LASER-BASED AUTOMATIC RUN TIMING DEVICE

A PROJECT REPORT

Submitted to

The Inspector General of Police

Tamil Nadu Uniform Services Recruitment Board (TNUSRB)

Chennai - 600008

ABSTRACT

Run Timing system is a system employed for the purpose of measuring the time taken by athletes in running sports events. The existing systems require a manual operator for monitoring and recording the run time taken by each athlete. Hence the existing transponder timing system suffers because of the requirement of constant human intervention and support which is error-prone. The proposed Laser-based Automatic Run timing system is primarily deployed for the purpose of observing, collecting and then recording the run time of a participant in a running race in an ordered sequence. The entire procedure of monitoring and recording the running time are comprehensively automated and hence requires minimal system-human interaction. The data collection is triggered as soon as the start signal for the running race is triggered. In any competitive running race, if a person starts before the initial trigger, the existing systems fail to capture this aberration. But in the proposed system, when any participant starts running before the start signal is triggered, a false start will be identified and the evaluation process as a whole will be halted. After the participants start the race without any false start, the system records the time taken individually by each individual to complete the race. This response is analyzed by the system and the collective output is sent to the laptop for visual representation.

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CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

Chapter 1 introduces the terms and concepts used to develop the proposed laser-based run timing automation system. The system proposed to develop aims to be an automated system that can be used for monitoring and tracking athlete's performance during events such as running race.The proposed system incorporates various hardware components such as Arduino mega, Laser, LDR and Xbee in order to record the time taken by an athlete to complete a race instantaneously without human interference.

1.2 TRACKING SYSTEM

A tracking system is primarily deployed for the purpose of observing a person or an object and then collecting and recording the desired parameters from their behavior in a timely ordered sequence which is later used for further processing. The data collection is triggered as soon as when an event or anomaly occurs. Tracking systems vary either based on the purpose of usage or by the components with which they are designed. Few applications of tracking system include Athlete-performance tracking systems, Global positioning based tracking system, Warehouse management systems, Satellite Tracker and Automobile Tracking system. Each system is used for a different purpose with vivid software and underlying hardware combinations. We mainly focus on the Athlete based tracking system that is intended for the purpose of tracking and recording the time taken by an athlete to complete a running race or marathon accurately by eliminating human intervention.

1.3 ATHLETE-PERFORMANCE TRACKING SYSTEM

Athlete performance tracking system is a tracking system that is mainly used for purposes such as police or army personnel recruitment, athletics or any other sport to empirically estimate the time taken by an athlete to complete a race or marathon. This value extrapolated can then be later used for comparing the performance in juxtaposition with that of other athletes performance. Over the years several approaches have been proposed to accurately determine the exact time taken with precision by reducing error that may happen due to several factors like false starts, endpoint time dilation. In order to combat these errors, we consider few main approaches to instantaneously record and analyze the run time of athletes.

1. Camera-based tracking system
2. RFID based tracking system
3. Goal line technology-based system
4. GPS based tracking system
5. Laser-based tracking system

1.3.1 CAMERA BASED TRACKING SYSTEM

A camera-based tracking system in athletics involves motion capture and analysis techniques in order to interpret whether a certain event has occurred or not like whether if an athlete has crossed the finish line successfully or has started running before the initial start signal has been triggered. The cameras used for this system include high-speed photo finish cameras that are extremely costly and require costly hardware and software analysis purposes. The high expense of the components is because of the precision with which they can provide the result. This system typically involves two parts: Motion Capture and Motion Analysis.

Motion capture is the way of recording the locomotion of objects or individuals. It is utilized as a part of the military, amusement, sports, therapeutic applications, and for approval of Computer vision and mechanical technology. In filmmaking and computer game advancement, it alludes to recording activities of human performing artists and utilizing that data to invigorate computerized character models in 2D or 3D computer movement. When it incorporates face and fingers or catches unpretentious scenes, it is frequently alluded to as execution catch. In many fields, movement catch is once in a while called match moving, yet in filmmaking and recreations, a movement following, as a rule, alludes more to coordinate moving.

In movement catch sessions, locomotion of at least one individual is examined frequently. While early methods utilized pictures from numerous cameras to figure 3D positions, regularly the reason for movement catch is to record just the developments of the performing artist, not his or her visual characteristics. After capturing a motion, it is now indispensable to perform analysis over it.

Motion Analysis is utilized as a part of picture processing, rapid photography and machine vision that reviews strategies and applications in which at least two back to back pictures from a picture in successions, e.g., created by a camcorder or fast camera, are prepared to deliver data in light of the obvious movement in the pictures. In a few applications, the camera is settled with respect to the scene and items are moving around in the scene, in a few applications the scene is pretty much settled and the camera is moving, and sometimes both the camera and the scene are moving.

A video can be considered as an approximation of a pinhole camera, which implies that each point in the picture is lit up by a few point in the scene before the camera, more often than not by methods for light that the scene point reflects from a light source. Each obvious point in the scene is anticipated along with a straight line that goes through camera gap and converges in the picture plane.

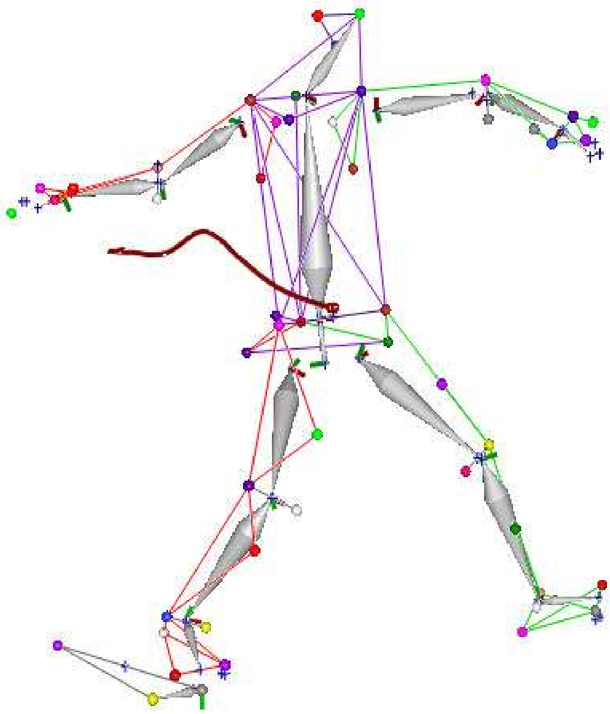

Fig 1.1 MOTION AND FEATURE POINTS CAPTURE

This implies at a particular point in time, each point in the picture alludes to a particular point in the scene. This scene point has a position with respect to the camera, and if this relative position transforms, it compares to a relative movement in 3D. It is a relative movement since it doesn't make a difference on the off chance that it is the scene point, or the camera, or both, that are moving. It is just when there is an adjustment in the relative position that the camera can recognize that some movement has happened. By anticipating the relative 3D movement of every unmistakable point once more into the picture, the outcome is the movement field, portraying the obvious movement of each picture point as far as a size and bearing of the speed of that point in the picture plane. A result of this perception is that if the relative 3D movement of some scene focuses is along their projection lines, the comparing clear movement is zero.

The movement examination preparing can in the least difficult case be to distinguish movement, i.e., discover the focuses in the picture where something is moving. More mind-boggling sorts of preparing can be to track a particular object in the picture after some time, to gather indicates that have a place the same unbending item that is moving in the scene or to decide the size and course of the movement of each point in the picture. The data that is delivered is regularly identified with a particular picture in the grouping, comparing to a particular time-point, yet then depends additionally on the neighboring pictures. This implies movement examination can create time-dependent data about movement.

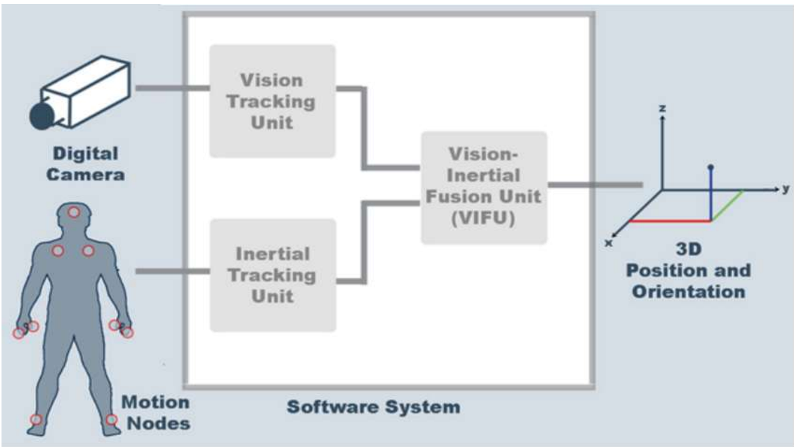

Fig 1.2 MOTION ANALYSIS

Though camera-based tracking system has several advantages such as the permanent recording of events and high precision analysis, it suffers from a variety of drawbacks. The system as a whole is extremely costly and requires extensive care while setting and maintenance. The system is static that is, it is not easy to frequently displace the system. The system requires complex software to process and it is not volatile in nature. It connotes that the system does not support frequent re-configurations. Another main disadvantage of the system is that it also takes a lot of time to process and analyze the video footages. Hence in a real-time dynamic environment such as police personnel recruitment where immediate and instantaneous results are required, the system becomes useless and inefficient. The system also fails when the lighting is low. Hence it cannot be used in scenarios involving non-luminous milieu.

1.3.2 RFID BASED TRACKING SYSTEM

Radio-frequency identification (RFID) is an innovation to record the nearness of a protest utilizing radio signs. It is utilized for stock control or timing brandishing occasions. RFID isn't a substitution for the barcoding, however a supplement for far-of recognition of codes. The innovation is utilized for consequently recognizing a man, a bundle or a thing. To do this, it depends on RFID labels. These are little transponders (radio receiver and transmitter) that will transmit character data over a short separation when inquired. The other piece to make utilization of RFID labels is an RFID label reader.

An RFID tag is an object that can be connected to or joined into an item, creature, or individual with the end goal of recognizable proof and following utilizing radio waves. A few labels can be perused from a few meters away and past the viewable pathway of the reader. Most labels convey a plain content engraving and a standardized identification as supplements for coordinate perusing and for instances of any disappointment of radio recurrence gadgets.

Most RFID labels contain no less than two sections. One is an incorporated circuit for putting away and handling data, regulating and de-balancing a radio-recurrence (RF) flag, and other particular capacities. The second is a radio wire for accepting and transmitting the flag.

There are by and large two sorts of RFID labels: Dynamic RFID labels, which contain a battery, and Inactive RFID labels, which have no battery.

Radio-frequency recognizable proof (RFID) utilizes electromagnetic fields to naturally distinguish and track labels connected to objects. The labels contain electronically put away data. Aloof labels gather vitality from a close-by RFID reader's questioning radio waves. Dynamic labels have a nearby power source, (for example, a battery) and may work several meters from the RFID reader. Not at all like a standardized tag, the label requires not be inside the observable pathway of the reader, so it might be inserted in the followed protest. RFID is one strategy for Automatic Identification and Data Capture (AIDC).

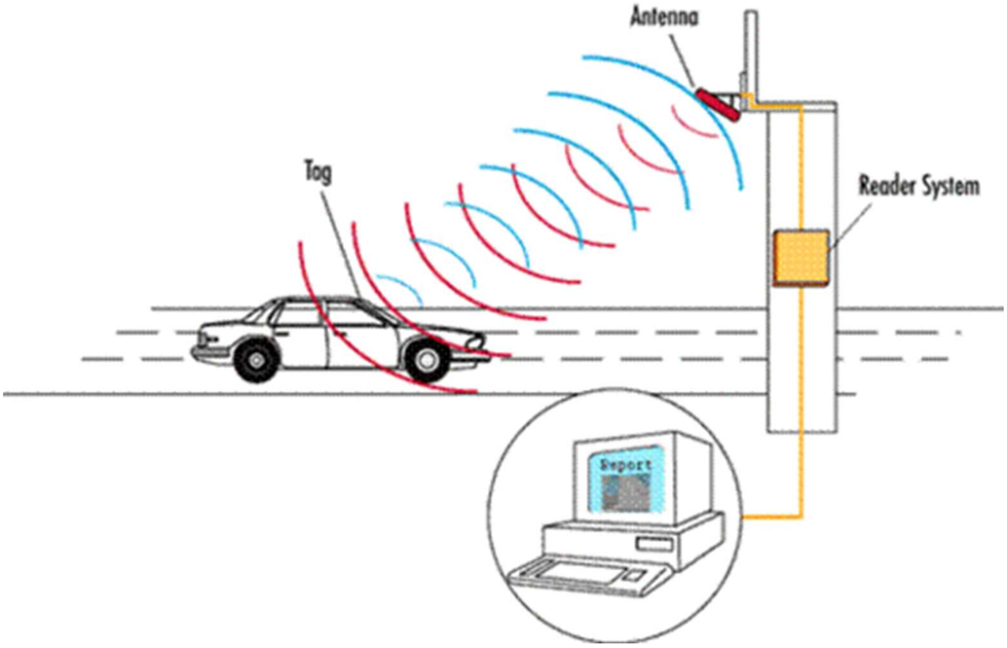

Fig 1.3 RFID BASED DETECTION SYSTEM

RFID labels are utilized as a part of numerous businesses, for instance, an RFID label joined to a car amid creation can be utilized to keep tabs on its development through the sequential construction system; RFID-labeled pharmaceuticals can be followed through distribution centers and embedding RFID microchips in domesticated animals and pets takes into account positive recognizable proof of creatures.

The RFID system makes use of the RFID tags and their corresponding readers for athlete tracking. In the start line, the system ensures that the tags of all the participants are within the RFID reader region before the initial trigger is enabled. On the verge of completion of the race, the order in which the participants reach the end line is determined by the extent and the order in which the RFID tags are read by the End Line RFID reader. This ensures that the system as a whole can comparatively be certain regarding the performance of the athletes.

Though RFID based tracking system has several advantages such as comparison based precision analysis and flexible architecture it suffers from a variety of drawbacks. The system as a whole is extremely costly and requires extensive care while setting and maintenance. This is because the system requires a minimum of two RFID readers and numerous RFID tags. Though the RFID tags are inexpensive, the RFID readers are extremely expensive and require a huge investment. Every time the system is set up, we need to reconfigure the software based on the reader and tags. Being electronic in nature, the system is prone to failure when exposed to extreme weathers like rain, storm and excessive heat. The system requires complex software to process and it is not volatile in nature. It implicates that the system does not support frequent re-configurations. The system also doesn't provide an accurate description about the performance rather provides a relative response. The system also fails when the vicinity of two athletes are extremely high. Hence in a real-time dynamic environment such as police personnel recruitment which doesn't tolerate such inaccurate results the system becomes ineffective. The system also fails under extreme weather conditions.

1.3.3 GOAL LINE TECHNOLOGY BASED SYSTEM

Goal-line technology is an electronic technology that was initially designed in the field of football first. Goal-line Technology (in some cases alluded to as a Goal Decision System) is a strategy used to decide when the football has totally crossed the objective line in the middle of the posts and underneath the crossbar with the help of electronic gadgets and in the meantime helping the official in deciding an outcome or not. The goal of Goal Line

Technology (GLT) is to help them in their basic leadership. The GLT must give a reasonable sign in the matter of whether the ball has completely gone too far, and this data will serve to help the official in settling on his ultimate choice.

This technique can be similarly applied to check whether a running athlete has crossed the finish line and the exact time that he has crossed the line can also be easily identified.

Another wave of innovation depends not on cameras but on an attractive field of wires introduced underneath the objective territory. With the GLT framework, a sensor is set inside the ball that can distinguish the attractive field made by a progression of wires running underneath the penalty box. The sensor communicates with a computer program to track the ball's area and when it crosses the objective line. Another program utilizes a comparable attractive field yet utilizes sensors in the objective casing rather than the ball to decide a ball's area inside the objective. Objective line innovation expects to make football a more target game and is by all accounts having great achievement up until this point. With most frameworks, the choice, at last, comes down to the official to decide if an objective has been scored. Much of the time, refs get an encoded alarm on their watches inside a moment of the objective line being crossed.

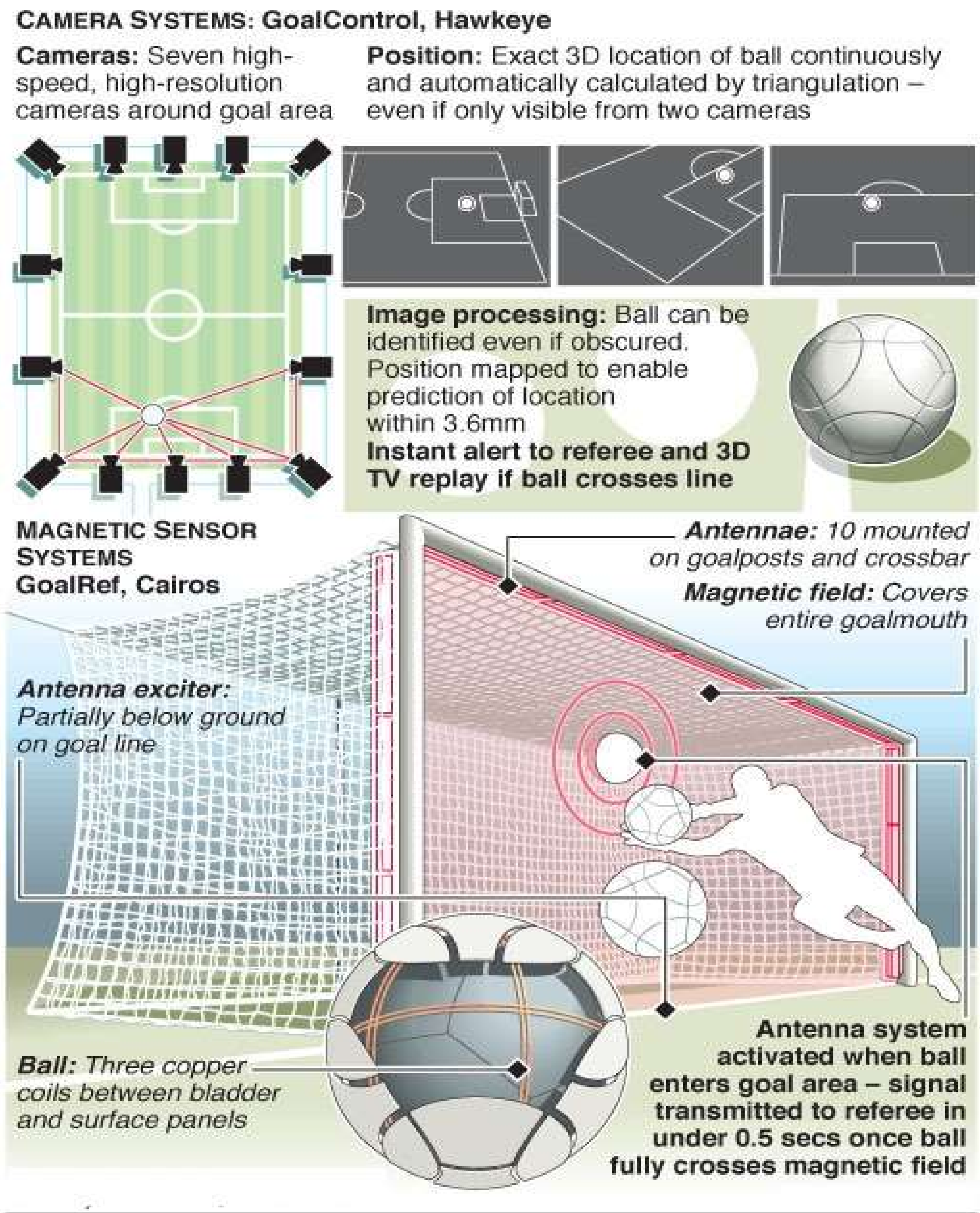

Fig 1.4 GOAL LINE TECHNOLOGY BASED SYSTEM

Though this technique might resemble that of the RFID based tracking system it varies considerably in a variety of aspects. First of all, the RFID system supports n users based on the number of RFID tags that resonates the reader.

But when we consider the GLT system, we can simply identify the individuality of every existing user regarding the order in which the athletes reach the finish line. Hence GLT is more suitable for single track running courses while RFID supports multi-track. GLT uses an electromagnetic field to interact with the athlete while the corresponding RFID system uses radio frequencies. It is glaringly patent that the radio frequency is extremely unstable in comparison with the powerful electromagnetic field. Hence the accuracy of GLT system will be higher than that of RFID system. Also, the initial setup cost of GLT is as high as RFID system. But the maintenance costs are very low. The system circuit is the only liability that must be carefully considered.

Even though GLT system possesses a variety of useful advantages like the stable system, high precision it lags in certain areas that prove to be fatal. These areas include the type of the track system used by the athlete. In a single user track, the GLT works the best in all possible way. But the system fails terribly in scenarios when multiple users run concurrently.

The system lacks the capacity to distinguish the idiosyncrasy between athletes and hence rendered useless in recruitment procedures where multiple participants run at once. The system also suffers from extreme weather conditions due to the electronic components that can easily be damaged by water, heat and other atmospheric conditions. Hence, conclusively, it is useless for real-time scenarios.

1.3.4 GPS BASED TRACKING SYSTEM

The GPS based tracking system is mainly used in large-scale races such as that of marathons. This system has the sole purpose of using the satellites to receive the global position of participants by some kind of tracker. The system requires persistent internet connectivity in order to transmit and receive the geosynchronous location of the participants. Systems in view of Global positioning services (GPS) are utilized as a part of practices and recovery by an extensive variety of groups over every single significant object.

The saddle that the participants wear holds a gadget containing a GPS chip, alongside extra parts like accelerometers, gyrators, and magnetometers, to track how and where a competitor moves. The GPS gadget is regularly matched with a heart rate screen, enabling the framework to appraise effort. In any case, checking organizations say that they aren't intended to give enough data to precisely track an athlete's performance during training.

1.3.5 LASER-BASED TRACKING SYSTEM

The laser-based tracking system is one of the tracking system used in the field of athletics in order to record the performance of the participants. A Laser-LDR system is set at both the start and finish lines such that the variation in the voltage in LDR due to abrupt luminous fluctuations will help the system to immediately record the response. This system is far superior when compared to other systems in a variety of aspects. The Laser and LDR components are cheaper in comparison to other components of the previous systems such as RFID Readers, Photo Finish cameras, and even the Electro-magnetic circuitry. Hence the system is highly volatile and flexible.

A Photo resistor (or light-dependent resistor, LDR, or photoconductive cell) is a light-controlled variable resistor. The protection of a photoresistor diminishes with expanding occurrence light force; as it were, it shows photoconductivity. A photoresistor can be connected in light-touchy finder circuits, and light-initiated and dim enacted exchanging circuits.

A photoresistor is made of a high protection semiconductor. Oblivious, a photoresistor can have a protection as high as a few mega ohms while in the light, a photoresistor can have a protection as low as a couple of hundred ohms. On the off chance that episode light on a photoresistor surpasses a specific recurrence, photons consumed by the semiconductor give bound electrons enough vitality to bounce into the conduction band. The protection range and affectability of a photoresistor can significantly vary among disparate gadgets. Also, special photo resistors may respond significantly contrastingly to photons inside certain wavelength groups.

The setup of the system is fairly simple and hence reconfiguring the system is also easy. In times of disaster management, even if the entire system is destroyed by calamities, we can easily redesign the system. The Laser-based system provides the highest possible accurate readings because the speed of light is extremely high and hence even a small variation will be effectively reflected in the system. The system is also prone to very small error rates and hence highly stable.

The existing Laser-based systems deploy a horizontal approach in which the Laser and LDR face each other horizontally in the finish line. This means that when two participants run parallel together then the system might not be able to recognize that another participant has completed the race. The proposed system eliminates this flaw by introducing a vertically oriented approach in which each user is made to enter a vertical luminous tapestry such that any participant no matter what will always cut the light energy and the system is triggered by this action.

1.4 ORGANISATION OF THE REPORT

Chapter 1 gives a brief introduction to the concepts and techniques used. Chapter 2 describes the detailed design and architecture description of the proposed Laser-based Automatic Run timing system. Chapter 3 describes the environmental setup and installation details. Chapter 4 presents the conclusion and the future works.

1.5 CHAPTER SUMMARY

In this chapter, the overview of the various concepts and techniques currently existing in the field of athlete performance tracking system were discussed. The idiosyncrasy and purpose of various tracking system were also reviewed. In next chapter, the proposed run timing system architecture and its components will be elaborated in detail.

CHAPTER 2

LASER-BASED AUTOMATIC RUN TIMING DEVICE

2.1 INTRODUCTION

Laser-based automatic run timing device is a system that is developed mainly for the purpose of monitoring the exact time taken by the participants to complete a running race. A Laser-LDR system is set at both the start and finish lines such that the variation in the voltage in LDR due to abrupt luminous fluctuations will help the system to immediately record the response. This system is far superior when compared to other systems in a variety of aspects such as cost, stability, flexibility, and configurability.

2.2 OBJECTIVE

The objective of the system is split into several parts that must work in an ensemble. The primary objective is to detect false starts made by athletes at the beginning of the race.Further, we must determine the time taken by an athlete to complete track events like 100m, 200m& 400m. After that, the running time of each athlete with an accuracy of 1/1000th of a second must be displayed on a laptop.The objective is also to ensure that each participant's data is measured individually and precisely.

2.3 ARCHITECTURE

The architecture of the system comprises of various entities that must be designed and integrated together in order to effectively reach the desired throughput. A Laser and LDR module based Starting block is placed at the beginning of each track. Another Laser and LDR module based Finishing block is placed at the end of each track. A laptop with customised software is connected to all the starting and finishing blocks. The candidate takes a position at the start line which has Lasers and LDR modules fabricated.

Once the timer is set on a gunshot sound is produced, the candidate starts running, and when the candidate crosses the finishing point, Laser and LDR module detects the changes in the reading and ranks the members based on their lanes.

The above-mentioned model architecture is displayed in the Fig. 2.1

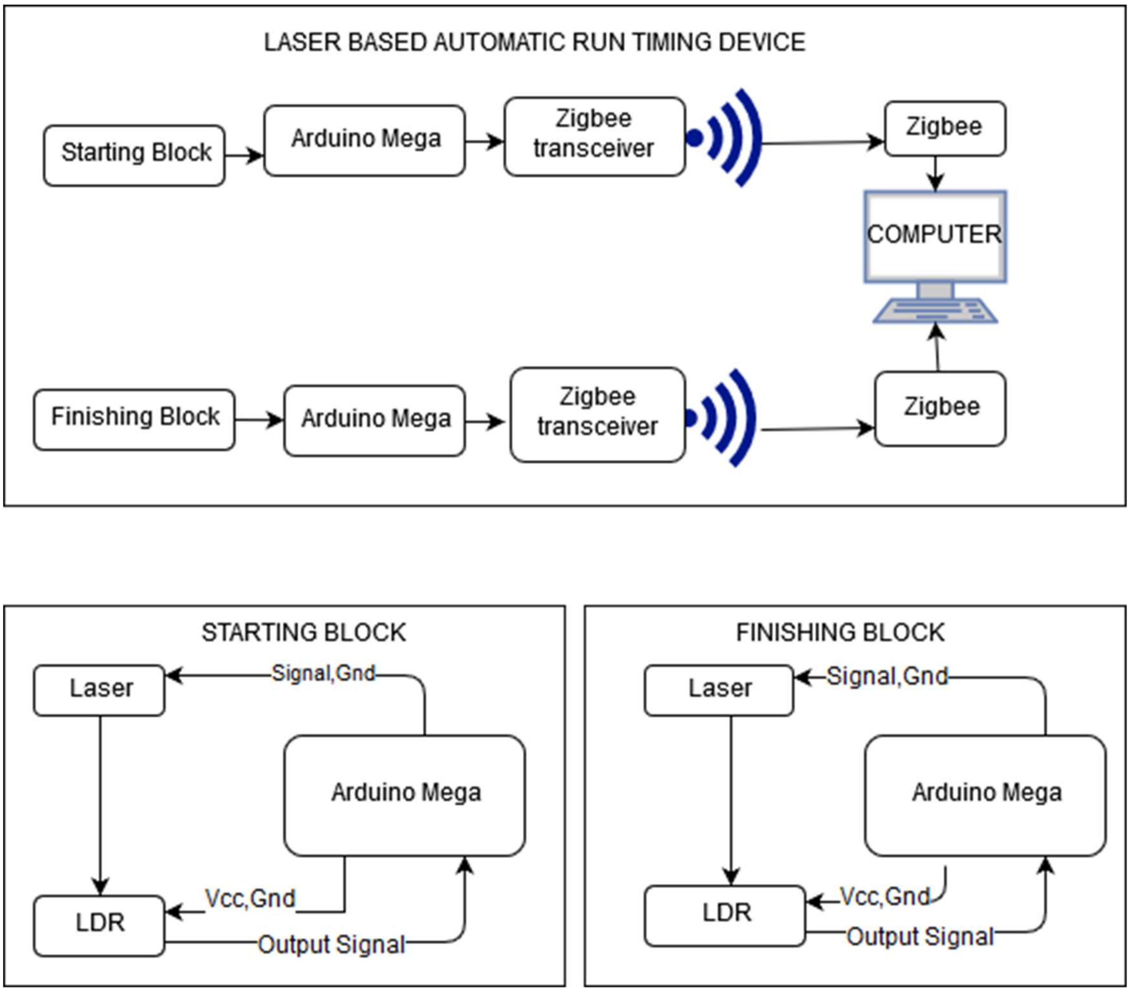

Fig 2.1 SYSTEM ARCHITECTURE

2.4 COMPONENTS USED

The system involves a variety of components that must be carefully designed and integrated in order to generate the desired output. The various components involved in the system are listed as follows.

1. Arduino Mega 2560
2. Xbee and its connecting module

3. Laser module for Arduino
4. LDR module for Arduino
5. Power Bank
6. Connecting Wires and Jumping wires
7. Spike box
8. USB A-B cables
9. Mini USB cable
10. Breadboards(PCB)
11. 3D printed materials
12. L-Clamp

2.5 MODULES

2.5.1 ARDUINO MEGA

Arduino is a computer hardware and software company, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself kits. The pin configuration of Arduino Mega is shown in the Fig.2.2.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using the programming languages C and C++. The Arduino project provides an integrated development environment (IDE) based on the Processing language project. The Arduino Mega is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins, a power jack, 4 UARTs (hardware serial ports), a USB connection,16 analog inputs, an ICSP header, a 16 MHz crystal oscillator, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

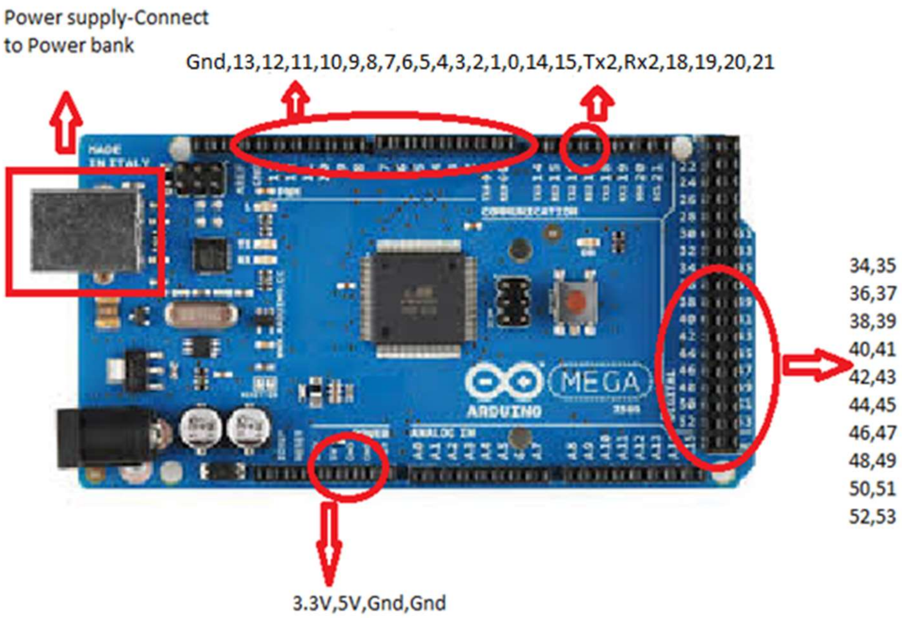

Fig 2.2 ARDUINO MEGA BOARD

2.5.2 ZIGBEE

Zigbee is an IEEE 802.15.4-based specification for a suite of high-level communication protocols used to create personal area networks with small, low-power digital radios, such as for home automation, medical device data collection, and other low-power low-bandwidth needs, designed for small-scale projects which need a wireless connection. Hence, Zigbee is a low-power, low data rate, and close proximity (i.e., personal area) wireless ad-hoc network.

The technology defined by the Zigbee specification is intended to be simpler and less expensive than other wireless personal area networks (WPANs), such as Bluetooth or more general wireless networking such as Wi-Fi. Applications include wireless light switches, home energy monitors, traffic management systems, and other consumer and industrial equipment that requires short-range low-rate wireless data transfer

2.5.3 LASER MODULE FOR ARDUINO

Laser transmitter module, 650 nm (red), gives an intense red beam. This laser emits Red colored light which travels in a linear fashion.

- Power consumption: 30 mA at 5 V

Pin layout

- Pin - = **GND**
- Pin + = **Positive pin not connected**
- Pin S = **+5V**

2.5.4 LDR MODULE FOR ARDUINO

An LDR (or light-dependent resistor, LDR, or photoconductive cell) is a light-controlled variable resistor. The resistance of an LDR decreases with increasing the light intensity; it exhibits photoconductivity. An LDR resistor can be used in light-sensitive detector circuits, and light- and dark-activated switching circuits. An LDR is made of a high resistance semiconductor. In the dark, an LDR can have a resistance as high as several mega ohms (MΩ), while in the light, an LDR can have a resistance as low as a few hundred ohms. If incident light on an LDR exceeds a certain frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electrons conduct electricity, thereby lowering resistance. The resistance range and sensitivity of an LDR can substantially differ among dissimilar

devices. Moreover, unique LDRs may react differently for different wavelength bands.
A photoelectric device can be either intrinsic or extrinsic. An intrinsic semiconductor has its own charge carriers and is not an efficient semiconductor, for example, silicon. In intrinsic devices, the only available electrons are in the valence band, and hence the photon must have enough energy to excite the electron across the entire bandgap. Extrinsic devices have impurities, also called dopants, and added whose ground state energy is closer to the conduction band; since the electrons do not have as far to jump, lower energy photons (that is, longer wavelengths and lower frequencies) are sufficient to trigger the device. If a sample of silicon has some of its atoms replaced by phosphorus atoms (impurities), there will be extra electrons available for conduction. This is an example of an extrinsic semiconductor.

The LDR module has two light emitters, one for Power supply and other for the output from the LDR.

Pin layout

- Pin - = **GND**
- Pin O = **Output pin**
- Pin S = **+5V**

2.5.5 POWERBANK

Powerbanks are used for charging smartphones and mobile tablet devices. A powerbank- a portable device can supply power from its built-in batteries through a USB port. They recharge with USB power supply. Technically, a powerbank consists of rechargeable Lithium-ion or Lithium-Polymer batteries installed in a protective casing, guided by a printed circuit board (PCB) which provides various protective and safety measures. The Powerbanks are used to supply power to the Arduino.

2.5.6 3D PRINTED MATERIAL

The boxes and other enclosures are 3D printed. The 3D printed materials ensure security protects LDR from sunlight.

2.6 CHAPTER SUMMARY

In this chapter, the overall architecture of the proposed Laser-based automatic run timing system and its components are explained. The six modules of the system are enunciated and the architectural descriptions are explained. In next chapter, the environmental setup and the installation details along with the implementation details will be discussed.

CHAPTER 3

ENVIRONMENTAL SETUP

3.1 INTRODUCTION

Chapter 3 discusses the environmental setup and installation details of the proposed laser-based automatic run timing device. It describes various tools, approaches and the software requirements used to successfully run the system along with the screenshot of the installation windows.

3.2 STARTING BLOCK

A pair of Laser – LDR (fabricated with L-clamp) must be placed in each track as shown in Fig.3.1a and Fig.3.1b. The Laser-LDR is kept 1.2m away from each other. Before the start of the race, we have to check if the Laser exactly falls on the LDR. Make sure that the Laser light falls on the Athlete’s arm at the starting position. After the start of the race, the Laser affecting LDR’s output denotes False start.

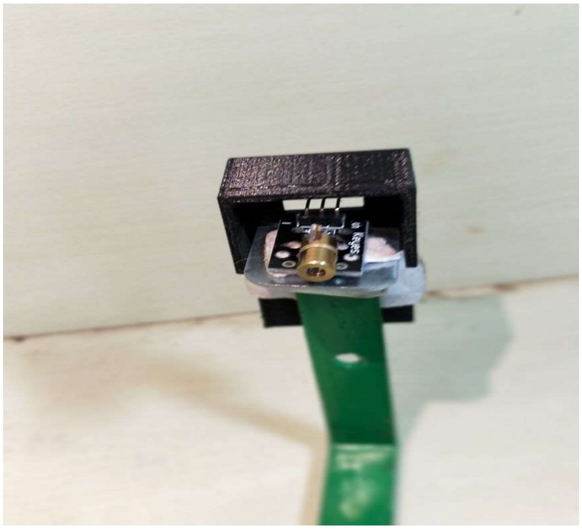

Fig. 3.1a Laser in the Starting point

Fig. 3.1b LDR in the Starting point

3.3 FINISH LINE

For 1 Track system, the Laser and LDR must be placed as shown in the Fig. 3.2. This is a Virtual picture for a single track. A Long pole of 8ft height is present. The Lasers are placed at the top of the pole 0.3m from each end. The Laser is projected downwards at an angle 69.5°. The LDR which are present inside the box are placed at the two ends of each track in such a way that the laser light enters the Laser box and falls on the LDR. Both the Laser and LDR are connected to the Arduino Mega.

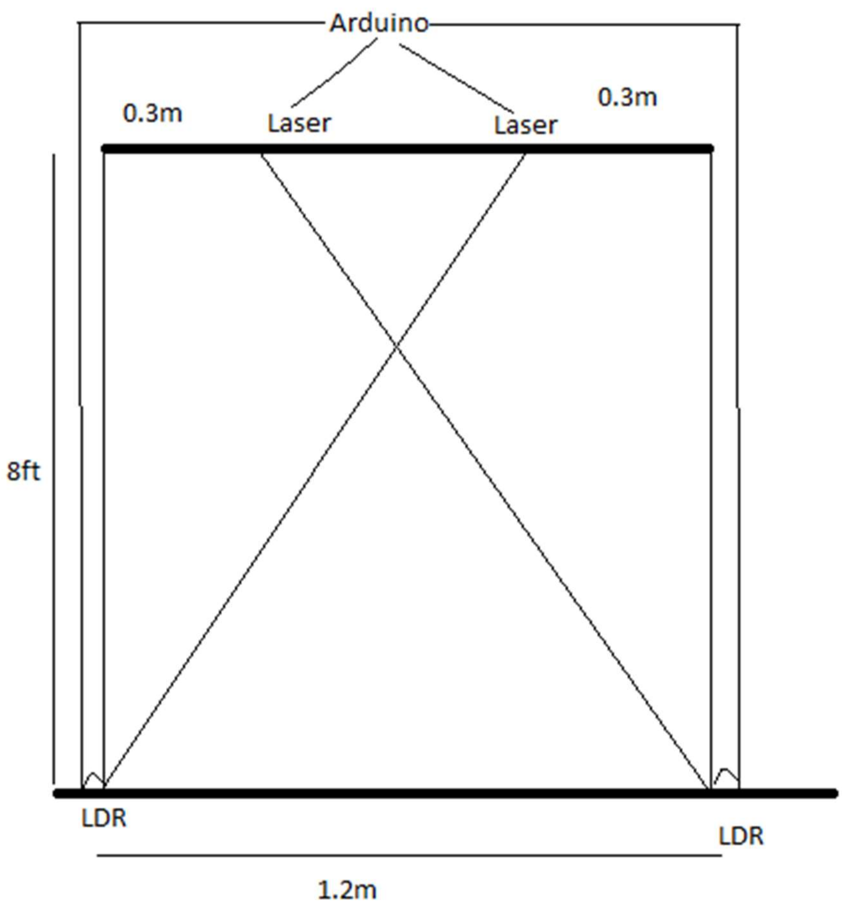

Fig 3.2 FINISHING LINE

3.4 MECHANISM

FALSE START DETECTION

APPROACH 1

The Pressure sensors/ Piezoelectric sensors are generally used to detect the False start in a Track event. These sensors are fabricated into the starting block. As the Starting block is not going to be used, the consistency of the Piezo sensor was tested under various scenarios in the absence of Starting block. The Piezoelectric sensor did not consistently detect pressure differences for every trial.

APPROACH 2

According to the observation made regarding the false starts, the athlete raises his hands simultaneously along with his/her back foot. So a set of Laser - LDR (Light dependent resistor) module is set for each track to identify false starts.

RUN TIME DETECTION

APPROACH 1

Usually, the Digital cameras with high precision are used to automatically stop the timer. The Time is calculated by Photo finish. As the image processing algorithms are deployed, the processing capacity of the Processing unit of the camera is to be very high. But as we tested using Raspberry pi and its Camera module (low cost), there is a latency of 1.2 - 4 seconds.

APPROACH 2

The set of Laser – Light Dependent Resistor (LDR) module is used at the Finish line of the track event. A pair of Laser–LDR module sets are placed in each track. The Laser is placed at the top of the pole facing downwards inclined at an angle of 69 degrees. The Light from Laser creates a virtual X shaped wall-like appearance. When the Athlete breaks the Circuit, the trigger is notified to the system. Accordingly, the run time is detected. The Lane in which the Athlete finishes first is identified and displayed.

3.5 WORKFLOW

The workflow of the software system is as follows:

The Athlete takes a position in his respective lane at the starting point. The position of the Athlete has to be in such a way that he must block the laser from falling on the LDR. The readings from the LDR are continuously monitored by the Python code through the pyserial. If the Athlete starts to run before the gun shot, then Laser will affect the LDR readings. So it is inferred as a false start. In case if it is not a false start, the Selenium driver opens the browser to start the timer. If the Athlete doesn't make a false start, then the timer runs unless there are any discrepancies caused by the finish line. At the finish line as the Athlete completes the race, the corresponding changes are inferred from the LDR. These readings are sent to the Arduino and in turn, the Python code splits the time based on the finish time of each athlete. The Starting point position is shown in Fig. 3.3a, after the start of the race the stopwatch starts as shown in Fig. 3.3b, as the athlete reaches finish line the stopwatch stops as shown in Fig. 3.3c

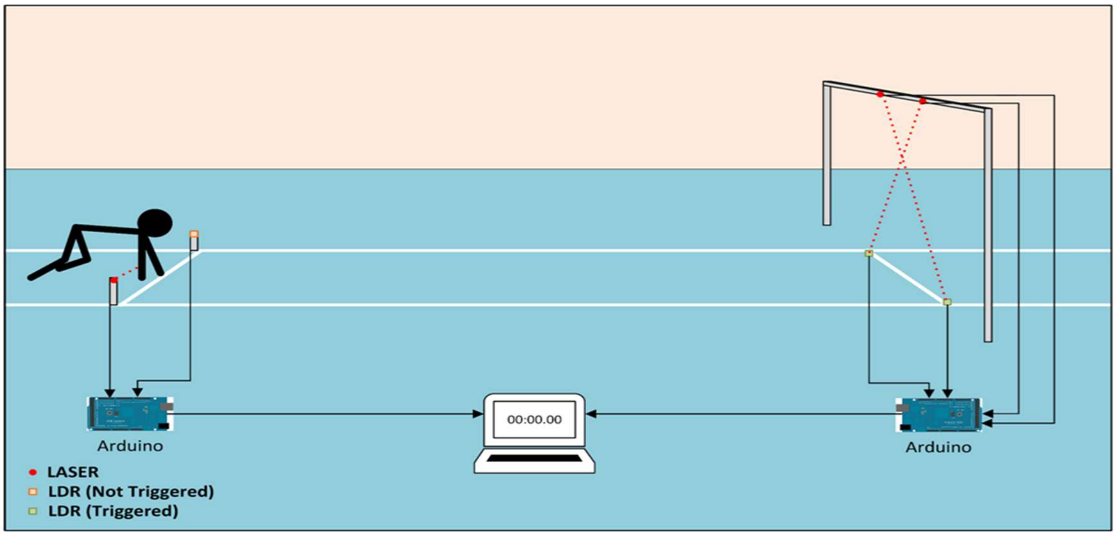

Fig3.3a STARTING POSITION

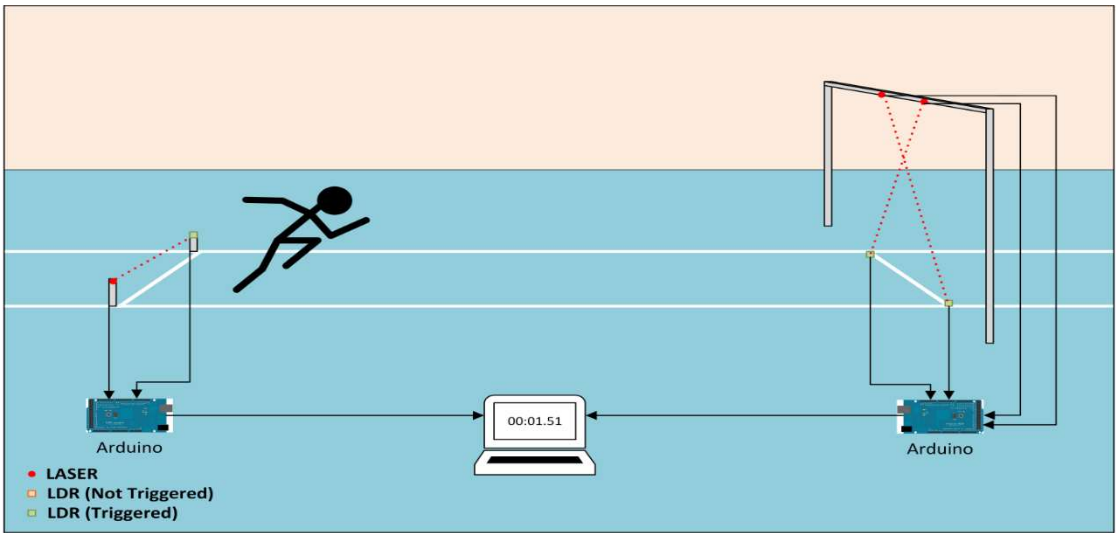

Fig 3.3b AFTER START OF RACE

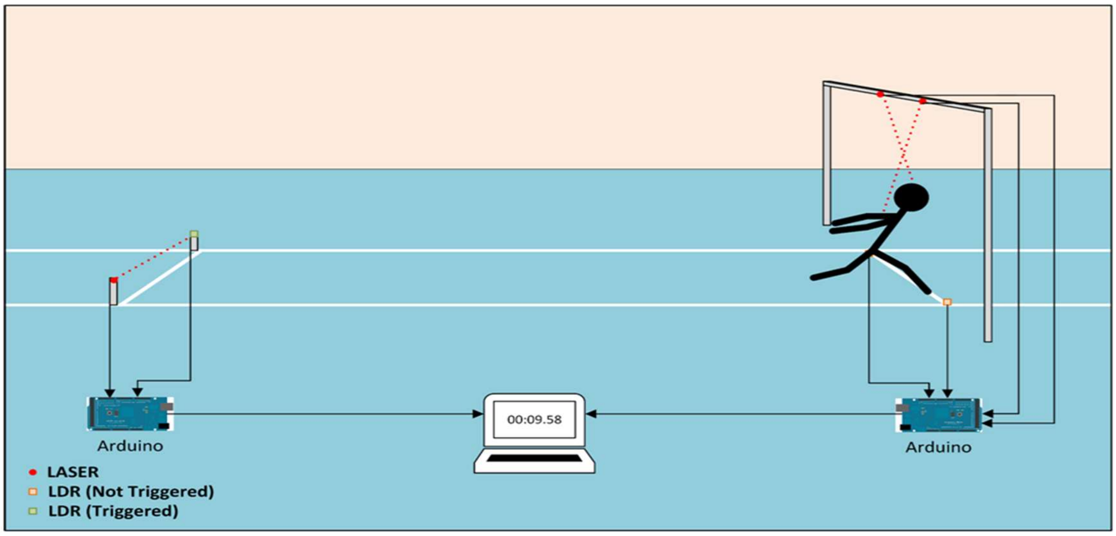

Fig 3.3c AT THE FINISH POINT

3.6 USE OF ARDUINO

The Laser - LDR modules are connected to the Arduino Mega each at the starting and finish the block .This Arduino Mega is in turn connected to the System through Wired /Wireless connections. The Laser - LDR mechanism connected to the Arduino has an accuracy up to 0.001 seconds. Arduino sends all the values to the System.

3.7 SHORTCOMINGS WE OVERCAME

Piezo sensor was highly inconsistent with its results. The Digital Cameras had latency of 1.2-4 seconds. As the Laser - LDR module set is used, intensity of Sunlight was a major concern. At times, the intensity of Sunlight used to match/exceed the intensity of Laser. The LDR module is enclosed inside a box so that Sunlight does not affect LDR readings. A hole is placed in the box so that the direct sunlight is eliminated and the Laser falls on LDR at an inclined angle.

CHAPTER 4
SOFTWARE REQUIREMENTS

There are some prerequisite compilers and plugins which must be installed in the system of the User. Those software requirements are:

- Python compiler (version 2.7.13)
- Selenium package for Python
- Pyserial package for python
- MySQLdb for Python
- Wamp server
- Firefox Browser (Javascript enabled)
- Geckodriver
- Arduino IDE

Python compiler

Majority of the software is coded in Python, so the Python compiler of the version 2.7.13 must be installed in the respective user's laptop.

Selenium Package

Selenium is an open-source tool that is used for test automation. It is licensed under Apache License 2.0. Selenium is a suite of tools that helps in automating only web applications. This tutorial will give you an in-depth understanding of Selenium and its related tools and their usage.

Pyserial Package

A pyserial module encapsulates the access for the serial port. It provides backends for Python running on Windows. The module named “serial” automatically selects the appropriate port and continuously gets the readings from the Zigbee. The pyserial version is 2.7.

Wamp server

WampServer refers is a software for the Microsoft Windows OS, consists of the Apache web server, OpenSSL for SSL support, MySQL database and PHP programming language.

Geckodriver

Note that with geckodriver v0.19.0 the following versions are recommended:

Firefox 55.0 (and greater)

Selenium 3.5 (and greater)

4.1 WINDOWS INSTALLATION

1. **Python 2.7.13 compiler**
2. **Selenium with Python**
3. **Pyserial package**
4. **MySQLdb python package**

- Copy the given "Python27" folder into the "C:\" directory of your WINDOWS system. After copying gets completed, Install the "python-2.7.13","pyserial","MySQL-python" application files using given installer packages in the existing "C:\Python27" directory.

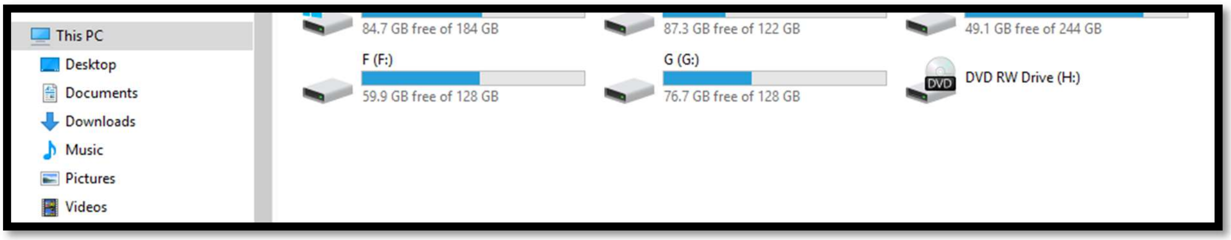

Fig 4.1 THIS PC SCREENSHOT

- Set the Environment PATH for Python27
- Right Click on "This PC" as shown in Fig 4.1.
- Click(Left) on the Properties.
- Now click Advanced System Settings as shown in Fig. 4.2.

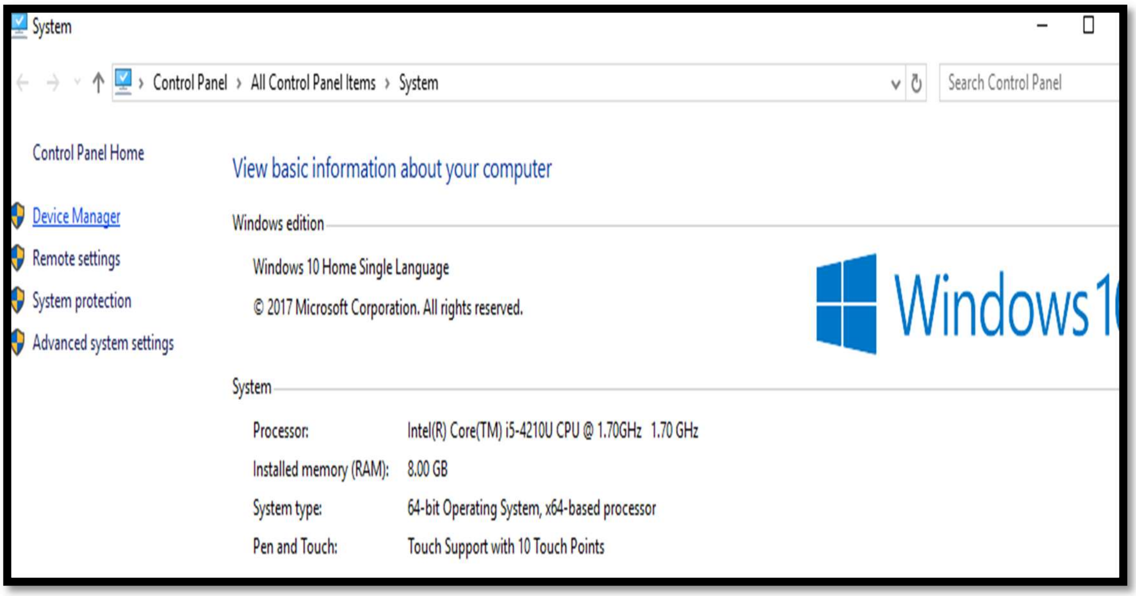

Fig 4.2 ADVANCED SYSTEM SETTINGS

- Click on Environment Variables as shown in Fig 4.3.

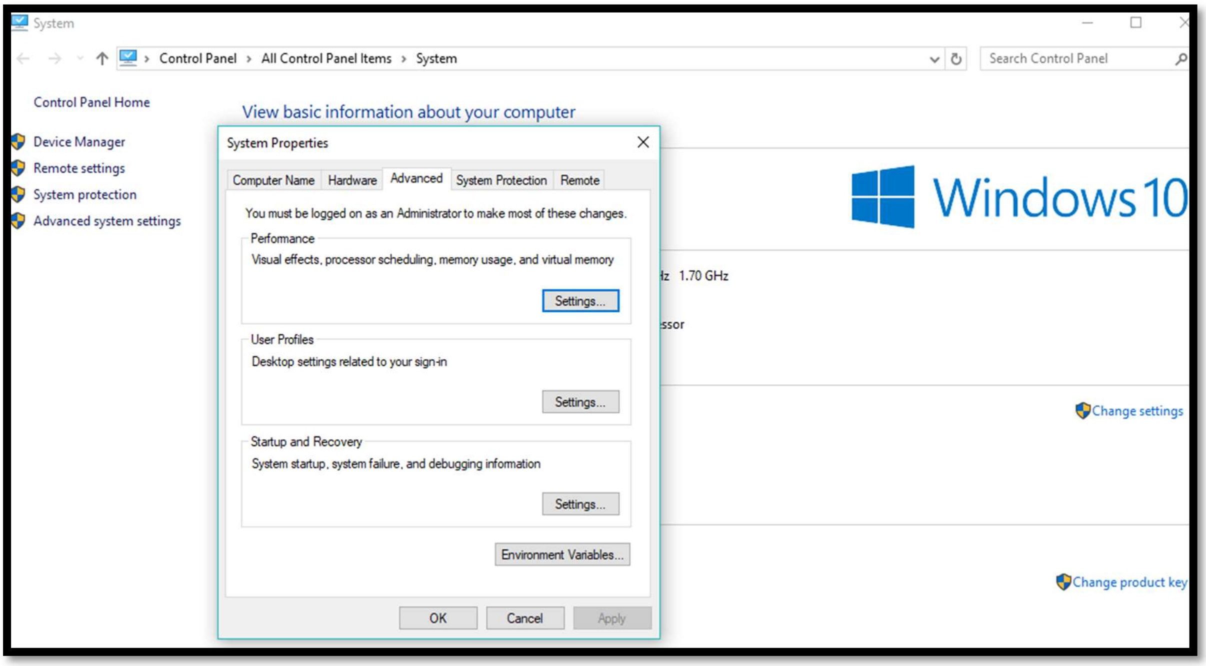

Fig 4.3 ENVIRONMENTAL VARIABLES

- Click on New under System Variables as shown in Fig. 4.4.

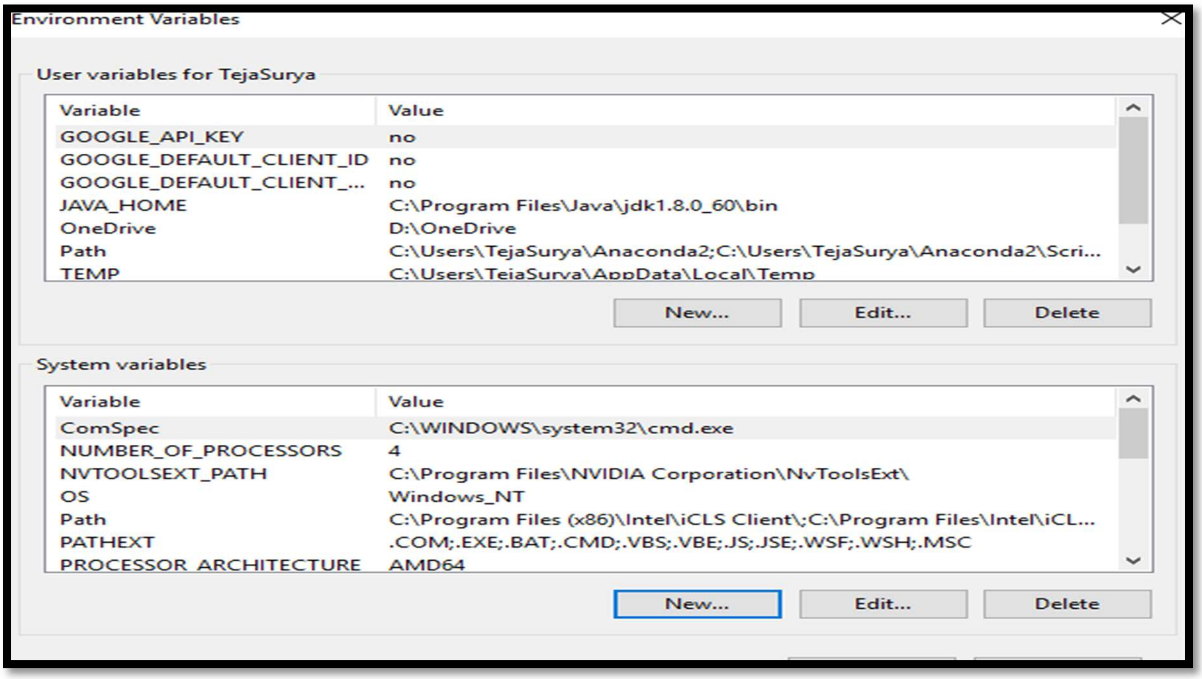

Fig 4.4 NEW SYSTEM VARIABLES

- Enter the Variable name as “Path”.
- Enter the Variable value as “C:\Python27”,Click OK button.
- Now select “Path” under System Variables, Click Edit button.
- Now select “Path” under System Variables, Click Edit button add “;” symbol next to existing Variable value and enter “C:\Python27\Scripts” and click OK button or Click New button and Enter another path as “C:\Python27\Scripts”, Then Click OK button.
- After setting the path, the Environment variable will look like as shown in Fig. 4.5.

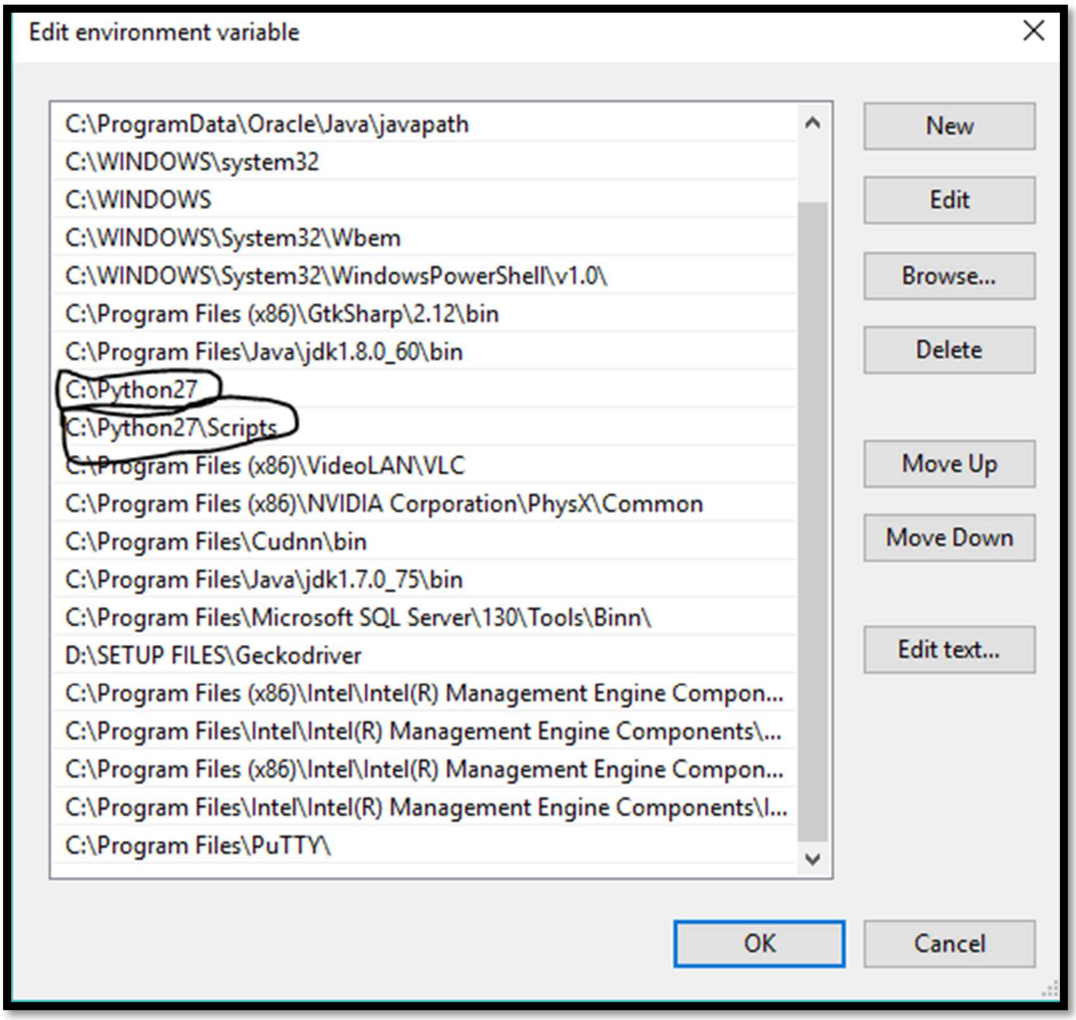

Fig 4.5 PYTHON27 PATH

5. **Wamp server**
    - Install the given “wampserver” application file in “C:\wamp” directory.
    - After installation, Copy the given “login”, “Test Stopwatch” folders into “C:\wamp\www” directory.
    - Copy the given “mysql” folder into “C:\wamp\bin” directory; replace the existing files.
6. **Mozilla Firefox**
    - Click on the Installer of the Mozilla Firefox installer
7. **GeckoDriver**
    - Copy the Geckodriver file into the C:\ directory
    - Set up the path for the Path of Geckodriver (C:\Geckodriver)
    - The procedure is same as done above for Path setting.

- In the Fig. 4.6 the Path is different. But in your system, set path as “C:\Geckodriver”.

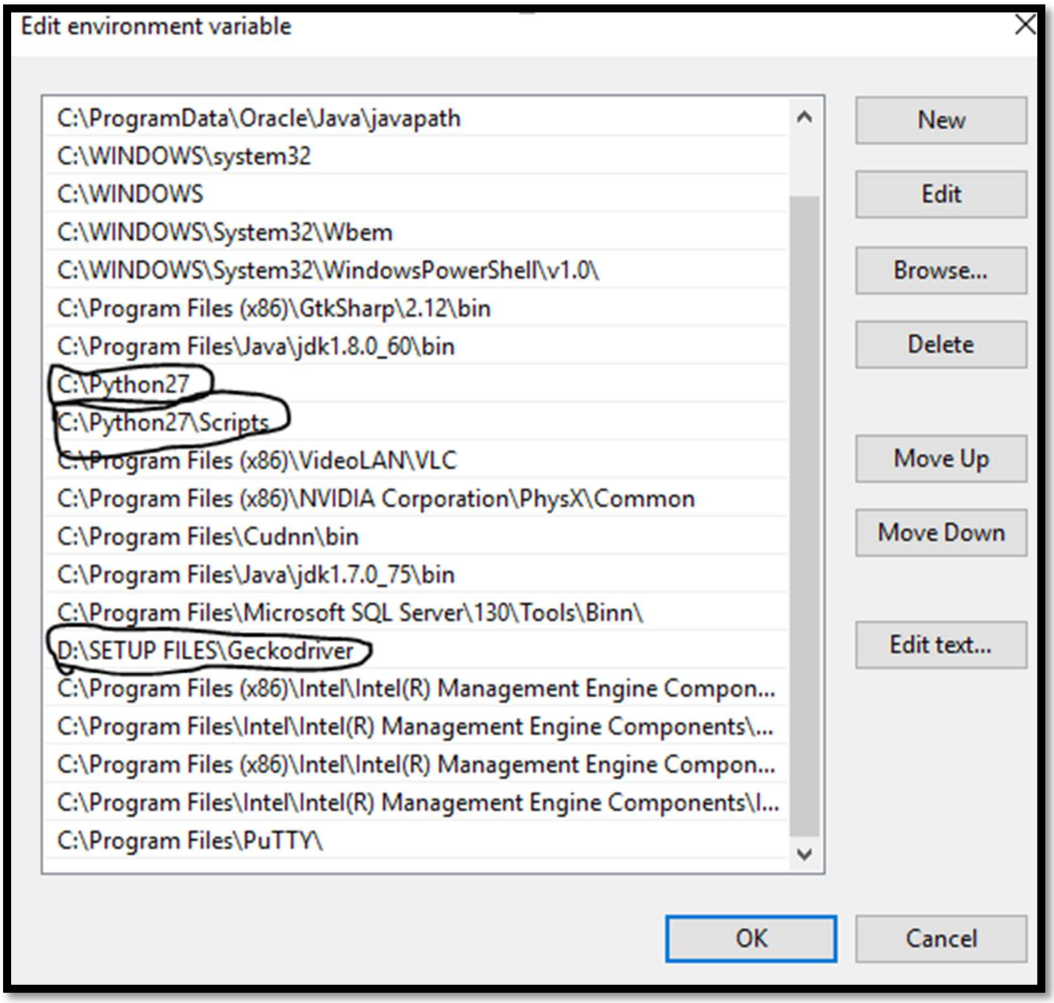

Fig 4.6 GECKODRIVER PATH

8. **StartRace Python file**

- Copy the “StartRace” folder to the Desktop of the System.

4.2 Windows Execution

- Make sure all the Hardware components are connected as mentioned above and they are in a perfect working condition.
- Start the Wamp server by clicking on Wamp manager application in the Path "C:\wamp\" as shown in Fig. 4.7.

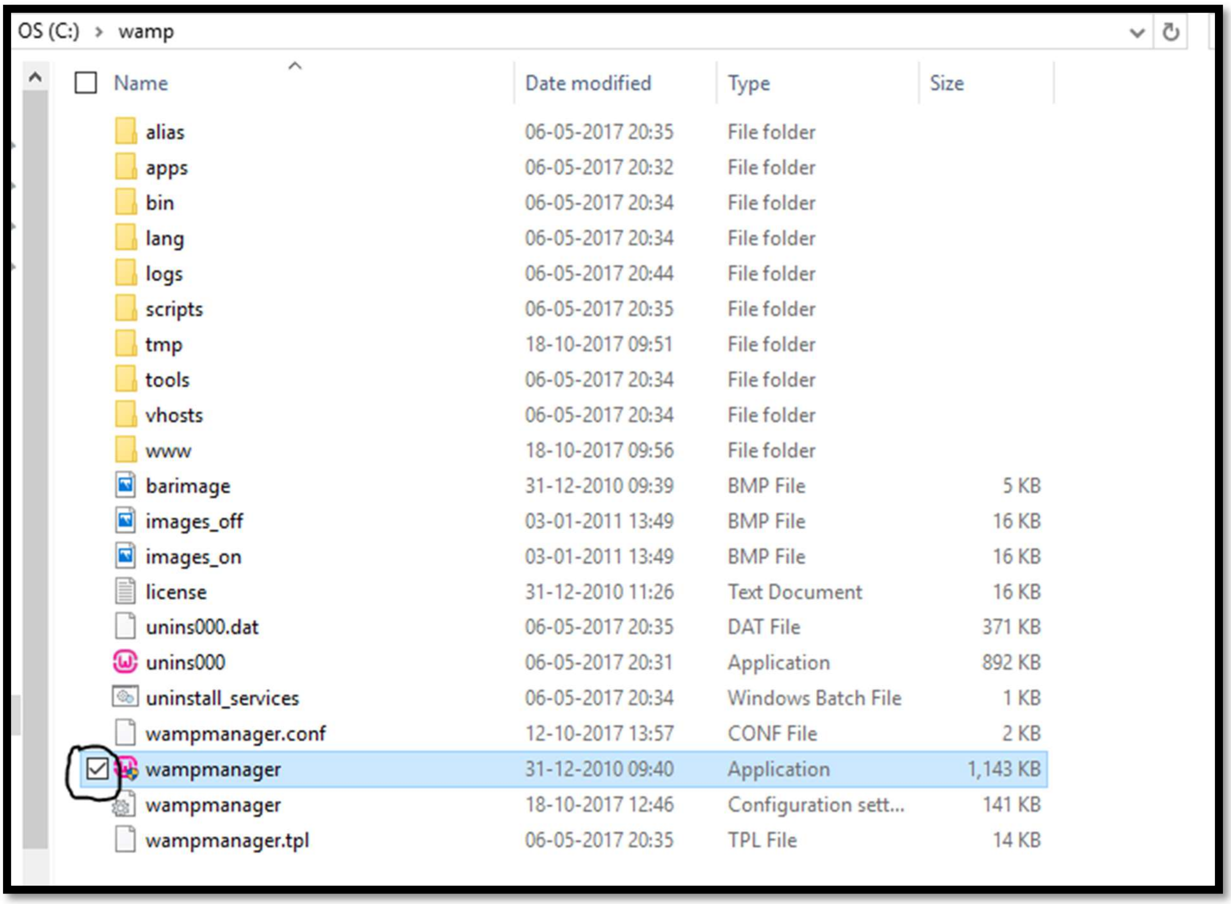

Fig 4.7 WAMP SERVER APPLICATION

- Wait for 1 minute, till the Wamp server starts all the services.
- Now Open the Mozilla Browser, Enter the Link "http://localhost/login/".
- The Login page appears as shown in Fig. 4.8.

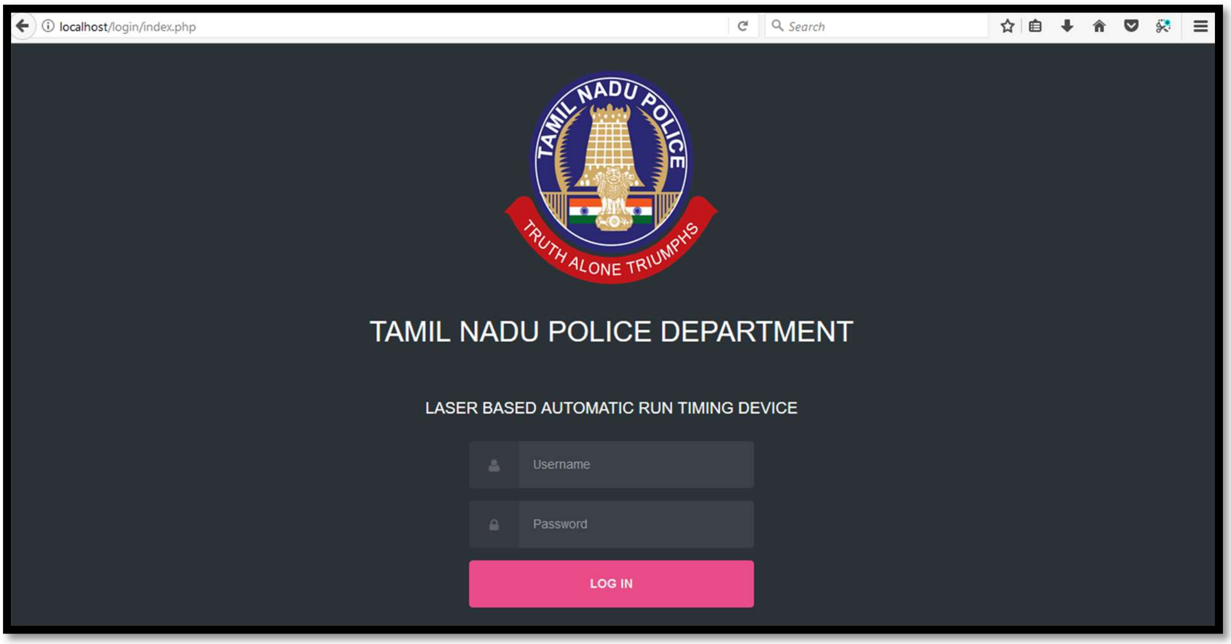

Fig 4.8 LOGIN PAGE

- The Username is “admin” and Password is “admin”.
- Now Choose the Number of tracks to be used by clicking on the “Number of Tracks” button as shown in Fig. 4.9.

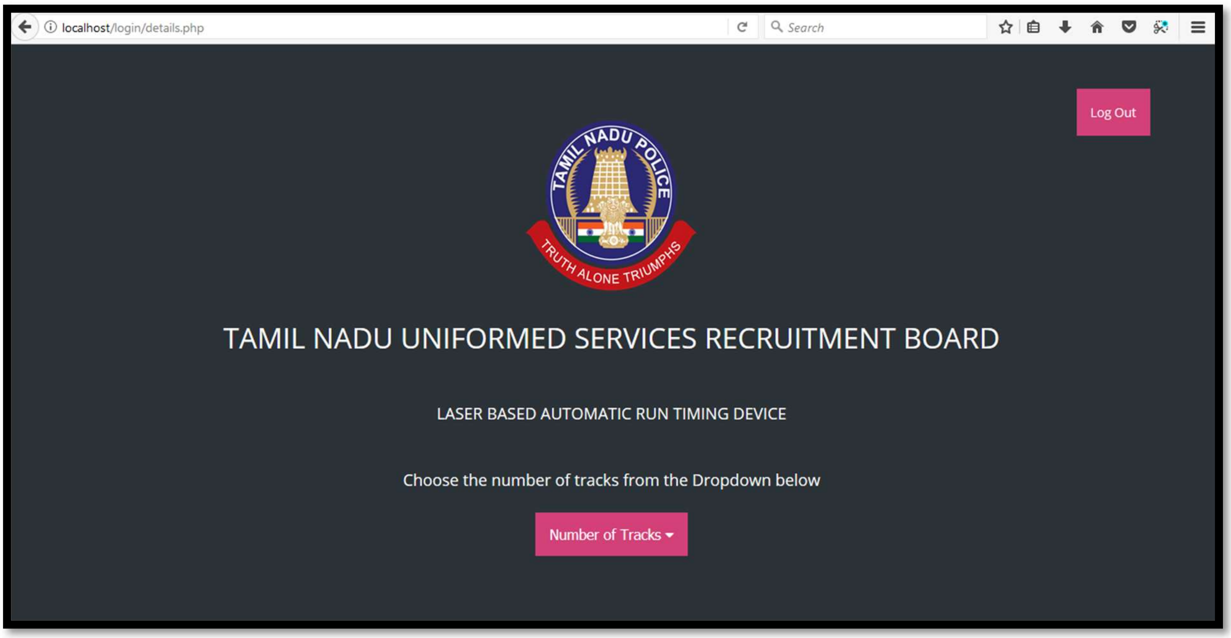

Fig 4.9 CHOOSE THE TRACK PAGE

- The user can logout of the system by clicking the “Logout” button at the top right corner; User will be redirected to Login page.
- Now enter the Name of the Athletes to the corresponding track and Click on “Save” button as shown in 4.10.

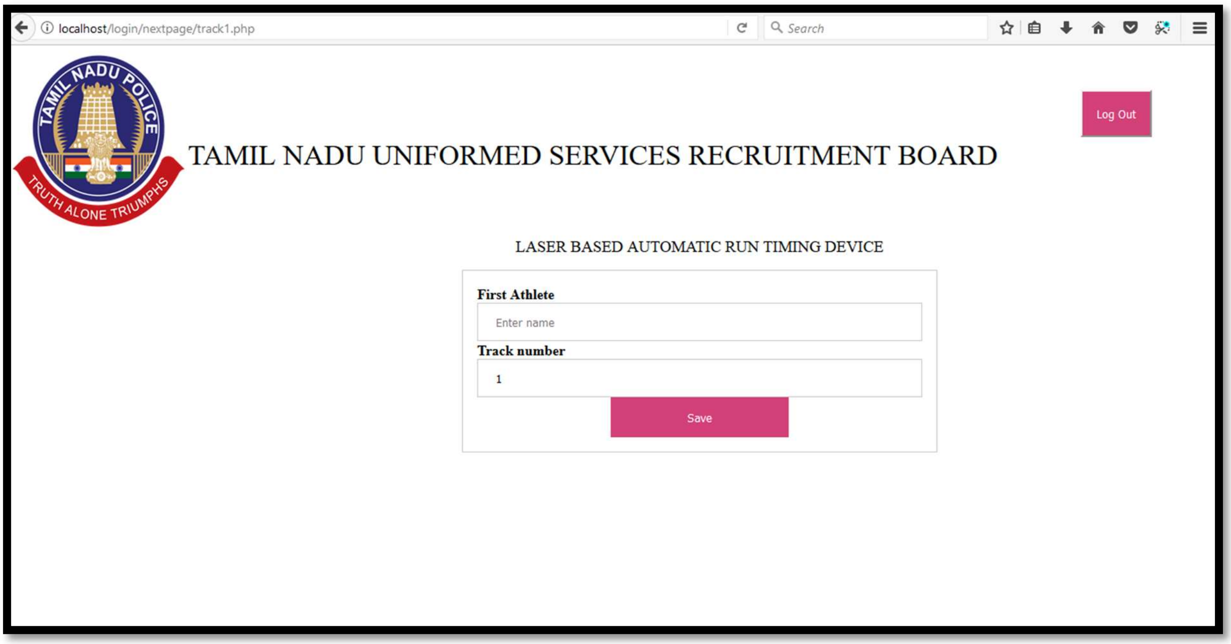

Fig 4.10 REGISTER PAGE

- Athletes name was registered successfully.
- Click on the Home button.
- Minimise the FireFox browser.
- To start next race, Click the “To start next race,Click here” button.
- Click the startrace.bat file in the StartRace folder of Desktop.
- Stopwatch Timer Starts automatically in the new Firefox window as shown in Fig. 4.11.GunShot sound comes and the timer has started.

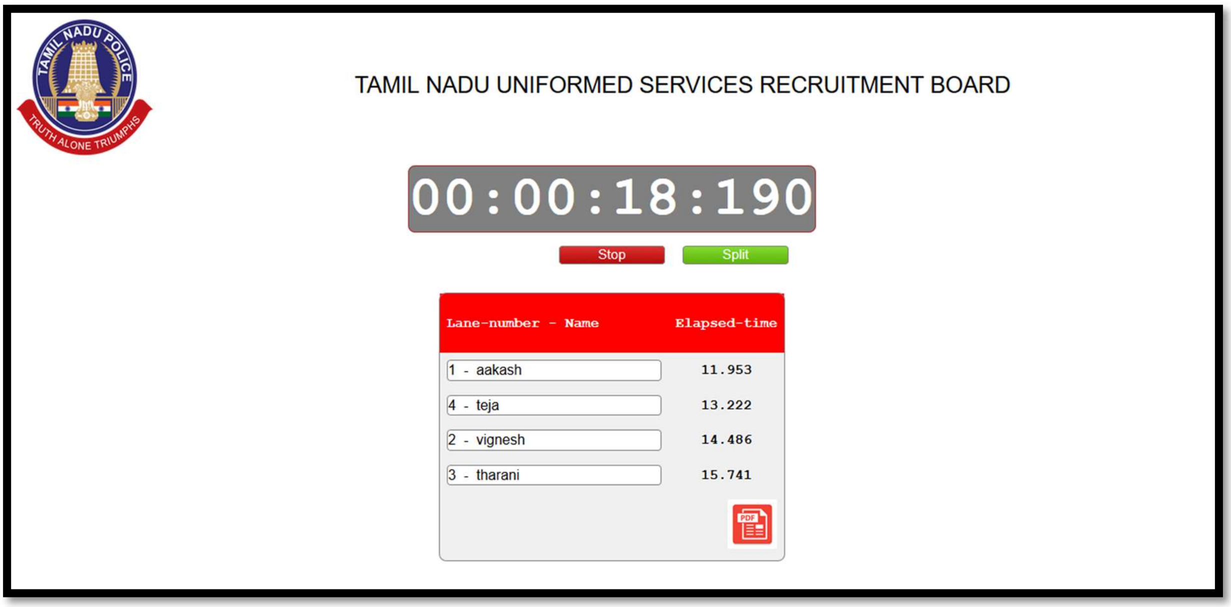

Fig 4.11 STOPWATCH

- If an athlete makes a False start, the Program execution stops and the Track with False start is denoted in the Windows terminal.
- Click on the PDF button to save a screenshot of the timer page as PDF as shown in Fig. 4.12.

Fig 4.12 REPORT PRINTED PDF

4.3 UBUNTU INSTALLATION

These installation rules correspond to the Ubuntu OS version 16.04. All the commands are given in build.txt file in Ubuntu Installation folder.

1. **Python 2.7.13 compiler**
    - The Python compiler comes pre-installed on all Ubuntu Operating systems.
    - Now Install pip by entering the following commands in the Terminal.

```
$ sudo apt-get update && sudo apt-get -y upgrade

$ sudo apt-get install python-pip
```

2. **Selenium with Python**
    - To install Selenium with Python enter the following command in the terminal.

```
$ sudo pip install selenium
```

3. **Pyserial package**
    - To install Pyserial package with Python enter the following command in the terminal.

```
$ sudo apt-get update

$ sudo pip install serial
```

4. **MySQLdb python package**
    - To install MySQLdb package with Python enter the following command in the terminal one by one.

```
$ sudo apt-get update

$ sudo apt-get install python-dev libmysqlclient-dev

$ sudo pip install MySQL-python
```

5. **Lamp server**
    - To install Lamp server enter the following command in the terminal one by one.

```
$ sudo apt-get update

$ sudo apt-get install apache2

$ sudo apt-get install mysql-server
```

- During installation of MySQL server, a prompt for password is asked in the terminal itself, Don't enter any password, just press "Enter" key.

```
$ sudo apt-get install php libapache2-mod-php

$ sudo /etc/init.d/apache2 restart

$ php -r 'echo "\n\nYour PHP installation is working fine.\n\n\n";'
```

- After Successful installation of Lamp server, Open the Firefox browser and enter the link “localhost/phpmyadmin”.
- A database page appears, there create a database with the name “automation” as shown in the Fig. 4.13.

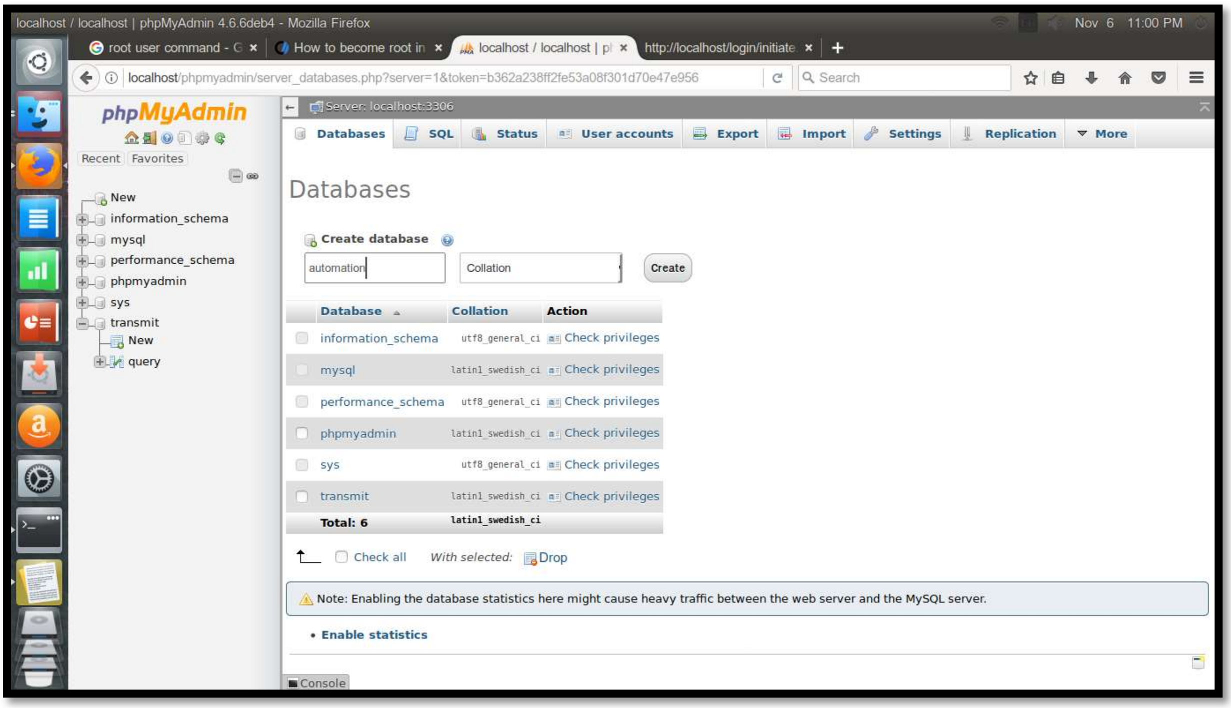

Fig. 4.13 Database creation

- Now inside the “Automation” database under the SQL tab enter both the SQL commands given below and click GO button at the right bottom of the page as shown in Fig. 4.14.

CREATE TABLE `details` (`sno` INT(11) NOT NULL AUTO_INCREMENT, `name` TEXT, `trackno` INT(11), PRIMARY KEY (`sno`));

CREATE TABLE `tracks` (`track` INT(11) NOT NULL AUTO_INCREMENT, PRIMARY KEY (`track`));

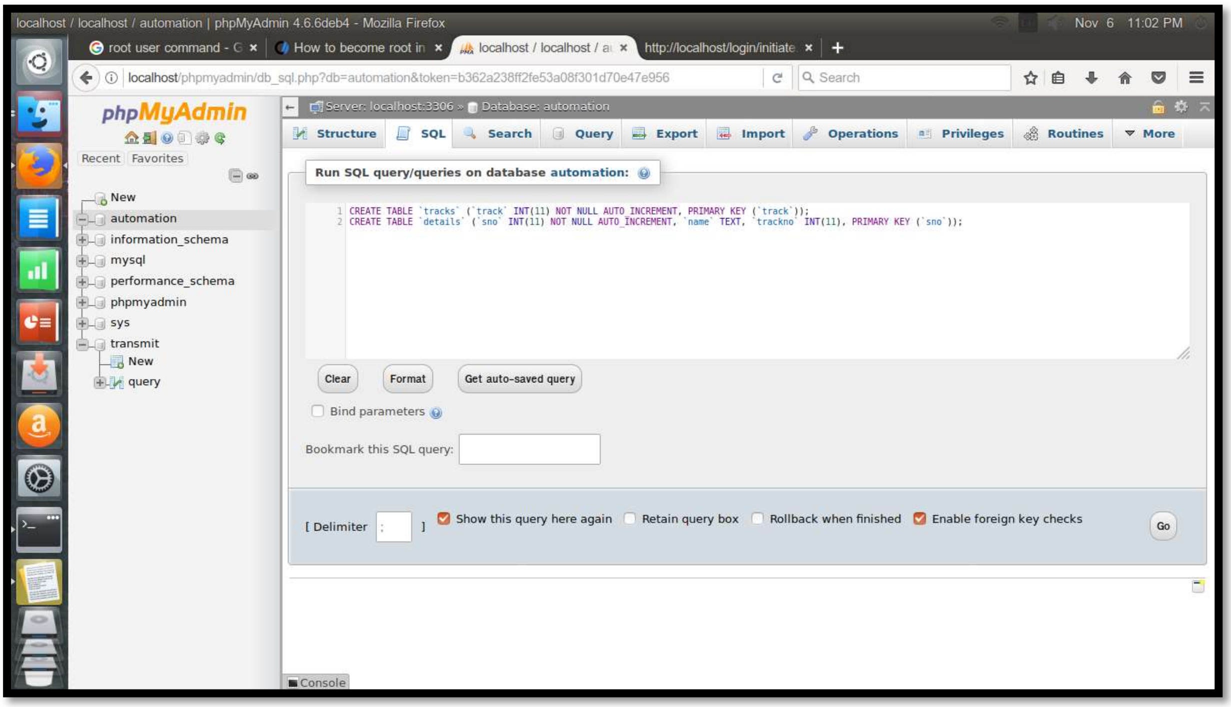

Fig. 4.14 Tables creation

- Table successfully created as shown in the Fig. 4.15.

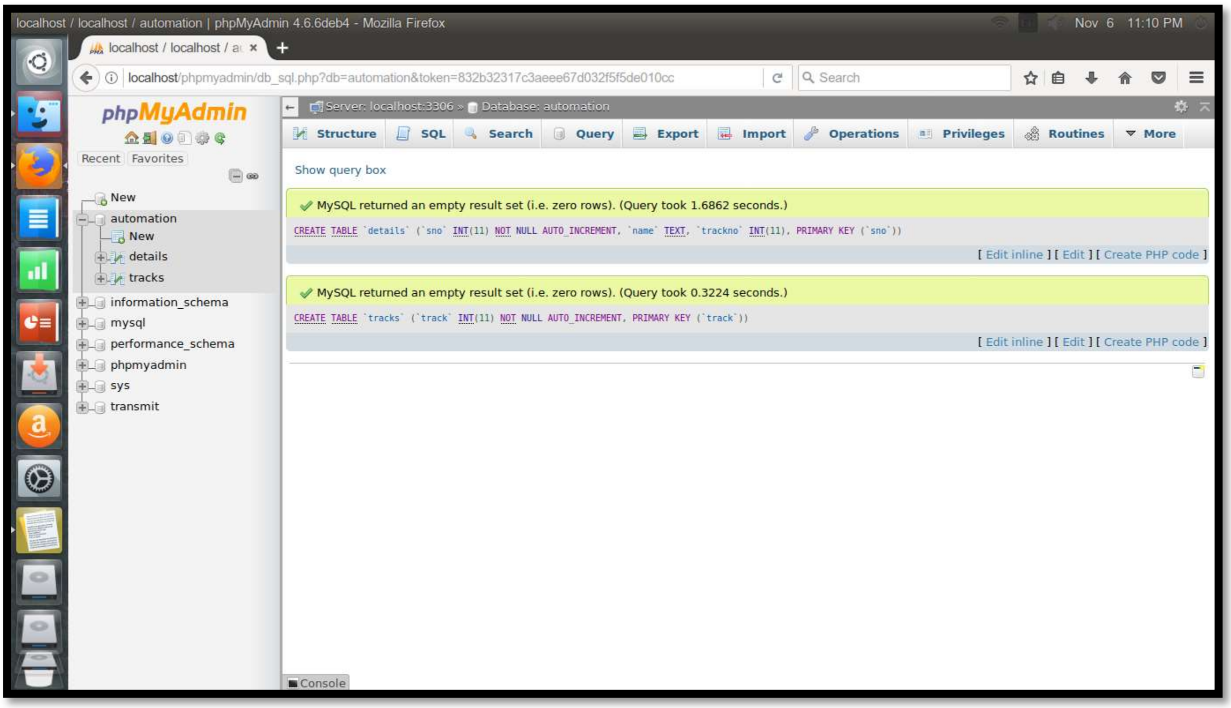

Fig. 4.15 Tables created

- Close the Firefox browser.
- Enter the following command in terminal to access root files.

```
$ sudo nautilus
```

- Copy the given “login” and “TestStopwatch” folder into the “/var/www/html” directory.

6. **Mozilla web browser**
   - Though the Firefox browser is preinstalled in Ubuntu, execute the following commands one by one in the Terminal.

```
$ sudo apt-add-repository ppa:mozillateam/firefox-next

$ sudo apt-get update

$ sudo apt-get install firefox xvfb

$ Xvfb :10 -ac &

$ export DISPLAY=:10
```

7. **Geckodriver path**
   - To install Geckodriver, enter the following commands in the Terminal.

```
$ wget
https://github.com/mozilla/geckodriver/releases/download/v0.18.0/geckodriver-v0.18.0-linux64.tar.gz
```

   - Extract the file with:

```
$ tar -xvzf geckodriver*
```

   - Make it executable

```
$ chmod +x geckodriver
```

   - Add the driver to your path so that other tools can find it. Modify the command and Enter the path based on the place where the geckodriver is downloaded.

```
$ export PATH=$PATH:/path-to-extracted-file/geckodriver
```

8. **StartRace**
   - Copy the StartRace folder into the Desktop.

4.4 Ubuntu Execution

- Make sure all the Hardware components are well connected and they are in a perfect working condition.
- Open the Firefox browser and enter the link "http://localhost/login"
- The login page appears as shown in the Fig. 4.16.

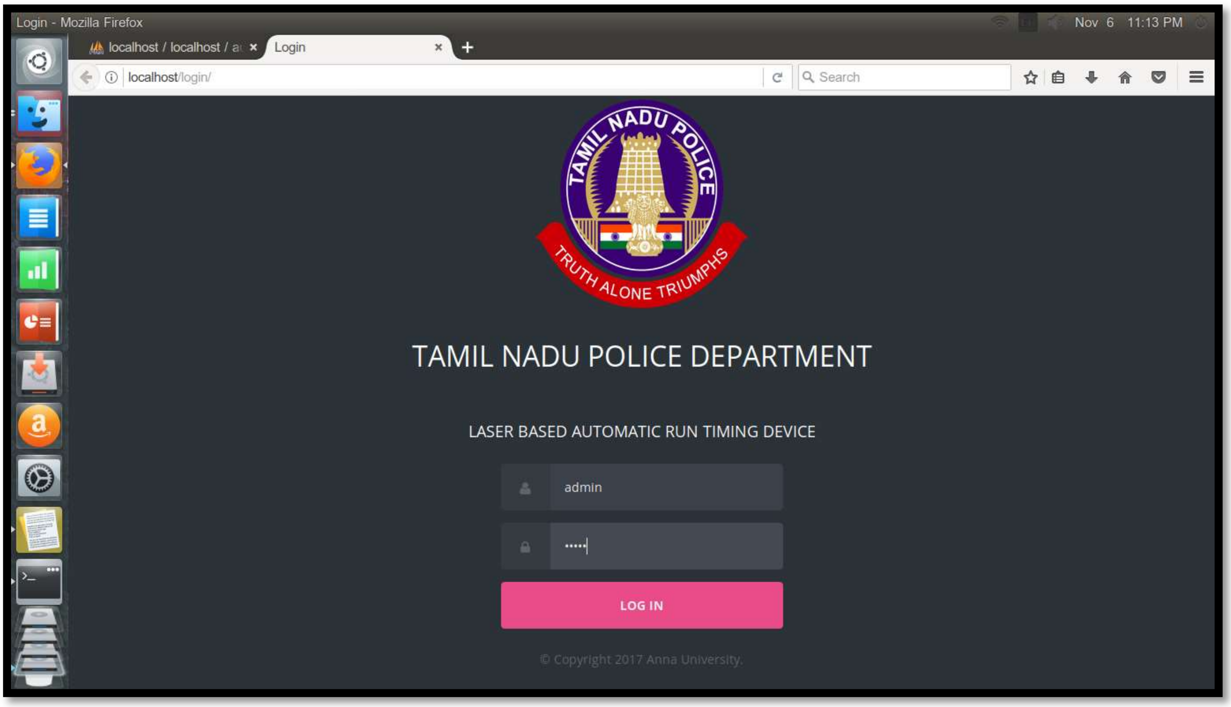

Fig. 4.16 Login page-Ubuntu

- Enter the Username - "Admin" and Password - "Admin".
- Now Choose the Number of tracks to be used by clicking on the "Number of Tracks" button as shown in Fig. 4.17.

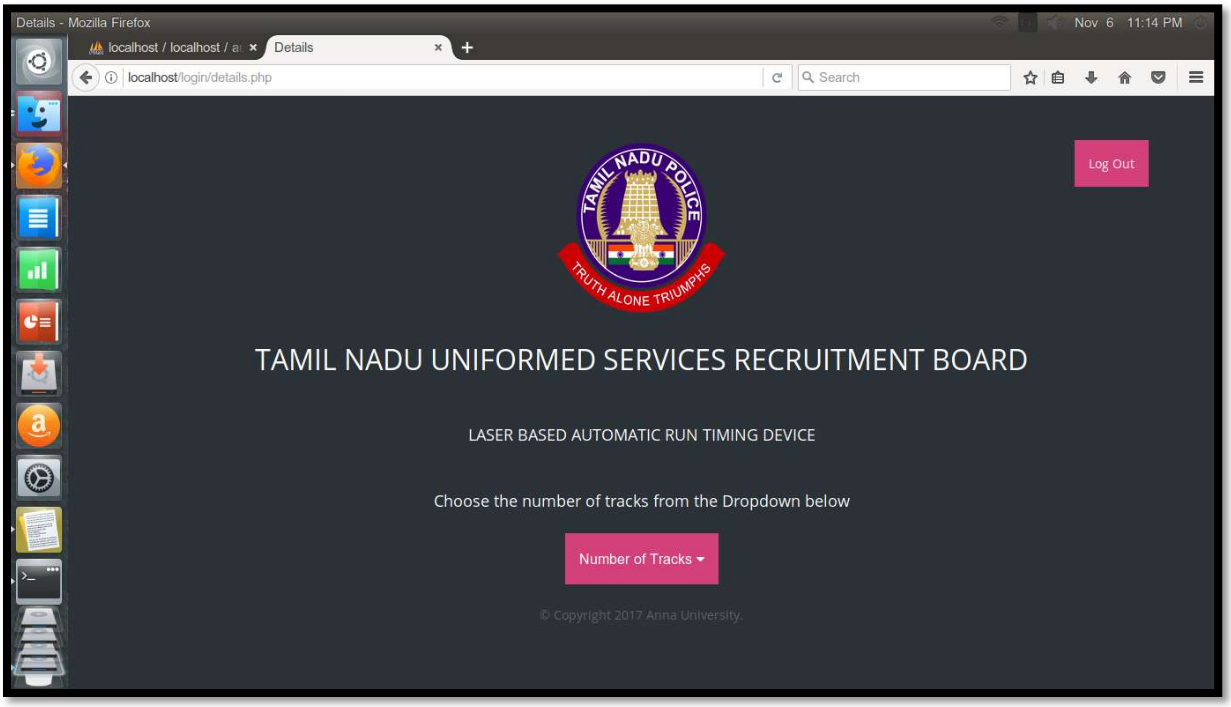

Fig. 4.17 CHOOSE THE TRACK -Ubuntu

- The user can logout of the system by clicking the "Logout" button at the top right corner; User will be redirected to Login page.
- Now enter the Name of the Athletes to the corresponding track and Click on "Save" button as shown in Fig. 4.18.

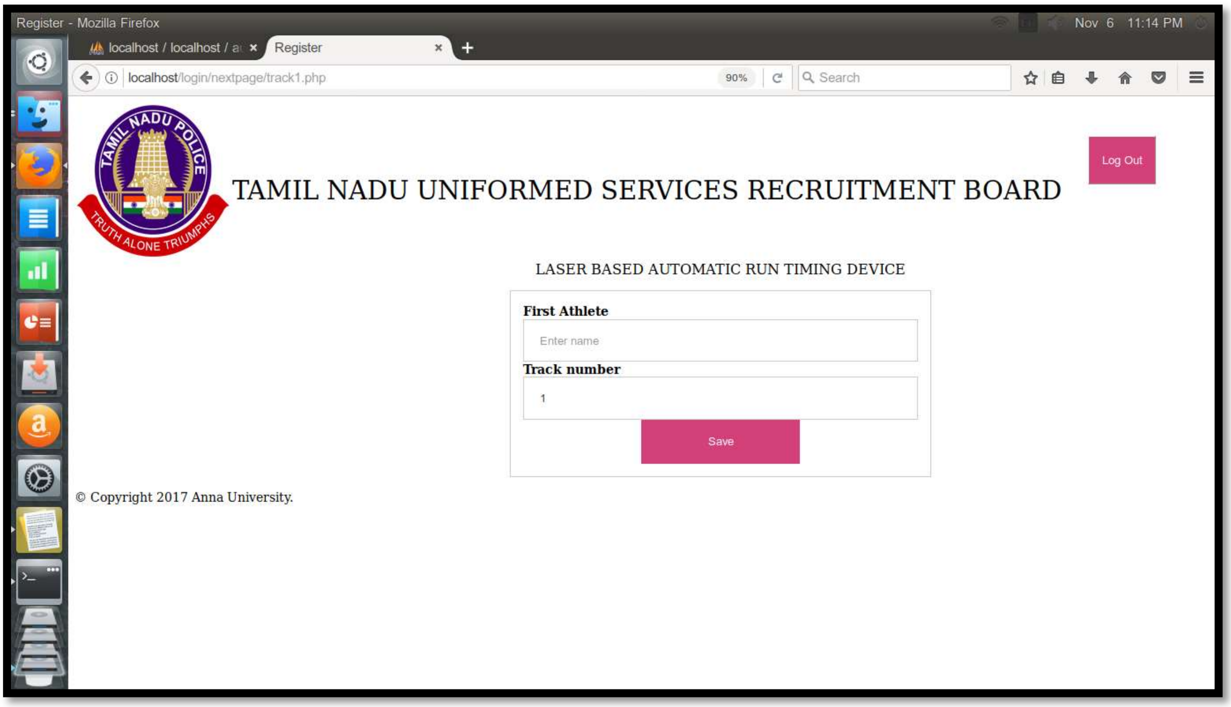

Fig. 4.18 REGISTER PAGE-Ubuntu

- Athletes name was registered successfully as shown in Fig. 4.19.

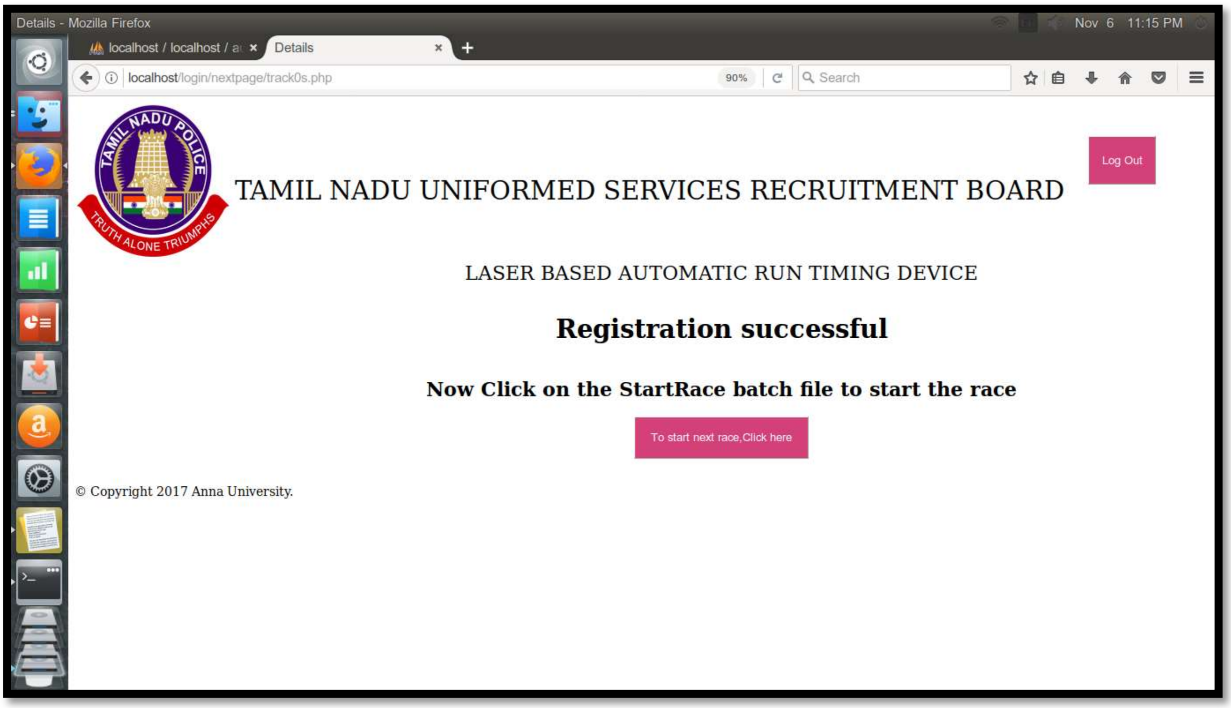

Fig. 4.19 SUCCESSFULLY REGISTERED PAGE-Ubuntu

- Minimise this FireFox browser.
- Open the Terminal and enter command "su" and enter the system password. Now you are a root user.
- Now run the following command to StartRace.

$ sh StartRace.sh

- Stopwatch Timer Starts automatically in the new Firefox window as shown in Fig. 4.20.
- GunShot sound comes and the timer has started.

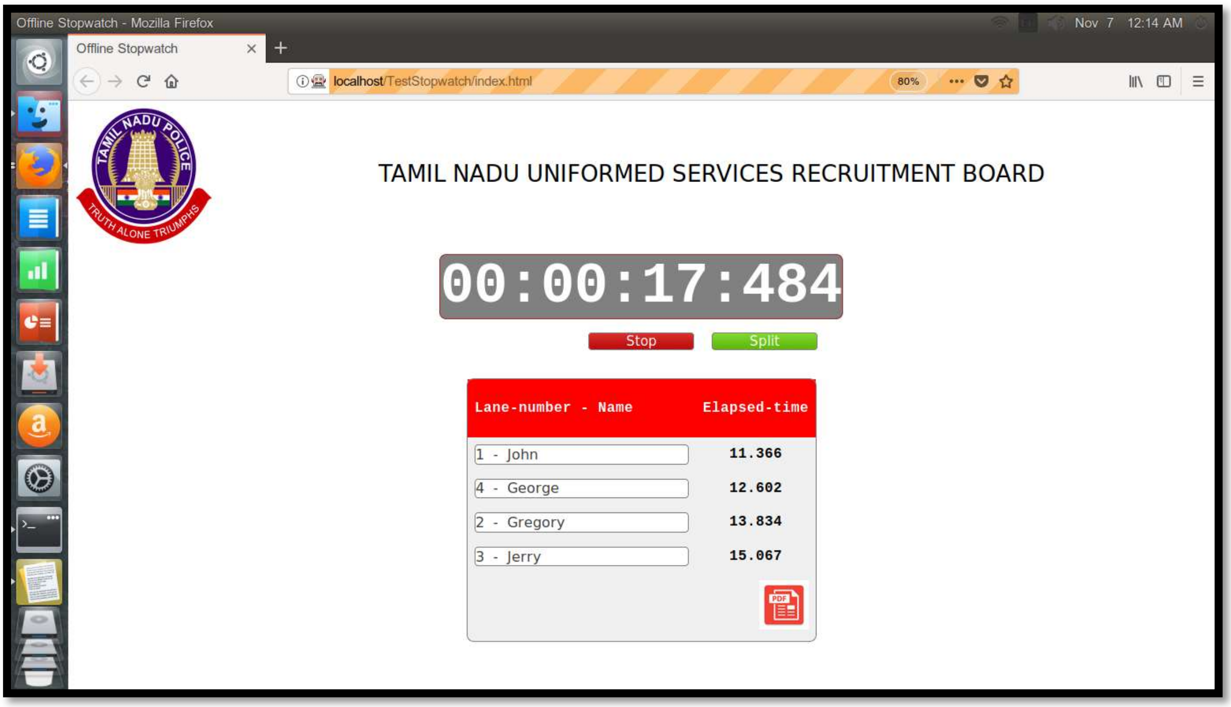

Fig. 4.20 STOPWATCH-Ubuntu

- If an athlete makes a False start, the Program execution stops and the Track with False start is denoted in the terminal.
- Click on the PDF button to save a screenshot of the timer page as PDF as shown in Fig. 4.21.

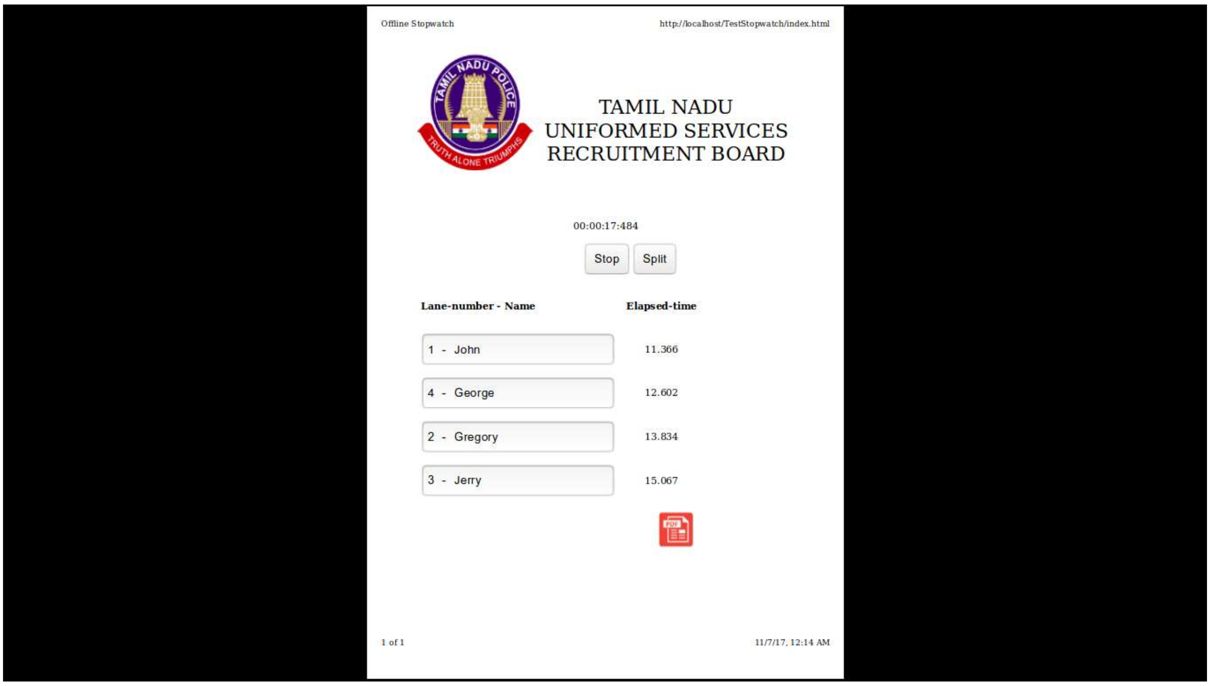

Fig. 4.21 REPORT PRINTED PDF-Ubuntu

- To start next race, Click the "To start next race, Click here" button(as shown in the Fig. 4.19).

5 CONCLUSION

The Laser-based Automatic run timing device is built in a cost-efficient manner. The LDR Laser-based mechanism is effective than Motion Analysis, RFID based tracking system, Goal based system and Geosynchronous system. The Laser-LDR system is accurate to 1/1000th of a second. The system has been designed to work for any number of tracks from 1 to 10 tracks. Once the system is setup, the user can decide upon the number of tracks required for a particular heat and select the number of tracks in the accompanying software. There is no need for the user to manually alter sensors from either the starting block or finishing line. The software is easy to use, provided it is operated in the sequential order – Log in, Number of tracks, StartRace. The system must be handled with care, the soldering done are delicate. The system is highly modular. If any hardware fails or malfunctions, it can be replaced with ease.