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Threshold Monitoring System For Improving Batsman's Performance

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Abstract : The main aim of the project is to improve batsmen' performance by measuring the degree of bat rotation, the exact timing required to play a shot, the force imparted by the bat on the ball wrist acceleration and footwork and so on. This Smart system aims at not only in improvising the batsman's performance but also helps the fans to play their favourite cricketer's trademark shot with ease. Although trainers are present to coach the players this Smart system would be an added advantage to identify the players' performance more accurately. Smart system consists of sensors fitted in bat, shirt sleeves, knee joints and Microcontrollers. The Sensors measure all the values during the play and processes it using the microcontrollers. The obtained data would be sent out to the trainer's mobile or laptop through the BLE and the data could be represented as a graphical image so as to interpret the performance very easily and to rectify the players' mistakes at ease.
Keywords : gyroscope, accelerometer, BLE, smart phone, flex sensors, monitoring.

I. Introduction

Cricket is a sport that takes plenty of enthusiasm, effort and dedicated practice. Like all other type of sports a solid technical foundation is essential to develop one's skills further. The basic skills necessary in cricket are batting, bowling and fielding. A qualified coach with additional experience of playing the game at a high standard would be ideally suitable to learn the basics. To shine in batting and bowling skills, often specialist coaches are sought.

A batsman must have good and-eye coordination along with quick reflexes, strength, speed, stamina and a knack for seeing scoring opportunities. By constantly keeping an eye on the ball the flight of the ball, its speed, swing and the spin imparted on it by the bowler can be identified by the batsman. The next skill that plays a big role in one's batting is footwork. It is a common error to stand fixed to one spot and swing at the ball. Good amount of footwork is necessary to cope up for the line and length of the delivery and for the shot that one decides to play. A good batsman must have a solid forward and backward defensive and that would form the backbone of defence. A wide selection of offensive shots will help to make use of these situations. Patience is the major quality of a great batsman and if the batsman develop his skills and is strong in his basics he may become a great player over the period of time.

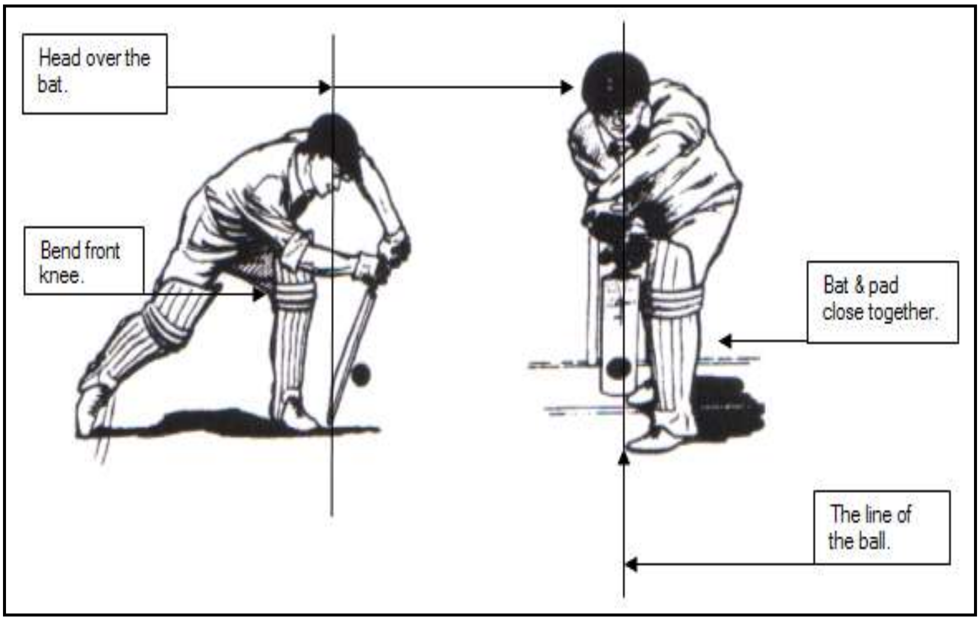


Fig.1-Pictorial representation showing need for head, arm & knee movements to play a shot

With the introduction of some technologies in cricket a new angle of entertainment is available to players and spectators. It has indeed resulted in improving their performance and their fitness. Although trainers are required to coach a player it is necessary to keenly observe his small mistakes. Training centres still lack any technical support hence training is done with the help pf naked eye. Hence the advent of technology for training centres would be highly useful in order to train players with ease and to measure their performance accurately at low cost is required[1].

II. Basic Block Diagram

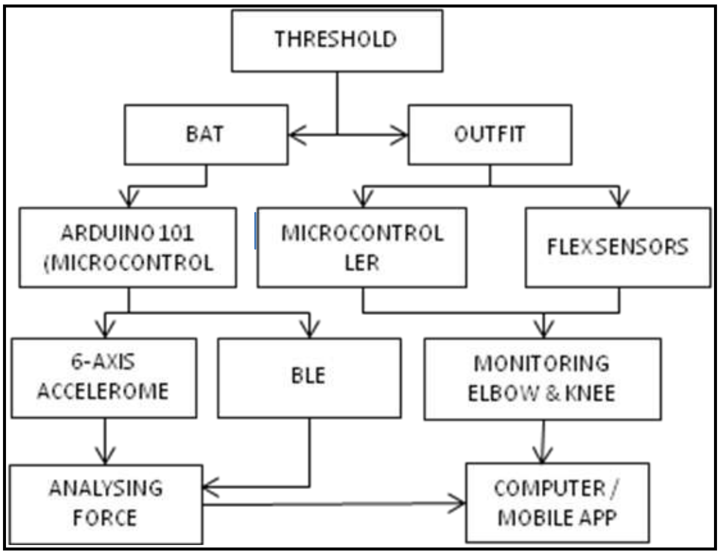


Fig2: Block Diagram

The block diagram of Smart system is shown in Fig.1. The first objective of our project is to determine the acceleration and angular movements using the 6-axis accelerometer BMI160 and using the formula to calculate average acceleration. Flex sensors are used for measuring the flexibilities of knee and elbow joints for proper footwork and wrist movements. BLE is the wireless transmission device for transmitting data to the mobile through an app for easy interpretation and easy monitoring.

III. Components Description

A. Accelerometer BMI160

The BMI160 that is a small, low noise, low power 16-bit inertial measurement unit designed for use in variety of applications like augmented reality or indoor navigation which require highly accurate and real-time sensor data.

In full operation mode, with the accelerometer and gyroscope enabled, the current consumption is typically 950 μA, enabling applications in battery driven devices. It is available in a compact 14-pin 2.5 x 3.0 x 0.8 mm^3 LGA package[2].

B. Arduino/Genuino 101

Fig.4: Schematic diagram

Genuino 101 is the microcontroller used for the project. It is similar to Arduino UNO. The Arduino UNO uses an Atmel ATmega328P module while the Genuino 101 uses a low-power Intel® Curie™module powered by the Intel® Quark™ SE SoC. It is a learning and development board that is a low-power consumption of the Intel® Curie™ Module with the simplicity of Arduino and delivers high speed processing. It has the same form and peripherals as that of the UNO but with the addition of on-board Bluetooth LE capabilities and a 6-axis accelerometer/gyro to help to easily expand our creativity into the connected world.

The module contains two tiny cores, 32-bit ARC architecture core, both clocked at 32MHz an x86 (Quark). The Intel toolchain compiles the Arduino sketches optimally across both cores to provide better performance. The Genuino 101 has 14 digital input/output pins (of which 4 can be used as PWM outputs), 6 analog inputs, same as that of UNO, a USB connector for serial communication and sketch upload, a power jack, an ICSP header with SPI signals and I2C dedicated pins. The board operating voltage and I/O is 3.3V but all pins are protected against 5V overvoltage. The Arduino 101 (USA only) and the Genuino 101 (outside USA) has been designed in collaboration with Intel®.

C. Flex Sensor

This flex sensor is a variable resistor. The resistance of the flex sensor increases as the body of the component bends. One side or both sides of the sensor is printed with a polymer ink that has conductive particles embedded in it. When remaining flat these sensors will have resistance value in the range of 30kΩ. As it is bent, the resistance between the two terminals will vary from to resistance range of 70kΩ at a 90° angle. By combining the flex sensor with a static resistor a voltage divider can be developed as a result variable voltage can be obtained and using a analog-to-digital converter it can be processed using a microcontroller[4].

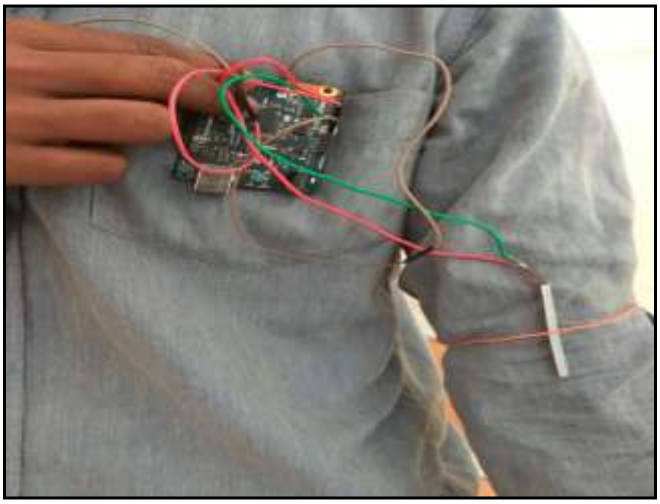


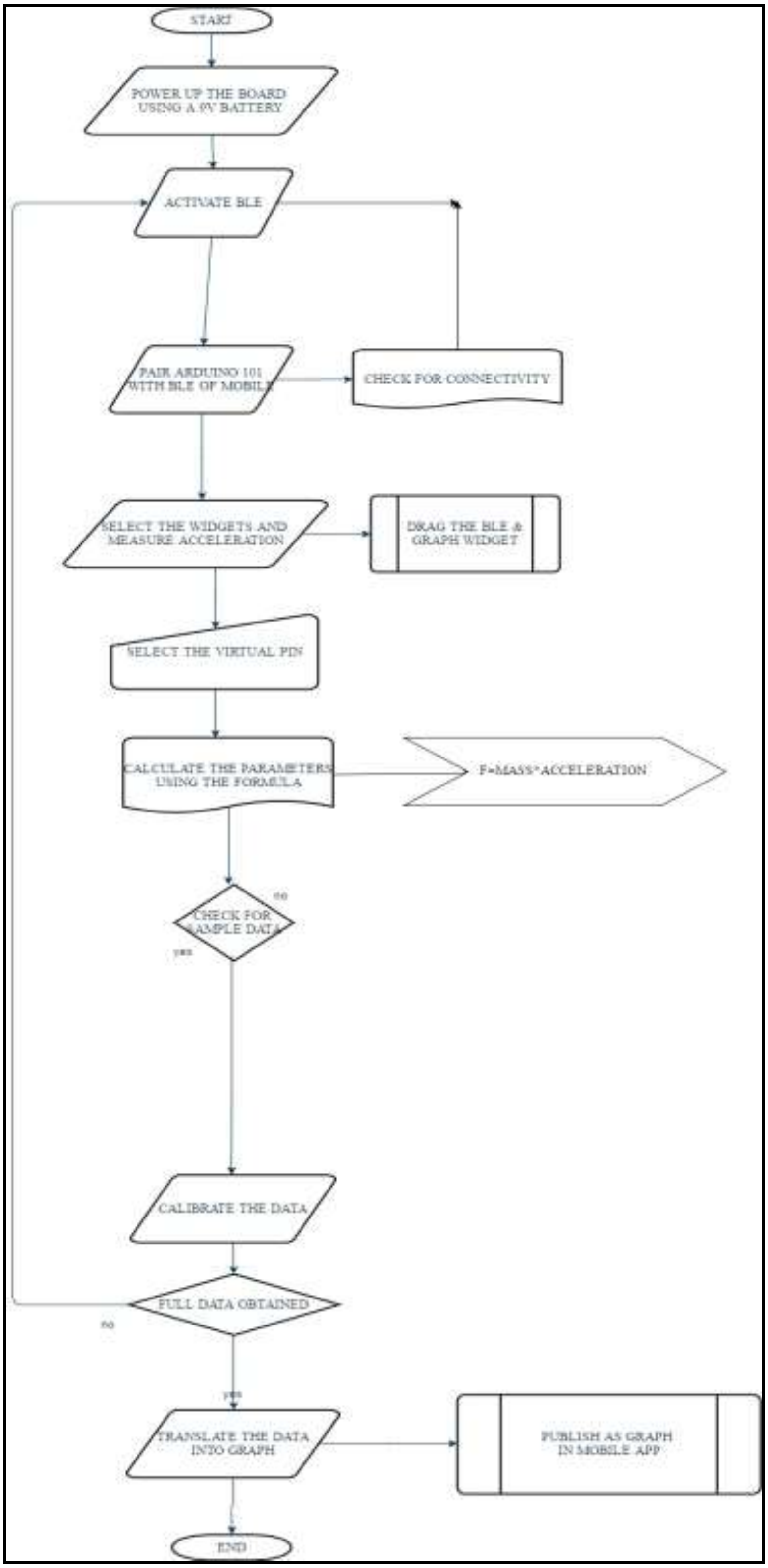
Fig.6: Flex sensor fitted in the joints

D. Bluetooth Low Energy

Bluetooth low energy (Bluetooth) is a wireless personal area network protocol that was designed by the Bluetooth Special Interest Group aimed that finds its application in the healthcare, fitness, beacons, security, and home entertainment industries. Bluetooth is intended to provide considerably reduced power consumption and cost and also further distant communication range. Moreover it is estimated that by the end of 2018 almost all electronic devices would be incorporated with BLE functionality.

The nRF51822 is a powerful, highly flexible multiprotocol SoC ideally suited for *Bluetooth®* low energy and 2.4GHz ultra low-power wireless applications. The nRF51822 is built around a 32-bit ARM® Cortex™ M0 CPU with 256kB/128kB flash + 32kB/16kB RAM for improved application performance. The embedded 2.4GHz transceiver supports both Bluetooth low energy and the Nordic Gazell 2.4 GHz protocol stack which is on air compatible with the nRF24L series products from Nordic Semiconductor.

III. Flowchart Indicating App Display From Arduino 101



The above flowchart indicates the data transfer from the accelerometer to the mobile app through microcontroller and BLE. Once the board is powered up and the program is uploaded through an USB cable the program gets stored in the ROM that cannot be changed by external events until the program memory is cleared. Then the board can be placed on the bat and can be powered up by using a battery and the data could be viewed through the app.

Fig.8: Sample APP display

IV. **Prototype**

Fig.9: Prototype for analysis & Integration of sensors in bat

As shown in fig.9 the sensors (6-axis accelerometer, microcontroller & BLE) are fixed to the backside of the bat such that they move in accordance with the bat movements both linearly and angularly so that the required acceleration and ball impact can be found out very precisely.

V.Analysis

For a batsman to play a perfect shot the importance of bat movements and footwork are necessary. Analysis of various parameters such as acceleration, force, angular movements of bat, ball contact, joint movements of players has been analysed. By finding out the average acceleration from the raw acceleration data produced in the accelerometer force can be easily calculated.

Avg.acceleration, A=sq.rt((Ax^2)+(Ay^2)+(Az^2))

Where, Ax=acceleration along x-axis
Ay=acceleration along y-axis
Az=acceleration along z-axis

F=m*A

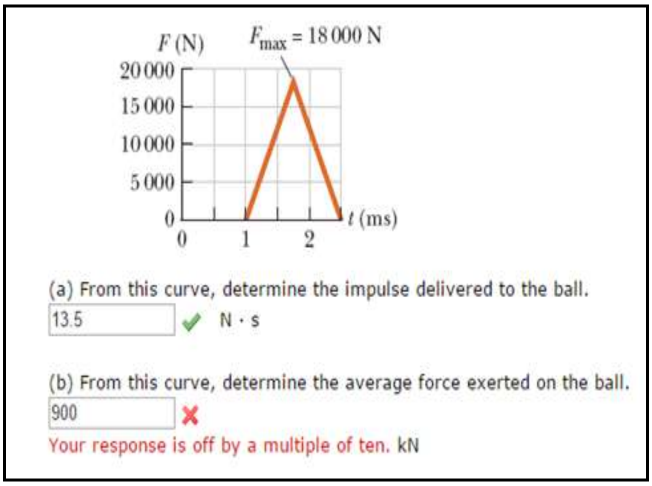


Fig.10: Impulse response when ball is in contact

Fig.11: Graph indicating ball being middle by bat

Fig.12: Graph indicating ball being edged by bat

From the Fig. 11 & 12 we can differentiate the types of impulses during middling the ball & edging the ball. The sudden peaks indicate ball contact and the highest amplitude indicate the force imparted by the bat.

The interpretation of gyroscopic values from the BMI160 module and its conversion into a similar pictorial representation. Gyroscopic values often can be represented as three dimensional values from gyroscopic sensor. Since BMI160 is a 6-axis sensor, it can provide 3-axis accelerometer as well as 3-axis gyroscopic output[6].

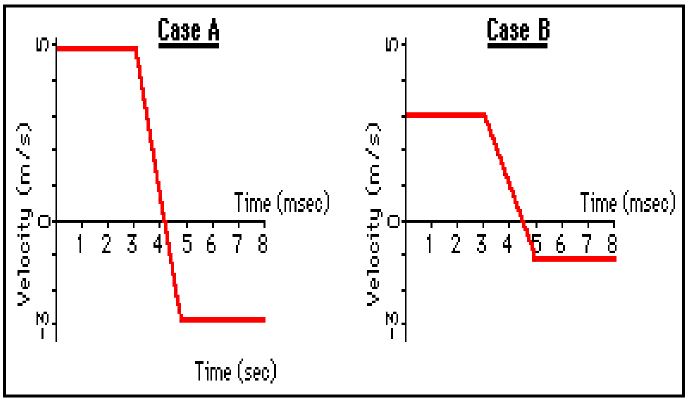


Fig12: Graphs indicating different impulses

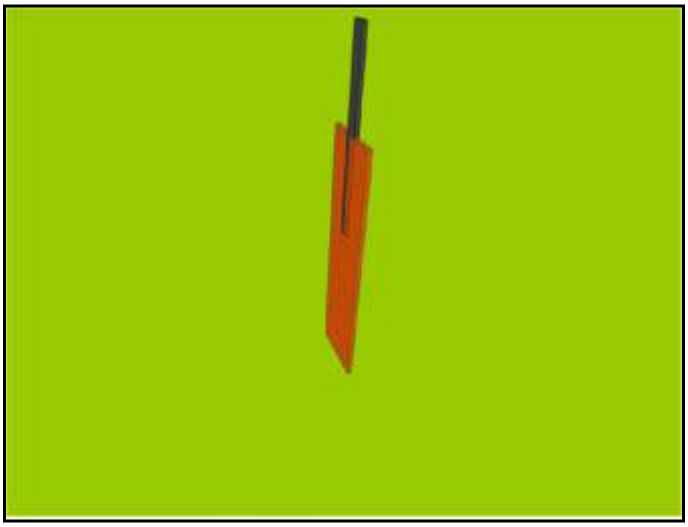


Fig.13: Pictorial representing image of bat

This pictorial representation of the gyroscopic values as shown in Fig.13 can be interpreted with that of acceleration output so that the trainer can visualize and can train the necessary shot required for the player to be performed[7]. For a perfect shot to be played the angle of the bat is very important as it determines the force and several other parameters also. Hence during the acceleration analysis the app will provide with acceleration details of the bat along with that of angular movements to interpret very accurately.

VI. Comparison of Different Parameters of Players

Parameters such as force, acceleration, footwork are necessary for batsman and it varies from one player to another one. Some batsman may prefer to impart force on the ball irrespective of the speed and swing of the ball[8]. They may not get preferred shot selection and may get out easily. But players who prefer lighter stance, rely heavily on the footwork mostly depend on imparting little amount of force to the ball and the ball timing so that they can get preferred shots at ease without losing their wicket[9].

Name Of The Batsman	Favourite Shot	Force Imparted	Ball Timing	Foot Work	Flex Value Of Fore Hand
Sachin Tendulkar	Straight Drive	20n	90%	95%	57k
Brian Lara	Straight Down The Ground	30n	85%	90%	58k
M.S.Dhoni	Helicopter Shot	80n	60%	60%	47k
Virender Sehwag	Upper Cut	45n	70%	20%	53k
Sourav Ganguly	Cover Drive	35n	75%	70%	55k
Adam Gilchrist	Hook Shot	40n	80%	65%	62k
Rahul Dravid	Leg Glance	15n	90%	85%	40k

VII. Conclusion

This paper proposes a method for low cost easy monitoring of the players performance using 6-axis sensors and flex sensors for easy interpretation of bat acceleration and angular movements so as to find the force, ball timing and ball impact on the bat and flex sensors are used to determine the wrist acceleration and footwork as it eliminates not only the availability of high cost cameras for precision training but also provides the platform for the trainer to train player with ease as those data would be sent to their mobile app for easier interpretation. The future scope of this method also leads to virtual reality training so that players do not need huge area for practice and can practice even in given small amount of space[10].

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