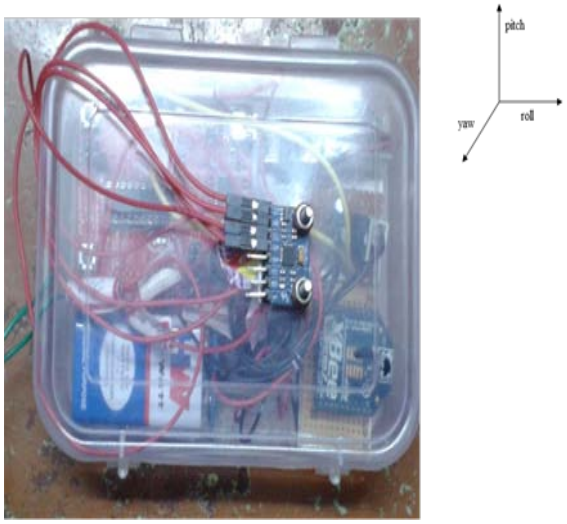


Figure 6: Portable Device Mounted on Dash Board



Figure 7: Observing the values of VMU by MU.

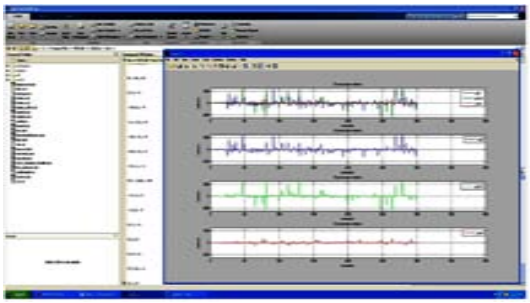


Figure 8: Plotting Sensor values and analyzing

When the vehicle is taking left, the yaw axis changes from positive to negative direction. When the event (left turn) occurs the minimum and maximum values of roll, pitch and yaw are captured as:

For normal condition:
Min: 0, 0, 2. Max: 0,-3, 32.
For aggressive condition:
Min: 1, 7, -50. Max: -2, 1, 26.

The below figures 8 and 9 shows plotted waveforms for left turn (normal and aggressive) conditions.

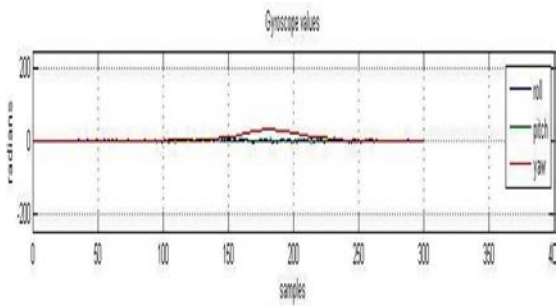


Figure 9: Plotted Sensor Values for Left Turn (Normal).

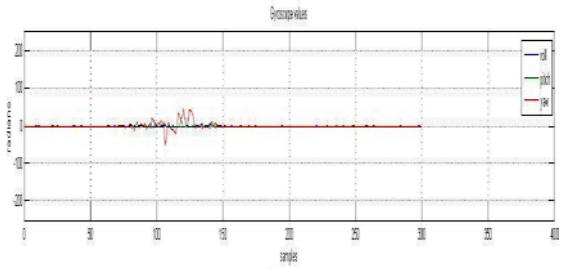


Figure10: Plotted Sensor Values for Left Turn (Aggressive)

When the vehicle is crossing speed breaker, the roll axis changes from negative to positive direction. When the event (crossing speed breaker) occurs the minimum and maximum values of roll, pitch and yaw are captured as:

For normal condition:

Min: 0, 2, 1. Max: -5, 10, -3.
For aggressive condition:
Min: -250, -105,112. Max: 185, -49, -67.

The below figures 10 and 11 shows plotted waveforms for speed breaking event (normal and aggressive) conditions.

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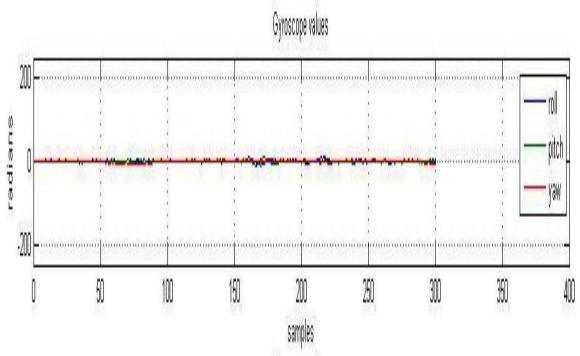


Figure 11: Plotted Sensor Values for Speed Breaker (Normal)

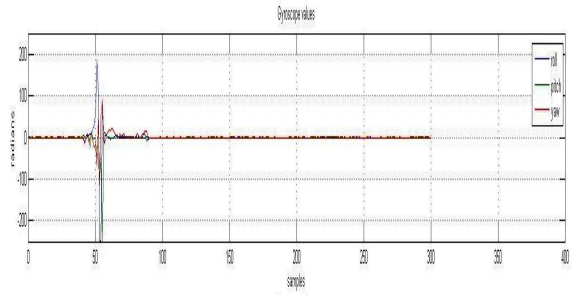


Figure 12: Plotted Sensor Values for Speed Breaker (Normal)

When the vehicle is crossing dig, the roll axis changes from negative to positive direction. When the event (crossing dig) occurs the minimum and maximum values of roll, pitch and yaw are captured as:

For normal condition:
Min: -15, 0, 1. Max: 18, 1, 0.
For aggressive condition:
Min: -38, 2, 8. Max: 250, 245, -37

The below figures 10 and 11 shows plotted waveforms for dig event (normal and aggressive) conditions.

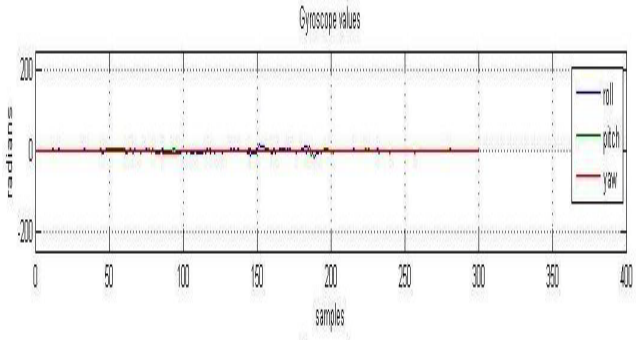


Figure 13: Plotted Sensor Values for Left Turn (Normal)

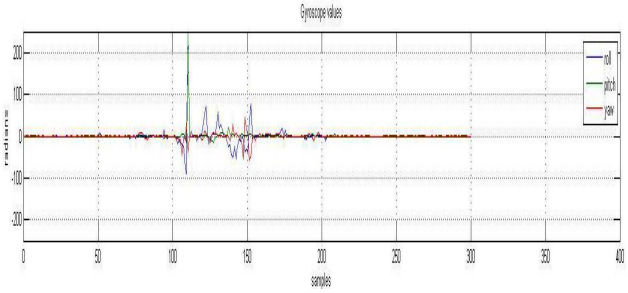


Figure 14: Plotted Sensor Values for Left Turn (Normal)

5. Conclusion and Future Scope

This paper presents a new design of commodity hardware with cheap and it consumes very less power designed oriented product for getting information from Vehicle Mount unit and analyze those values at Monitoring system. The system is designed by using MSP430G2553 controller for fast accessing to control and gyroscope for capturing heading information. VMU sends data to MS, those values are analyzed at MU. This project can be extended by integrating Accelerometer, GSM and GPRS which simultaneously monitors vehicle behavior, which provides more accurate results.

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