CHAPTER ONE

INTRODUCTION

1.1   Introduction:

The first edition of the Rail Technical Strategy (RTS) was published by the Department for Transport in 2007 in conjunction with the white paper delivering a Sustainable Railway. It set out a long-term vision of the railway as a system and explored how technologies and technical approaches could help respond to key challenges. so we must obtained it in Khartoum to ultimate the benefits of railway , by using radio frequency identification (RFID) automatic equipment identification solutions help improve operational efficiency for freight rail systems. Location and time data collected from this technology enables better management and improves performance to increase train operation monitoring and control functions.

Railway systems are a crucial part of today's infrastructure with rail traffic continually increasing over the years. This increment in traffic has resulted in more year on the railroad track and more interactions with the general public improvements, The majority of real-time bus arrival information systems are based on the use of data from Radio Frequency Identifier systems. The location data generated from RFID systems are used together with other information, real-time operations data (e.g, travel time between specific stops), are being continually made to passenger information by screens that allocate in entrance halls and provide departure/arrivals information and communicate stations at

which particular trains. With these improvements, deployments of these systems become more practical and cost-effective.

As we know that it is surely impossible to stop the running train at instant is some critical situation or emergency arises. Therefore at the places of traffic density, suburban areas and crossings there is severe need to install a railway gate in view of protection purpose.

1.2 Problem Statement:

Lack of information about the route , departure time ,arrival time and other information for passenger whom are using train has become a major challenge for railway system in Sudan (Khartoum), also a lot of trains accidents are occurring due to crossing issue.

1.3 Proposed Solution:

Design an automatic reliable identification and train tracking information system depends on the train location, to provide up to date information including arrival time, the next station or stop, also automatic railway gate control at the crossing points.

1.4 AIM and Objective:

The main aim of this project is to design an automatic railway system.

The objectives are:

1. To propose a control system for the train rail system.

2. To propose an information tracking system for the train.

3. To simulate the proposed system.

1.5 Methodology

The methodology of the track railway is about to connect trains through wireless and monitor their location using RFID technology and LCD display, to achieve the objective above. The methodology include several steps first, reading position of the train from RFID second, display this position in the LCD and then send it to another stations using wireless communication ,finally the screen in every station display information .and controlling gate (open –close) in every distance across railway by train moving. The software programed used to design in the system design is arduino and the components are arduino microcontroller, LCD , dc motor, RFID and X-bee wireless.

1.6 Thesis layout:

This thesis is organized as follows: Chapter 1 includes the introduction, Chapter 2 about background and literature review, Chapter 3 demonstrates Methodology and how the system work, Chapter 4 presents the results and discussion, Chapter 5 is conclusion and recommendation. And the end the reference list

CHAPTER TWO

BACKGROUND AND LITRITURE REVIEW

2.1 Background

This section will introduce basic information about microcontroller, wireless communication, RFID, dc motor and LCD.

2.2 Microcontrollers

A microcontroller is a small, low-cost computer-on-a-chip which usually includes 8 or 16 bit microprocessor, random access memory(RAM), programmable read only memory(ROM) and/or flash memory parallel and/or serial I/O, timers and signal generators or counter , analog to digital (A/D) and/or digital to analog (D/A) conversion. There are many examples of microcontroller

2.2.1 Microcontroller 8051

This is a type of microcontroller contain 4k bytes ROM ,128 byte RAM, four 8bit input/output ,two 16 bit timers , serial interface , 64 k external code memory space ,64 k data memory space. 8051 have 40 pin, and has 4 ports(port 0, port 1, port 2, port 3) [1].

2.2.2 Microcontroller 8052

This is a member of the 8051 family, the 8052 has all the standard features of the 8051 as well as an extra 128 bytes of RAM and an extra timer, and has 256 bytes of RAM and 3 timers . It has 8K bytes of on-chip program ROM instead of 4K bytes. The 8051 is available in different memory types, such as erasable programmable read only

memory(EPROM), flash, and -RAM, all of' which have different part numbers [4].

2.2.3 Arduino Microcontroller

An Arduino is an open-source microcontroller development board as shown in Figure (2.1) the arduino hardware. Arduino can used to read sensors and control things like motors and lights. This allows uploading programs to this board which can then interact with things in the real world. With this, can make devices which respond and react to the world at large.

Figure 2.1:Arduino Microcontroller

There are a number of different types of Arduino to choose from. This is a brief overview of some of the more common types of Arduino boards you may encounter:

2.2.4 Arduino Uno

The most common version of Arduino is the Arduino Uno. This board is what most people are talking about when they refer to an Arduino [3] as shown in Figure (2.2).
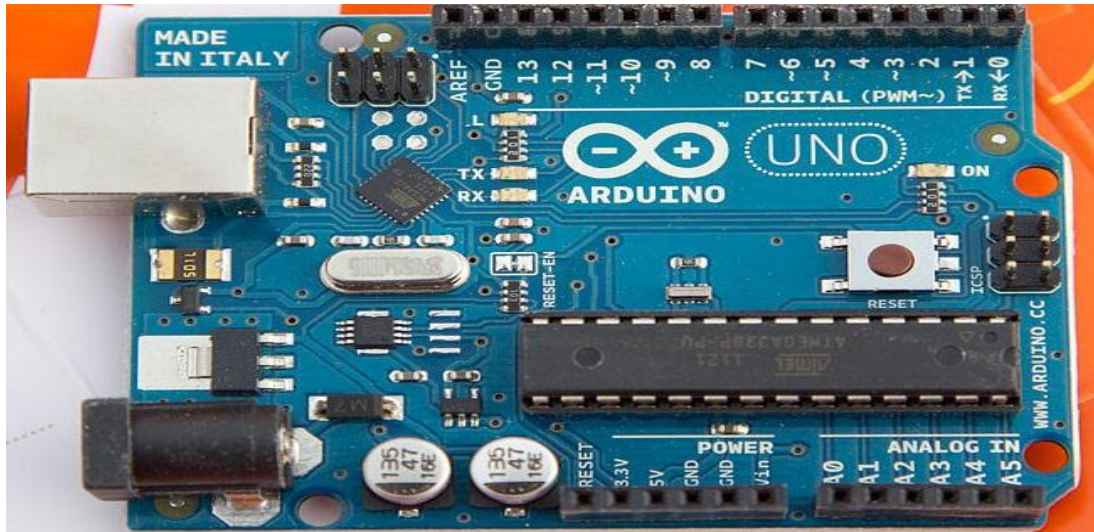

Figure 2.2: Arduino UNO Microcontroller

2.2.5 Arduino Mega2560

The Mega is the second most commonly encountered version of the Arduino family. The Arduino Mega as shown in Figure (2.3) is like the Arduino Uno's beefier older brother. It boasts 256 KB of memory (8 times more than the Uno). It also had 54 input and output pins, 16 of which are analog pins. However, all of the added functionality comes at the cost of a slightly larger circuit board. It may make the project more powerful [4] .
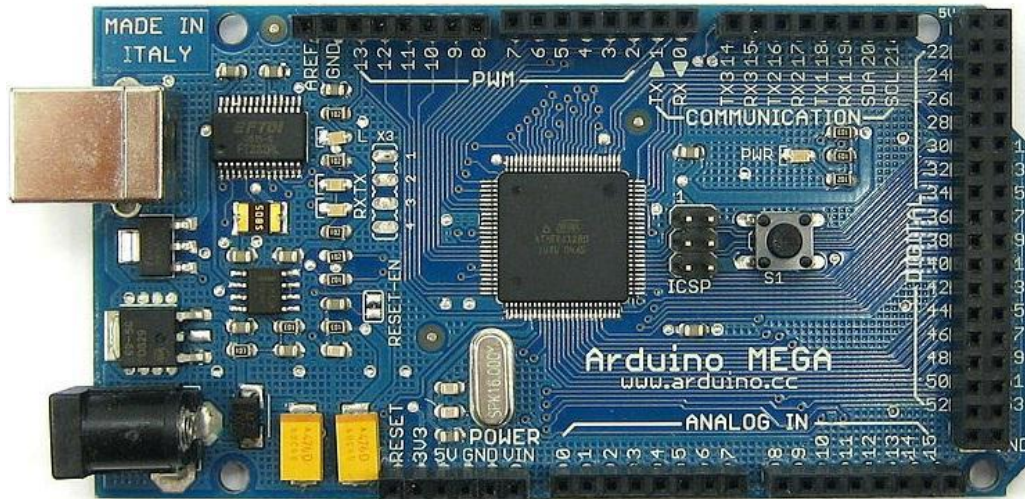
Figure 2.3: Arduino Mega Microcontroller

2.3 Radio Frequency Identification (RFID)

Radio Frequency Identification (RFID) technology is a non-contact, automatic identification technology that uses radio signals to identify, track, sort and detect a variety of objects including people, vehicles, goods and assets without the need for direct contact (as found in magnetic stripe technology) or line of sight contact (as found in bar code technology). RFID technology can track the movements of objects through a network of radio-enabled scanning devices over a distance of several meters.

2.3.1 RFID Tags

A radio-frequency identification system uses tags, or labels attached to the objects to be identified. Two-way radio transmitter-receivers called interrogators or readers send a signal to the tag and read its response.RFID tags can be either passive, active or battery-assisted passive. An active tag has an on-board battery and periodically transmits

its ID signal. A battery-assisted passive (BAP) has a small battery on board and is activated when in the presence of an RFID reader. A passive tag is cheaper and smaller because it has no battery; instead, the tag uses the radio energy transmitted by the reader. However, to operate a passive tag, it must be illuminated with a power level roughly a thousand times stronger than for signal transmission. That makes a difference in interference and in exposure to radiation.Tags may either be read-only, having a factory-assigned serial number that is used as a key into a database, or may be read/write, where object-specific data can be written into the tag by the system user. Field programmable tags may be write-once, read-multiple; "blank" tags may be written with an electronic product code by the user.RFID tags contain at least two parts: an integrated circuit for storing and processing information, modulating and demodulating a radio-frequency (RF) signal, collecting DC power from the incident reader signal, and other specialized functions; and an antenna for receiving and transmitting the signal. The tag information is stored in a non-volatile memory. The RFID tag includes either fixed or programmable logic for processing the transmission and sensor data, respectively.An RFID reader transmits an encoded radio signal to interrogate the tag. The RFID tag receives the message and then responds with its identification and other information. This may be only a unique tag serial number, or may be product-related information such as a stock number, lot or batch number, production date, or other specific information. Since tags have individual serial numbers, the RFID system design can discriminate among several tags that might be within the range of the RFID reader and read them simultaneously.

2.3.2 RFID Reader

RFID systems can be classified by the type of tag and reader. A Passive Reader Active Tag (PRAT) system has a passive reader which only receives radio signals from active tags (battery operated, transmit only). The reception range of a PRAT system reader can be adjusted from 1–2,000 feet (0–600 m)[citation needed], allowing flexibility in applications such as asset protection and supervision.An Active Reader Passive Tag (ARPT) system has an active reader, which transmits interrogator signals and also receives authentication replies from passive tags.An Active Reader Active Tag (ARAT) system uses active tags awoken with an interrogator signal from the active reader. A variation of this system could also use a Battery-Assisted Passive (BAP) tag which acts like a passive tag but has a small battery to power the tag's return reporting signal.

Fixed readers are set up to create a specific interrogation zone which can be tightly controlled. This allows a highly defined reading area for when tags go in and out of the interrogation zone. Mobile readers may be hand-held or mounted on carts or vehicles[5].

2.4 A liquid-Crystal Display (LCD)

LCD is a flat-panel display or other electronic visual display that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly .LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements.

LCDs are used in a wide range of applications including computer monitors, televisions, instrument panels, aircraft cockpit displays, and signage. The LCD screen is more energy-efficient and can be disposed of more safely than a CRT. Its low electrical power consumption enables it to be used in battery-powered electronic equipment more efficiently than CRTs [6].

2.5 Communication Media

Communication media refer to the means of receiving data or information. In telecommunication, these means are transmission and channels for data storage and transmission. They are several types of communication media:

2.5.1 Ethernet

The original Ethernet was created in 1976. Since then, it has gone through four generations. There are many types of Ethernet such as standard Ethernet, fast Ethernet and so on.as shown in Figure 2.3
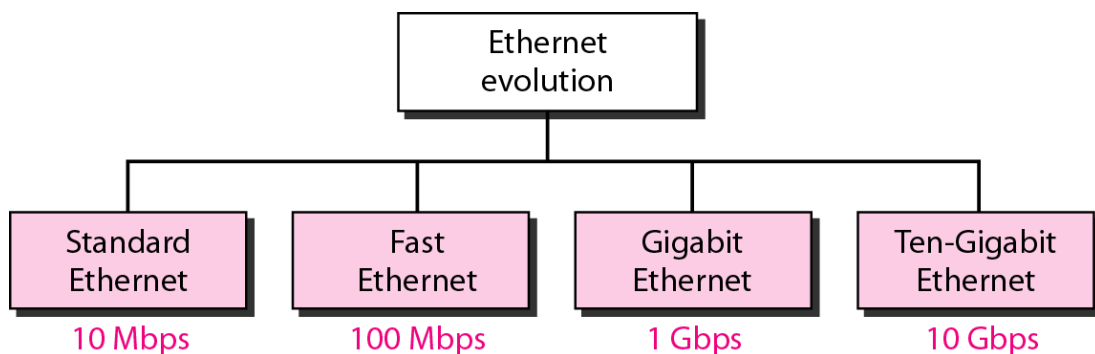
Figure 2.5 Types of Ethernet **[7]**

2.5.2 Wireless

Wireless is a technology uses in much application such a tracking systems. There are much type of wireless such as radio wave, microwave and infrared .The radio waves are used for multicast communications, such as radio and television, and paging systems, Microwaves are used for unicast communication such as cellular telephones, satellite networks, and wireless LANs. Infrared signals can be used for short-range communication in a closed area using line-of-sight

2.5.3 Wi-Fi (or WiFi)

Wi-fi is a local area wireless computer networking technology that allows electronic devices to connect to the network, mainly using the 2.4 gigahertz (12 cm) UHF and 5 gigahertz (6 cm) SHF ISM radio bands. The Wi-Fi Alliance defines Wi-Fi as any "wireless local area network" (WLAN) product based on the Institute of Electrical and Electronics Engineers' (IEEE) 802.11 standards .Many devices can use Wi-Fi, e.g. personal computers, video-game consoles, smartphones, digital cameras, tablet computers and digital audio players. These can connect to a network resource such as the Internet via a point. Wi-Fi can be less secure than wired connections, such as Ethernet, precisely because an intruder does not need a physical connection. Wi-Fi has adopted various encryption technologies. The early encryption wireless encryption (WEP) proved easy to break. Higher quality protocols (WPA, WPA2) were added later. An optional feature added in 2007, called Wi-Fi Protected Setup (WPS), and had a serious 9, flaw that allowed an attacker to recover the router's password. The Wi-Fi Alliance has since updated its test plan and certification program to ensure all newly certified devices resist attacks [8].

2.5.4 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 radios. 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 Wi-Fi. Applications include wireless light switches, electrical meters with in-home-displays, traffic management systems, and other consumer and industrial equipment that require short-range low-rate wireless data transfer. ZigBee has low power consumption limits transmission distances to 10–100 meters line-of-sight, depending on power output and environmental characteristics. ZigBee devices can transmit data over long distances by passing data through a mesh network of intermediate devices to reach more distant ones. ZigBee is typically used in low data rate applications that require long battery life and secure networking (ZigBee networks are secured by 128 bit symmetric encryption keys.) ZigBee has a defined rate of 250 kbit/s, best suited for intermittent data transmissions from a sensor or input device [9].

2.5.5 Bluetooth

Bluetooth is a wireless technology standard for exchanging data over short distances from fixed and mobile devices and building personal area networks (PANs). It was originally conceived as a wireless alternative to RS-232 data cables. It can connect several devices, overcoming problems of synchronization. Bluetooth is managed by the Bluetooth special interest group (SIG), which has more than 25,000 member companies in the areas of telecommunication; computing, networking, and consumer electronics The IEEE standardized Bluetooth as IEEE

802.15.1, but no longer maintains the standard. The Bluetooth SIG oversees development of the specification, manages the qualification program, and protects the trademarks a manufacturer must make a device meet Bluetooth SIG standards to market it as a Bluetooth device. A network of patents applies to the technology, which are licensed to individual qualifying devices [10].

2.5.6 XBee

Xbee is the brand name for Digi International for a family of form factor compatible radio modules. The first XBee radios were introduced under the Max Stream brand in 2005 and were based on the 802.15.4-2003 standard designed for point-to-point and star communications at over-the-air baud rates of 250 kbit/s. Two models were initially introduced a lower cost 1 mw XBee and the higher power 100 mW XBee-PRO. Since the initial introduction, a number of new XBee radios have been introduced and all XBees are now marketed and sold under the digi brand. The XBee radios used with the minimum number of connections – power (3.3 V), ground, data in and data out , with other recommended lines being Reset and Sleep. Additionally, most XBee families have some other flow control, I/O, A/D and indicator lines built in. A version of the XBees called the programmable XBee has an additional onboard processor for user's code [11].

2.6 A DC motor

A DC motor is any of a class of electrical machines that converts direct current electrical power into mechanical power. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic; to periodically change the direction of

current flow in part of the motor. Most types produce rotary motion; a linear motor directly produces force and motion in a straight line.
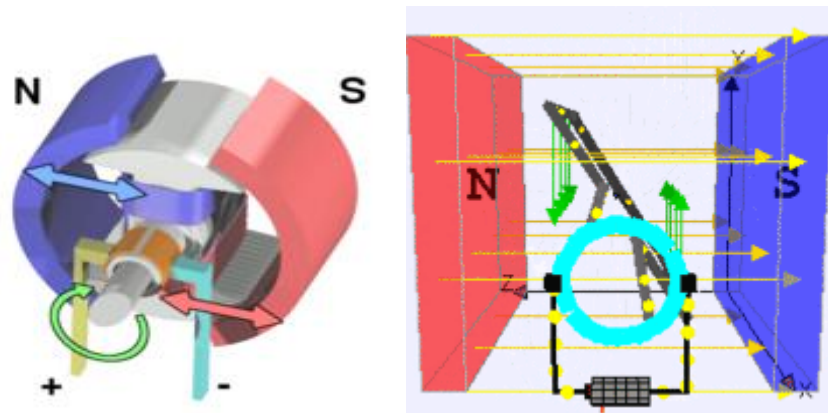

Figure 2.6: DC motor components

A brushed DC electric motor generating torque from DC power supply by using an internal mechanical commutation. Stationary permanent magnets form the stator field. Torque is produced by the principle that any current-carrying conductor placed within an external magnetic field experiences a force, known as Lorentz force. In a motor, the magnitude of this Lorentz force (a vector represented by the green arrow), and thus the output torque, is a function for rotor angle, leading to a phenomenon known as torque ripple) Since this is a single phase two-pole motor, the commutator consists of a split ring, so that the current reverses each half turn (180 degrees)[12].

2.7 Traffic light

Traffic lights alternate the right of way accorded to users by displaying lights of a standard colour (red, amber (yellow), and green) following a universal colour code, to ensure that traffic moves as smoothly and safely as possible and that pedestrians are protected when they cross the roads. A variety of different control systems are used to

accomplish this, ranging from simple clockwork mechanisms to sophisticated computerized control and coordination systems that self-adjust to minimize delay to people using the road.

In the typical sequence of colour phases:

- The green light allows traffic to proceed in the direction denoted, if it is safe to do so and there is room on the other side of the intersection.

- The amber (yellow) light warns that the signal is about to change to red. In a number of countries – among them the United Kingdom – a phase during which red and yellow are displayed together indicates that the signal is about to change to green. Actions required by drivers on a yellow light vary, with some jurisdictions requiring drivers to stop if it is safe to do so, and others allowing drivers to go through the intersection if safe to do so.

- A flashing amber indication is a warning signal. In the United Kingdom, a flashing amber light is used only at pelican crossings, in place of the combined red–amber signal, and indicates that drivers may pass if no pedestrians are on the crossing.

- The red signal prohibits any traffic from proceeding.

- A flashing red indication is treated as a stop sign.

In some countries traffic signals will go into a flashing mode if the Conflict Monitor detects a problem, such as a fault that tries to display green lights to conflicting traffic. The signal may display flashing yellow to the main road and flashing red to the side road, or flashing red in all

directions. Flashing operation can also be used during times of day when traffic is light, such as late at night.

Railroad signals, for stopping trains in their own right of way, use the opposite positioning of the colors, the two types cannot be confused, That is, green on top and red below is the standard placement of the signal colors on railroad tracks [13].
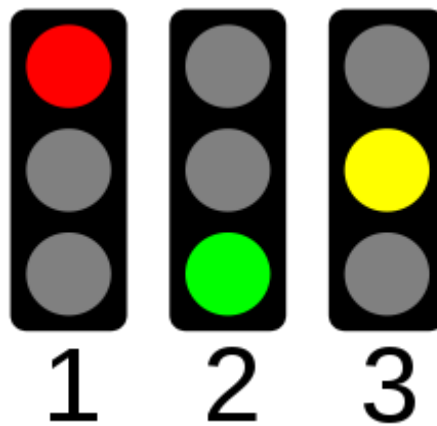

Figure 2.7: traffic light works

2.8 Literature Review

2.8.1 Related studies

Jiban Chandra Bhowmik and others [14] in their paper has proposed the implementation of a global positioning system (GPS) based train monitoring system that could locate a train at every instant. Here a GPS– GPRS module transmits the location information to a web server. Every track in the system will be assigned a unique number. Now this track position of the train is also transmitted with this location information via

an onboard computer placed on the train. This computer continuously updates the track position when the train is moving. This information is stored in the web server. When a client user requests for a particular train status, a web application shows the status in Google map. This implementation can effectively reduce train accidents in Bangladesh.

The Global Positioning System gives accurate position and velocity information anywhere in the world. The Global Positioning System (GPS) is a satellite-based navigation system made up of a network of 24 satellites placed into orbit. A GPS receiver must be locked on to the signal of at least three satellites to calculate a 2D movement. With four or more satellites in view, the receiver can determine the user's 3D position (latitude, longitude and altitude). Once the user's position has been determined, the GPS unit can calculate other information, such as speed, bearing, track, trip distance, distance to destination etc. There are three unknown position coordinates (x, y, z). Therefore, three equations from three satellites are required to solve for the three unknown coordinates. Here, (Ux, Uy, Uz) represents the GPS position. A fourth unknown is the error in the receiver's clock, which affects accuracy of the time difference measurement. To eliminate the clock bias error (Cb), a fourth satellite is needed to produce the fourth equation necessary to solve four unknown parameters using simultaneous equations. The solutions to the simultaneous equations for determining latitude and longitude are given in figure 1. The accuracy of a position determined with GPS depends on the type of receiver. Most of the existing hand held GPS units are of about 8-10 meter accuracy. For obtaining higher accuracy DGPS (Differential Global Positioning System) may be used.

Boggula Ramesh Reddy and others [15] in their paper Designed Advanced Railway Track Fault Detection System with remote station

messaging system using Zigbee Communication. Developed an embedded system to identifying rail track fault sending message to near station using Zigbee technology.

The Transportation of train always depends on railway tracks (rails) only. If there is a crack in these rails, it creates a major problem. Most of the accidents in the train are caused due to cracks in the railway tracks, which cannot be easily identified. Also it takes more time to rectify this problem. In order to avoid this problem, they are using the crack detector robot, which detects the crack in the rails and gives an alarm. A robot is an apparently human automation, intelligent and obedient but impersonal machine. It is relatively, that robots have started to employ a degree of Artificial Intelligence (AI) in their work and many robots required human operators, or precise guidance throughout their missions. Slowly, robots are becoming more and more autonomous.

Khizir Mahmud and others [16] in their paper based on microcontroller to reduce the complexity and cost. A low power dc motor is used as a track switching device. In the sensing unit photodiode is used for detecting IR radiation which ensures a reliable detection of trains entrance. A communication line communicates between the track switching device and main monitoring room. Total system can be monitored and visualize by a software which shows train's position, operation mode and safety status. This system can work both automatically and manually and also can be controlled by the software from the main control room which gives the system more flexibility in operation.

Railway has long been considered as the safest transportation media. To improve the efficiency of the transportation systems, it is necessary to investigate the accidents and find out the essential methodologies for

optimum management of information and resources available in railway rescue operations. The statistics shows that a huge number of accidents occurred due to human errors. Therefore, having a systematic way for railway operation management and reduction of human intervention, controlling activities, performances etc. may play a significant role to diminish the number and impact of accidents. Moreover, Reliable, accurate, precise, up-to-date and structured geospatial data is the key for decision making. Therefore, this system is very essential for the Bangladesh railway because it could bring an abrupt change to the existing train monitoring system.

V.SRIDHAR[17]in his paper aims is to make an automated place announcement system for Train using voice IC and the radio frequency wireless card for tracking the station data. The paper consists of microcontroller with the RF receiver and the voice recorder chip with speaker .The whole system is attached to the vehicle (BUS or Train). The encoded RFID tags are placed in the BUS stops or the railway stations. The microcontroller in the TRAIN is programmed in such a way that every station name saved in the voice chip which is having a unique code. So whenever the bus or train reaches the station, the reader in the bus or in the train receives the codes, which are transmitted from the tag and the microcontroller receives this code and checks in the look up table, saved in the chip. Whichever matches, the controller will send the command to the voice chip to play that particular voice. At the same time the train stops for about 10-15 seconds in the station and then before leaving the station, it will again start to announce and the train starts to move to next station. The voice chip will play the voice and this will be heard in the speaker. This voice is repeated till the train leaves the station. at an automated system to make announcements and display

at stations codes. Finally as a part of a project they can implement an automatic door opening system in feature by interfacing a dc motor to the micro controller. The main aim of the project is to make an automated place announcement system for Train using voice IC and the radio frequency wireless card for tracking the station data. It can be extended to any number of stations.

The implementation of the paper is based on Radio Frequency Tags and corresponding readers. Serial communication, non-volatile memory storage, voice chip implementation and others aid in bringing out the desired functionality. This embedded application mainly focuses on overcoming loop holes in the existing system.

K. Vidyasagar and others [18] in their paper Tracking of the system using IR sensors and RF Technology may enable the rail department to safeguard the human life from accidents. The positional status of the train transmitted to the control room using RF technology can be replaced the manual human interpretation. Automating the monitoring system may curtail the human errors from train accidents.

Emad Aboelela and others [19] In their paper proposed a fundamentally different approach to improve the current practices in railway operations using wireless sensor network (WSN). The primary technical and scientific objectives of the system introduced in thise paper are to generate innovative solutions for a number of the issues facing the railroad community through the development of a system based on WSN. The objectives from a railroad perspective include finding new approaches to reduce the occurrence rate of accidents and improving the efficiency of railroad maintenance activities.

The paper introduced a fundamentally different approach that utilizes wireless sensor network (WSN) to improve the current practices in railway operations. The primary technical and scientific objectives of the system introduced in this paper are to generate innovative solutions for a number of the issues facing the railroad community through the development of a system based on WSN.

a wireless sensor network deployed along a railway track. The network consists of one or more control centers (sink nodes) connected through a wire lined connection, and many wireless sensor nodes scattered across a sensing site (railway track). Each of these scattered sensor nodes are capable to collect the necessary data and to forward the data back to the sink. The data will be delivered to the monitoring system at the remote site through networked connections between the different sink nodes (base stations).

2.9 Summary

The existing system involves announcing the arrival and departure information manually in a particular station while the proposed one is an automated system with very limited human intervention. The proposed system uses relatively less expensive Tags which reduces the cost parameter of the system.

The literature overview of different systems for condition monitoring applications for inspection of railway components. These technologies, in conjunction with defect analysis and comparison with historical data, will enhance the ability for longer-term predictive assessment of the health of the track system and its components, more informed and proactive maintenance strategies, and improved understanding of track structure degradation and failure modes. Major of the studies used GPS

to send and receive data with microcontroller and others used Zig-bee wireless technology with different types of microcontroller, IR sensors and RF Technology, wireless sensor network (WSN), In spite of different purpose and used but the systems designed is not a collaborative system that consist of several point that monitor the position.

CHAPTER THREE

METHODOLOGY

3.1 Overview:

Railway track is about to connect stations with main station through wireless ,monitor train position using radio frequency identification (RFID), wireless technology and controlling crossing road gate by train moving.

This chapter describes the method used to develop track design to achieve a collaborative railway computing system for train's stations.

3.2 System Design

Each tag was written with 4 bits data including the train's ID. When train arrive any station reader that attached to train send a signal to the tag in station and read its response , microcontroller read information and extract other information about train (train position, arrival time, departual time, next station)send all these updated information of train real time to main station by wireless access (Xbee), and main station sends it again to other station to get full map about train moving with details and showing it to the passengers in station halls. Also train has full control of the gate unit opening and closing by moving that sends signal to microcontroller in the gate to operate dc motor that close the gate and when it departure already switch in other side send signal to the microcontroller to open the gate .

Railway tracking design consists of three parts: station unit, main station unit and gate unit. These two units (station and main station) are collaborative with each other, the main station is one part that

communicates with each station, and the gate unit communicates with train moving. From figure (3.1) the steps used on design are:

(1) Train arrives to station and RFID in station will read the information about train and analysis more information by microcontroller.

(2) The station unit will send information of the train (station ID, Arrival time, Departure time) to main station (the point that all stations gather on it).

(3) The main station unit will receive this information and display it on its own LCD, then will send it to other stations.

(4) Each station receives the train information, it will display it on its own LCD.

(5) Each station sends continuously its current train information to the main station unit.

(6) The main station receives these information, then display them on its LCD and send them all continuously to the other stations.

(7) Whenever a train approaches a level crossing, the gate should close automatically and after the train passes, the gate opens automatically.

The step followed in the design as shown in the Figure 3.1
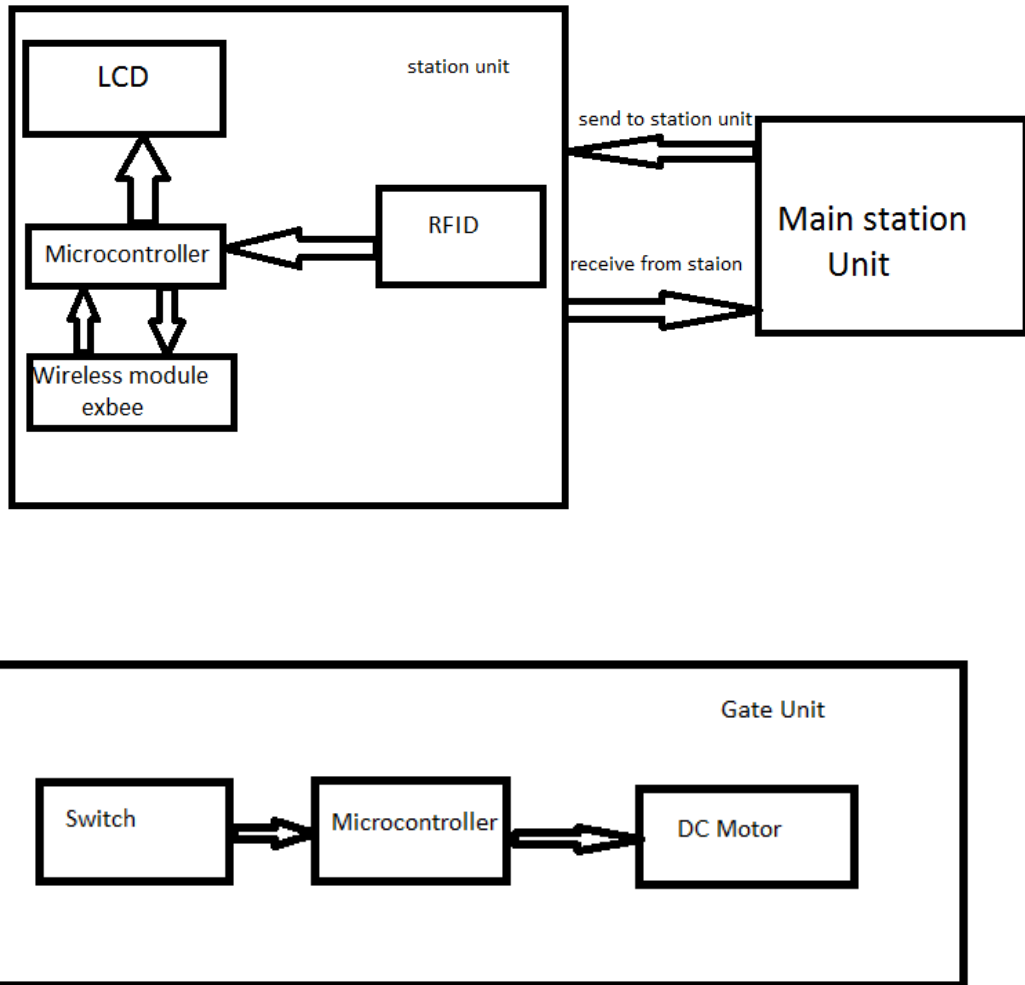
Figure 3.1: Component in each Unit with details.

The important unit in the previous steps is the main station unit that sends and receives data to other stations. There are two way of communication as shown in Figure 3.2:

(1) One way that the main station receive data from station unit, display it on the LCD and send this data to other stations.

(2)The opposite way is station unit receive data from the main station unit and display it on their LCD.

```
┌─────────────┐        ┌──────────┐        ┌─────────────┐
│ Receive data│        │          │        │Sends received│
│  from any   │═══════▶│   The    │═══════▶│data to other │
│   station   │        │  Main    │        │  stations    │
└─────────────┘        │ Station  │        └─────────────┘
                       │          │
┌─────────────┐        │          │        ┌─────────────┐
│Display data on│◀═════│          │◀═══════│Received data │
│central unit │        │          │        │ from other   │
│   screen    │        └──────────┘        │ statin and   │
└─────────────┘                            │ display it   │
                                           └─────────────┘
```
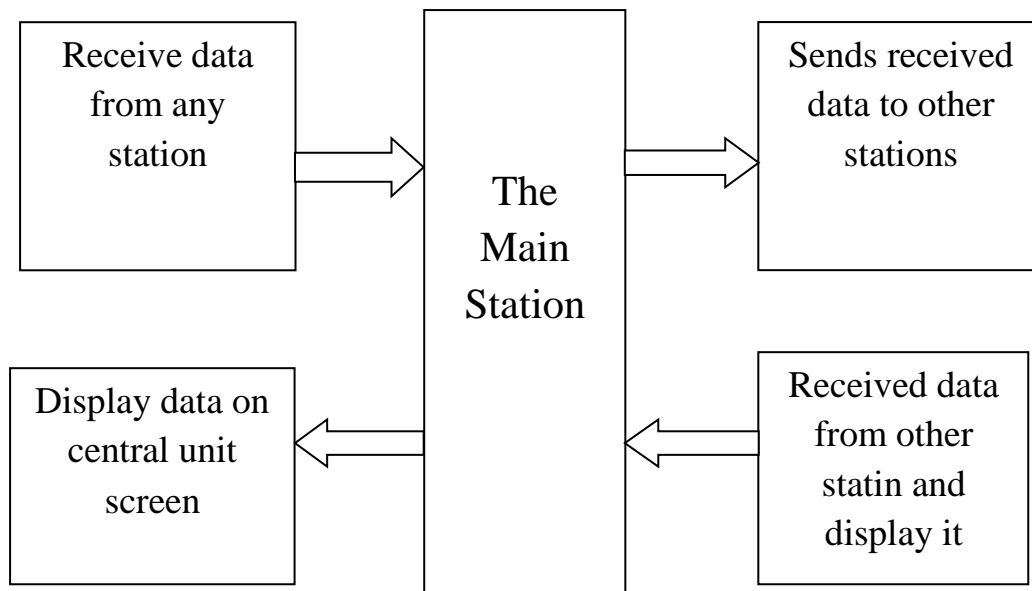
Figure3.2: Communication Ways in the Main Station

3.3 The Main Station

The function of the main station is to receive the train information (train position, arrival time, departual time, next station) from all stations (station1, station2, station3, station4)   through the wireless communication (X-bee), then the main station will send this point to other stations through the X-bee, also this unit receive all train identities from other stations, and display them on the LCD.

The following flow chart describe the flow of data As shown in Figure 3.3
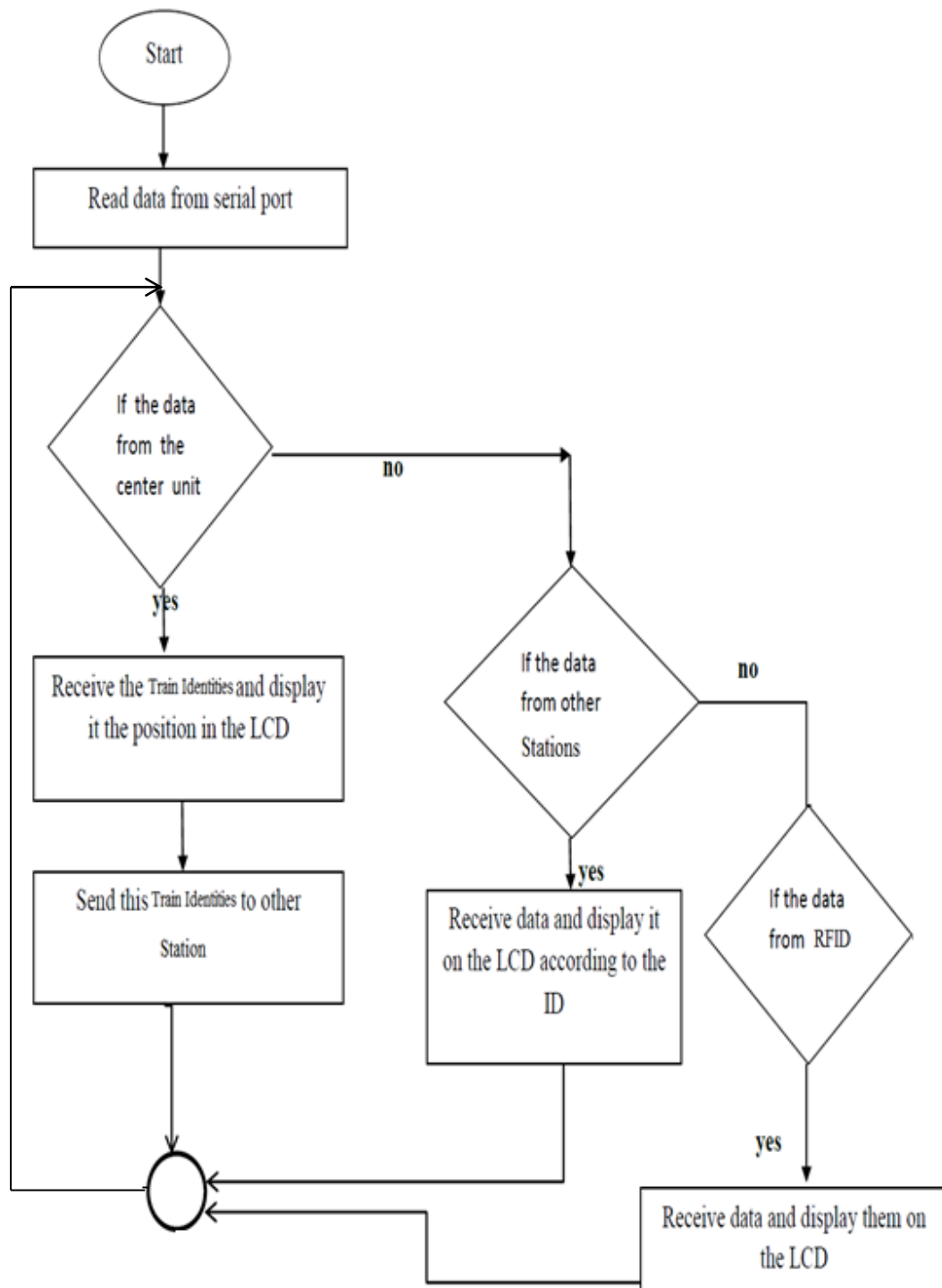
Figure 3.3: Flow Chart of the Main Station

The Figure 3.4 show the block diagram of that sends and received the flow chart sequence.

Send Identities ⟶

Receive Identities ⟵
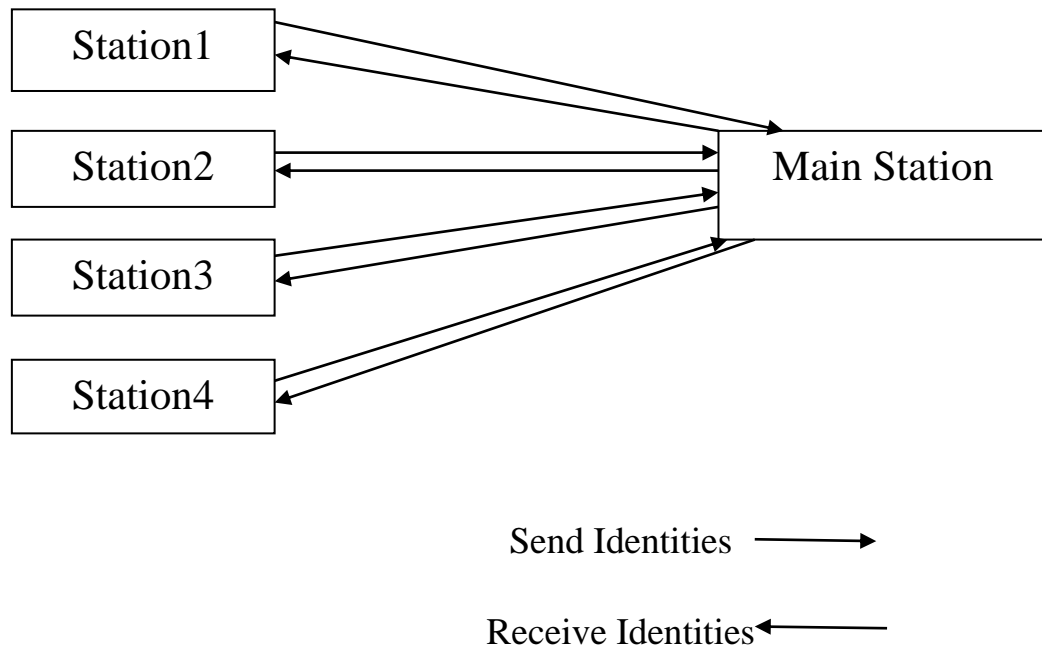
Figure (3.4): Send and Receiving Process of Main Station

3.4 The Stations

Every station must contained RFID tag device, Arduino microcontroller and X-bee, for analysis data when train arrives and RFID tag in station detect identities with the RFID reader that attached to the train and extract the information about the train (train position, arrival time, departual time, next station) send all these information to the main station continuously.

Figure 3.5 show the flow chart of sending and receiving data
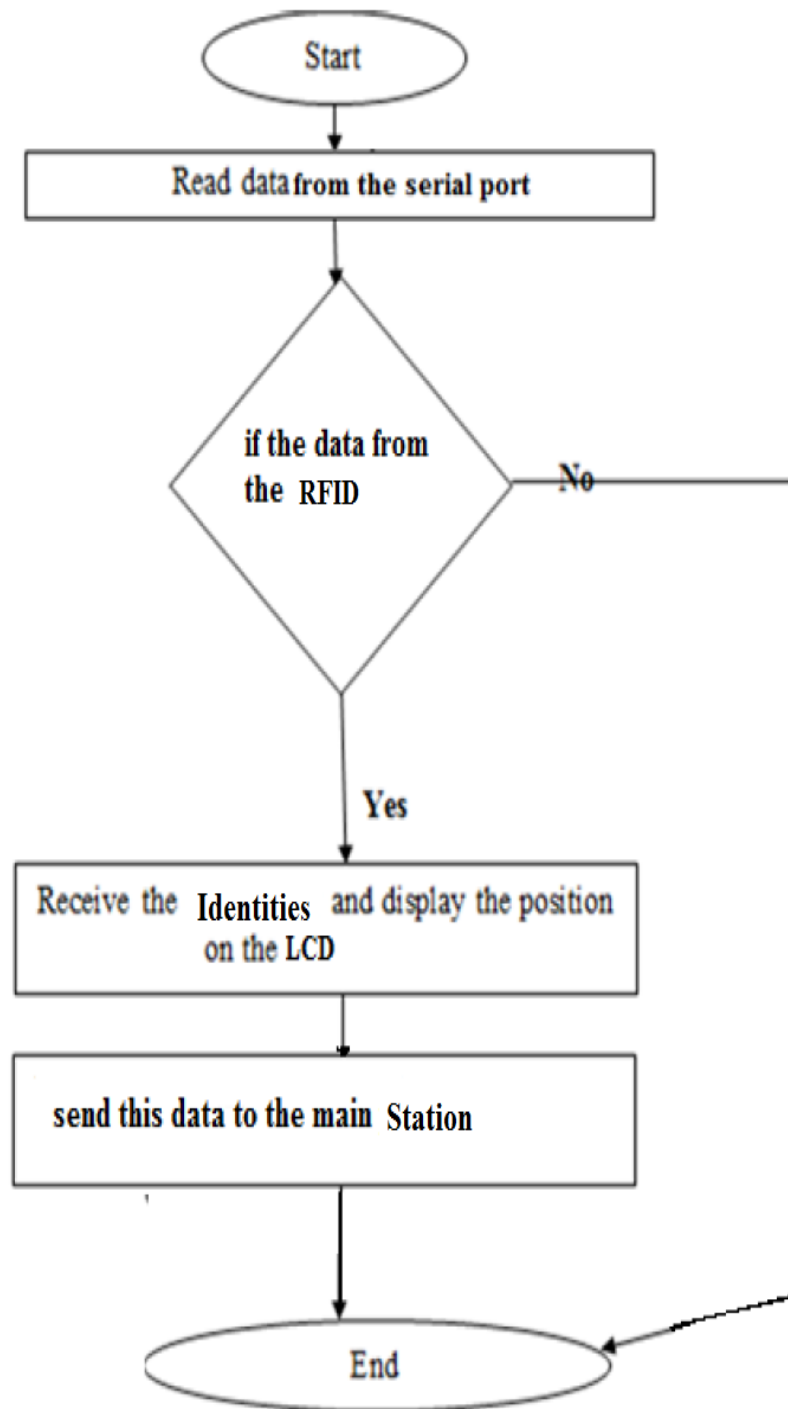
Figure 3.5: Stations Sending and Receiving Data

3.5 The gate

The railway gate is to be closed when a train is passing by the way. The opening and closing of the gate is to be done using DC motors and this DC motor is controlled by microcontroller. The signaling of the train is also controlled depending up on the gate position. Only when gate is closed the green signal is otherwise red signal. The automatic opening and closing of the gate and also the signaling which depending on the gate position that will be controlled by the microcontroller.
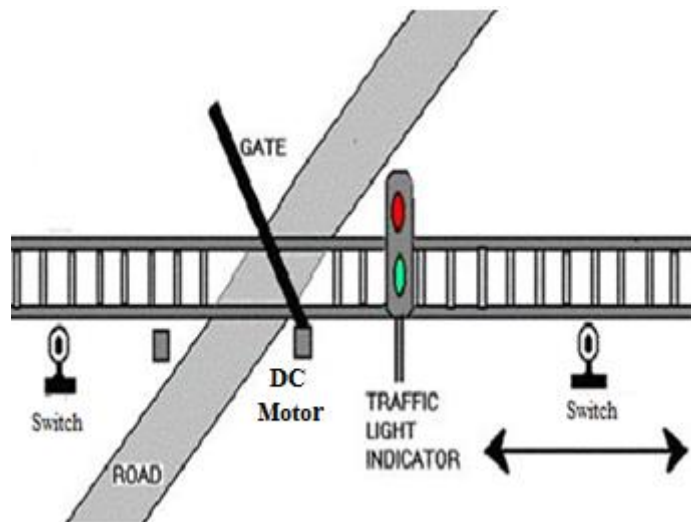
Figure 3.6: Component in gate Unit with details.

When train comes from aft side the switch is disturbed by the train, we have considered 5 seconds for this project. switches are fixed at 1Km on both sides of the gate. then only a signal goes to the microcontroller and then micro controller is activated and the program installed in the controller memory is executed. After receiving signal from aft side switch, micro controller activates. The gate across the road is closed with the help of DC motor and a red signal at the road for the passengers is activated. The gate and the signals are controlled by the instructions

stored in the controller. After crossing the gate area when the train reaches to the foreside switch then it sends a signal to the controller. Then controller again executes the instructions to lift up the gate and change the signal to green. The following flow chart describe the flow of data as shown in Figure 3.7
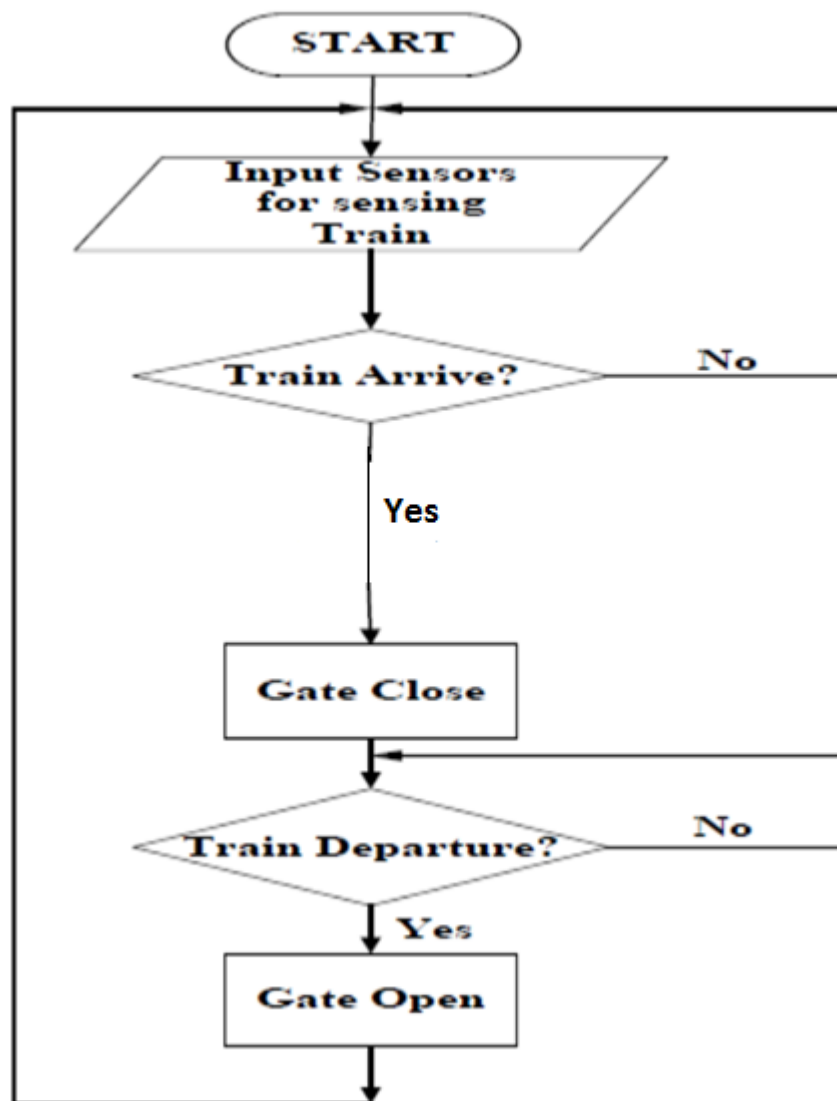
Figure 3.7: Flow Chart of the Gate Unit

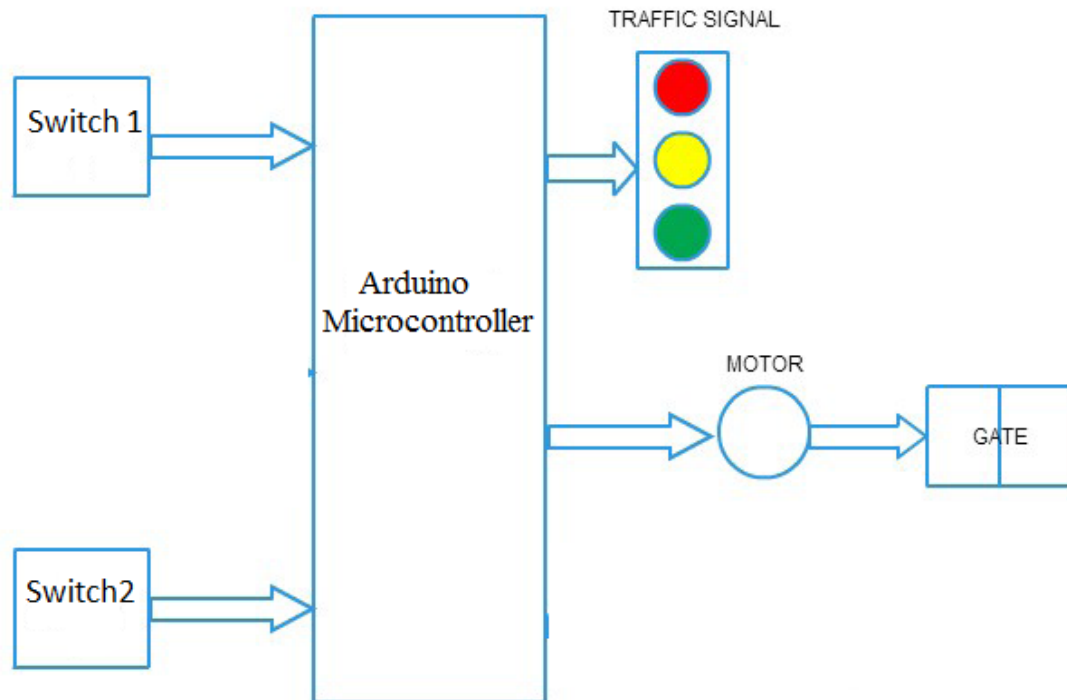The Figure 3.8 shows the block diagram of data following in gate unit.

Figure 3.8: Gate Unit with details.

3.6 The communication

There are two parts of communication, the first wireless communication is between the main station and the other station unit, the wireless used here is X-bee wireless technology.

The second's communication is between the train and all gate units, doing by microcontroller.

3.7 System Requirement

The system requires hardware and software part. The software programed used to design in the system design is arduino and the components are microcontroller, LCD, dc motor, RFID, X-bee wireless.

3.8 Hardware

To connecting the stations unit there are many multiple hardware component that used. The components used here are: RFID, Microcontroller, LCD and X-bee wireless.

To connecting gate unit, the component used here are: DC motor, motion sensor, traffic light.

3.9 Radio-frequency identification (RFID)

A RFID reader will be attached to a train and a tag will be placed in the track station. This is done so that when the reader reads the tag and identifies it as a train, only then it will detect train identifies, save it and send to stations.

3.9.1 The RFID frequency spectrum

RFID is considered as a non-specific short range device. It can use frequency bands without a license. Nevertheless, RFID has to be compliant with local regulations (ETSI, FCC etc.)

•LF: 125 kHz - 134,2 kHz : low frequencies,

•HF: 13.56 MHz: high frequencies,

•UHF: 860 MHz - 960 MHz: ultra-high frequencies,

•SHF: 2.45 GHz: super high frequencies

Here is a graph of the electromagnetic spectrum with the frequency bands that the RFID systems can use
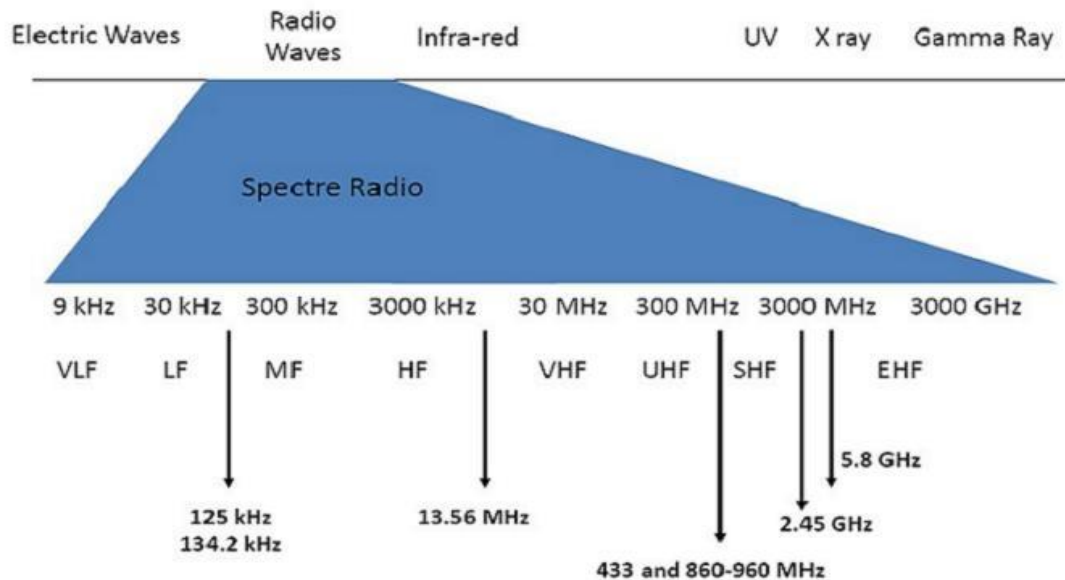
Figure 3.9: Frequency bands of the RFID

3.9.2 LF, HF and UHF RFID tags

• **RFID LF tags** are well adapted for logistics and traceability applications. Glass tags are small and light. They can used be with **all kinds of material - textiles, metals, plastics etc.**

• **RFID HF tags** are used in **traceability and logistics applications**. Loop antenna can be printed or etched on flexible substrates.

• **RFID UHF tags** have dipole like antenna etched or printed on all kind of substrate. The **read range of such a tag can be around 3 to 6 or even 8 meters.** Specific antenna design is required for metallic or wet environments[7].

3.10 Microcontroller

The microcontroller used in this project is Arduino Mega2560. The Arduino Mega 2560 is a microcontroller board based on the ATmega2560.It has 54 digital input/output pins of which 14 can be used as pulse width modulator (PWM) outputs, 16 analog inputs, 4 Universal asynchronous receiver transmitter (UART) serial ports, and a USB connection. The Arduino boards come with a library for interfacing with X-bee module and for dealing with analog or digital inputs and outputs. The Arduino used in the design shown in Figure 3.10 [5].
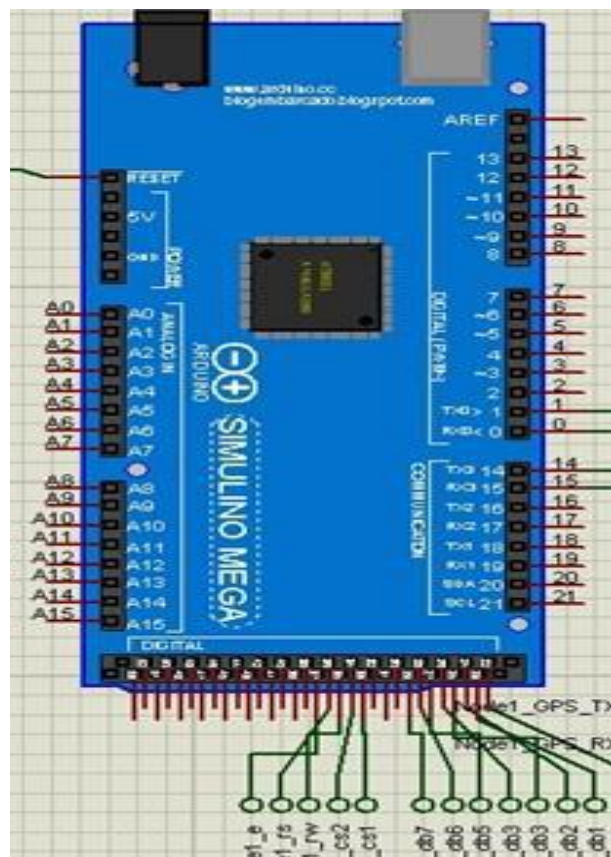
Figure3.10 :Arduino Mega2560

3.11 Graphic Liquid Crystal Display (G LCD)

A graphical LCD display module is typically required when the display of more than text is required. In this project graphic LCD 64x 128 was used. It's an extensive modification of the ks0108 that has higher performance, supports more Arduino boards and is easier to integrate with different panels [8]. The GLCD used in the design is shown in Figure 3.11
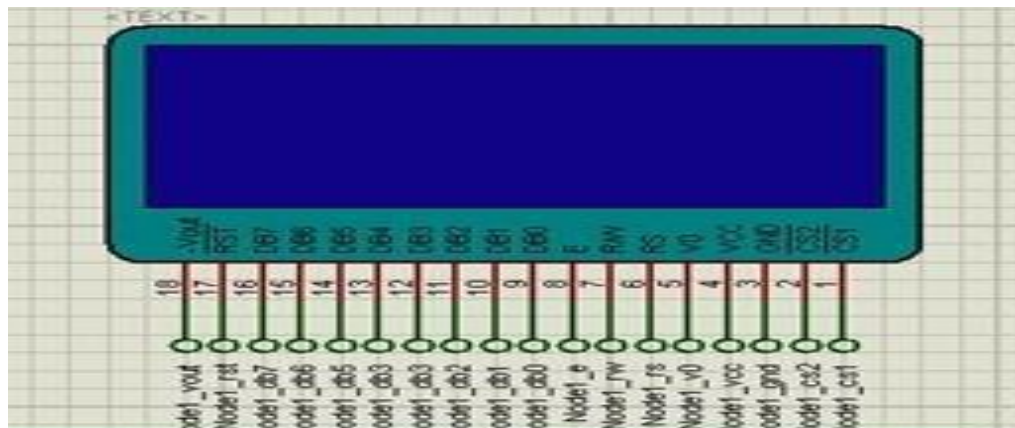
Figure 3.11: GLCD Used

3.12 Wireless X-Bee in the system

X-bee modules, which are based on the IEEE 802.15.4 standards was used in this system to build a low-power. For easy interfacing with X-bee Module, Arduino board was used. The Arduino boards come with a library for interfacing with X-bee module and for de ling with n log or digit l inputs nd output. don't need to be configured, and used for high-throughput applications requiring low latency and predictable communication timing are the reasons of using X-bee. Operate within the ISM 2.4 GHz frequency band and are pin-for-pin compatible with

each other. And Outdoor line-of-sight up to 1k The transmit power for X-bee is 1 mW and the Power-down Current less than10 µA [13]. the X-bee series1(s1) used in the design is shown in Figure 3.12.
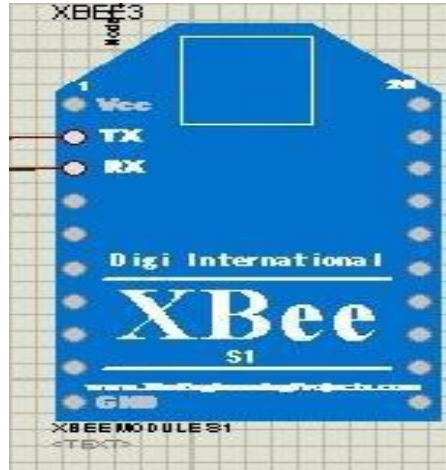
Figure 3.12: X-Bee s1in simulation

3.13A DC motor in the system

The system also uses DC motors to control the operation of the gates.as the Arduino UNO detects a high signal, When train comes from aft side the switch is disturbed by the train, we have considered 5 seconds for this project. Switches are fixed at 1Km on both sides of the gate. from left side switch, micro controller activates. The gate across the road is closed with the help of DC motor and a red signal at the road for the passengers is activated. and the Dc motor moves another 90 degrees [14].
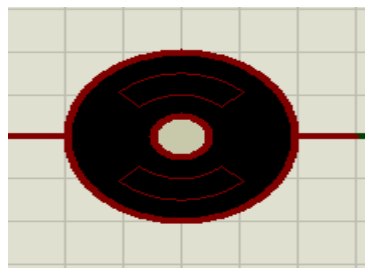
Figure 3.13: DC motor in simulation

The whole design of the above circuit component for the main station and the stations, as shown in the Figure3.14
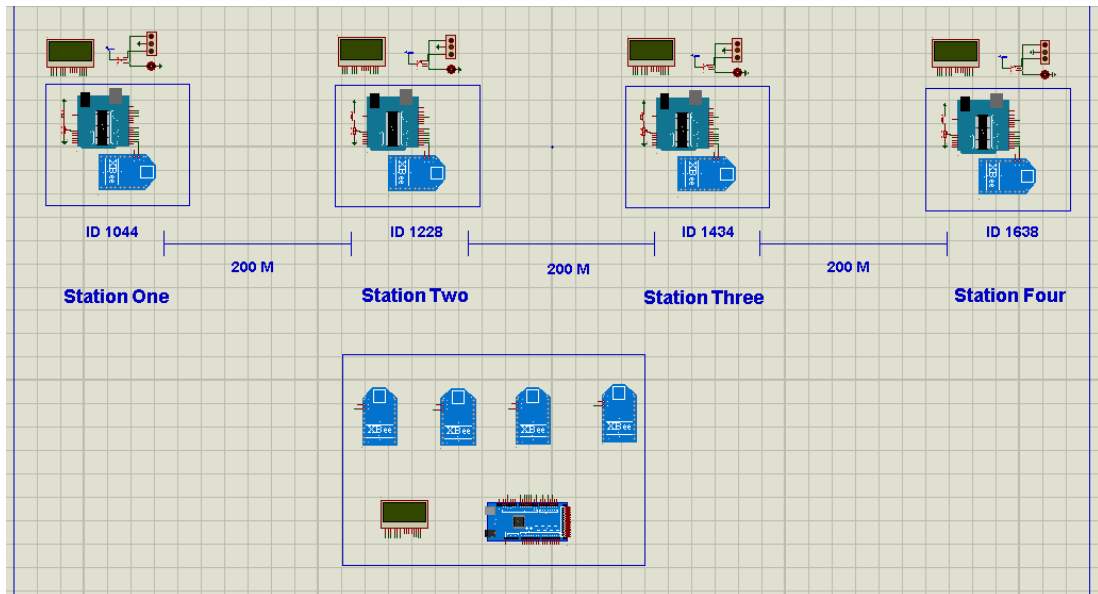
Figure 3.14: Main station Node, four station and gates Node

3.14 Software

The design used software, includes: Arduino Software. The main processing of the data is done by the Arduino processor IC. In order to create program and convert it to .hex file. In order to test our hardware virtually Proteus so that there will be no mistake when the actual hardware is soldered on PCB PROTEUS is useful tool. It allows us to simulate the code in real time environment.

3.15 Arduino Software

By using Arduino software the Arduino code was utility to program Arduino microcontroller to send and receive identities and convert it to a position to display it on the LCD.

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on

a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

Using an Arduino simplifies the amount of hardware and software development you need to do in order to get a system running. hardware platform already has the power and reset circuitry setup as well as circuitry to program and communicate with the microcontroller over USB. In addition, the I/O pins of the microcontroller are typically already fed out to sockets/headers for easy access (This may vary a bit with the specific model).On the software side, Arduino provides a number of libraries to make programming the microcontroller easier. The simplest of these are functions to control and read the I/O pins rather than having to fiddle with the bus/bit masks normally used to interface with the Atmega I/O (This is a fairly minor inconvenience). More useful are things such as being able to set I/O pins to PWM at a certain duty cycle using a single command or doing Serial communication.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Result

The existing system involves announcing the arrival and departure information manually in a particular station while the proposed one is an automated system with very limited human intervention

One of the easiest and cheaper automation systems in railways is by using RFID and XBEE module. In this system a unique RFID code is given to each train. Every train is identified by this RFID code. When train enters platform this code gets scanned and according to scanned data and vacancy of platform train gets diverted to that particular platform. Communication between train scanning system and central processing unit will be established by using XBEE modules. Connecting the main station with other stations unit from a distance far from the center can be done into two tasks: the first task is main station program design and other task is the other stations design.

First thing to do is to setting the virtual serial ports, as shows in Figure 4. Select "forth" because the connection between to four stations and the main station.
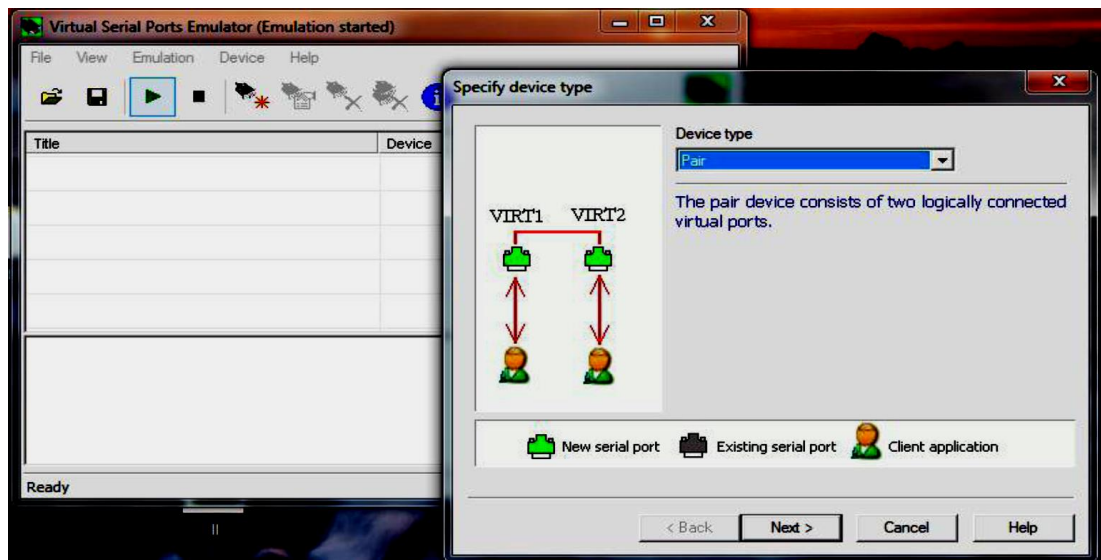
Figure 4.1: Setting of Virtual Terminal

After press next button, the Figure 4.2 will appear to select the com port for the first part of the connection. There is several com appearing in the drop down menu and one of them is chosen.
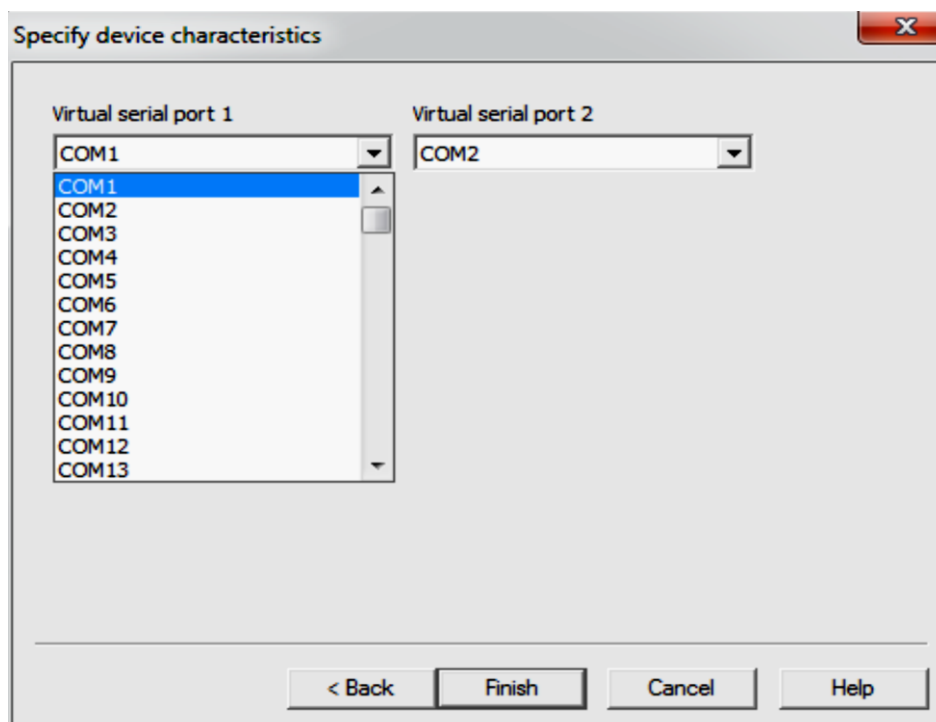

Figure 4.2: Select Com Port for the Connection.

After selecting the first com. Figure 4.3 shows selecting of the second, third and fourth com, the design needed four com because there are four unit stations.
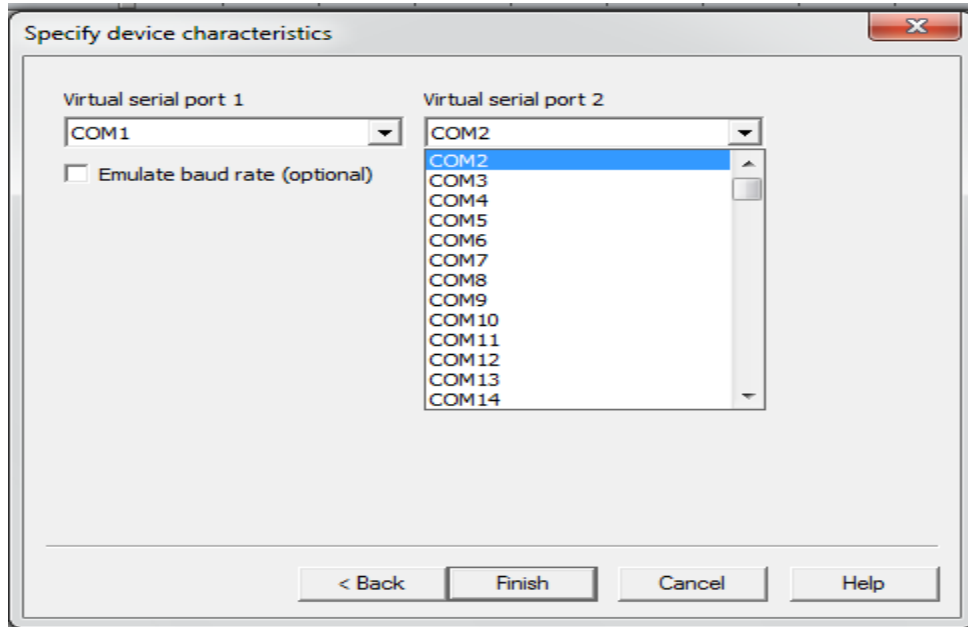

Figure 4.3: Select other Com Port for the Connection.

Finally press finish button, suppose com1 and com2,com3, com4 is selected as shown in Figure 4.4
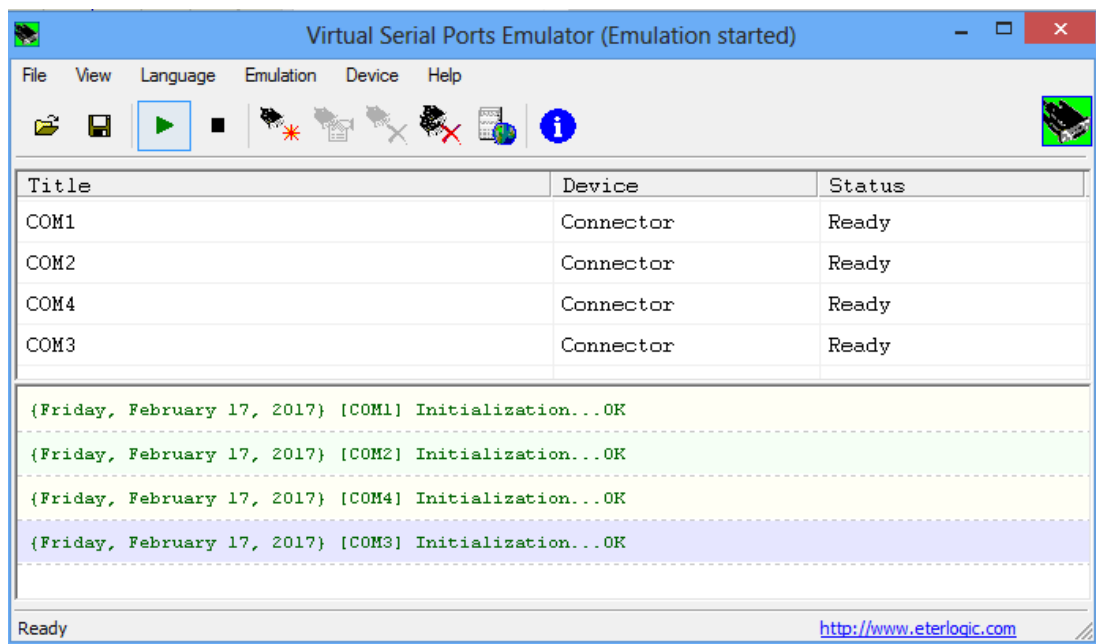
Figure 4.4: The four Connections Com1 with Com2, com3 and com4.

In the center unit station there is a form of map is shows as in Figure 4.6 when the program is load .After loading the com port is selected .It will be one of the com port that is setting in the virtual terminal

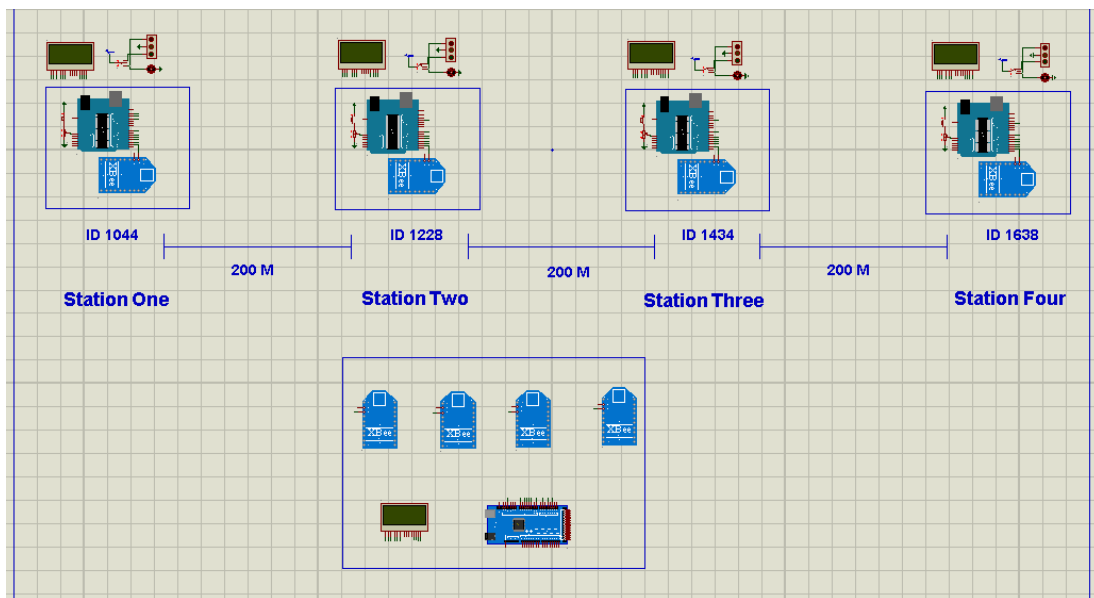The Figure 4.5 shows the circuit component of the main ,gate and other stations node.

Figure 4.5: Component of the Design

Every node consists of Arduino UNO microcontroller and main station has Arduino MEGA microcontroller, graphical LCD, RFID has been used in railway. Active RFID tag in station needs continuous power whereas Passive RFID reader in train is powered by the tag when RF energy is transferred from it to the reader in the train. So here the used them for the implantation of new technology where RFID reader is implemented on the train and the RFID tags are attached in the tracks of any station. The main coil is in RFID tag with a power supply and RFID reader also has a coil and a small chip mainly RAM which contain the 12 bit unique code. The tag then sends the information encoded in the tag's

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memory. And then send by wireless Xbee. After determine the train position, every station node reads its current position then send it to the main station.

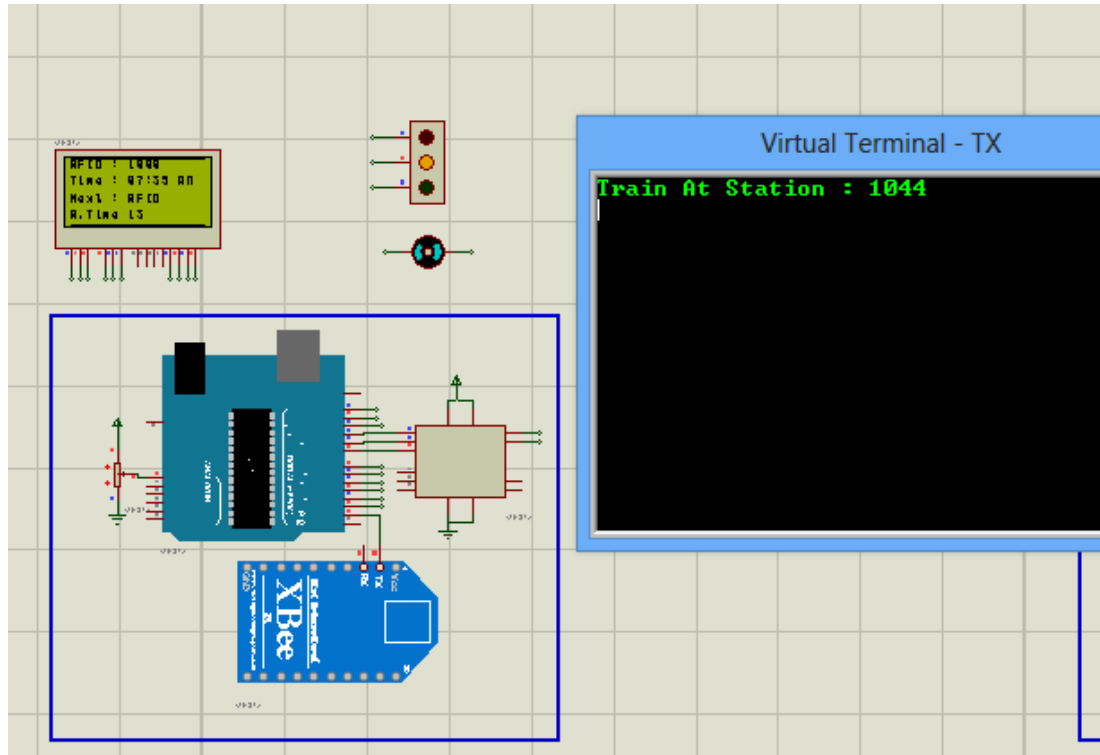Node1 read its position from RFID as show in the Figure 4.6

Figure 4.6: Node1 Position with the design.

Node2 read its position from RFID with the component of the circuit. As it show in the Figure (4.7)
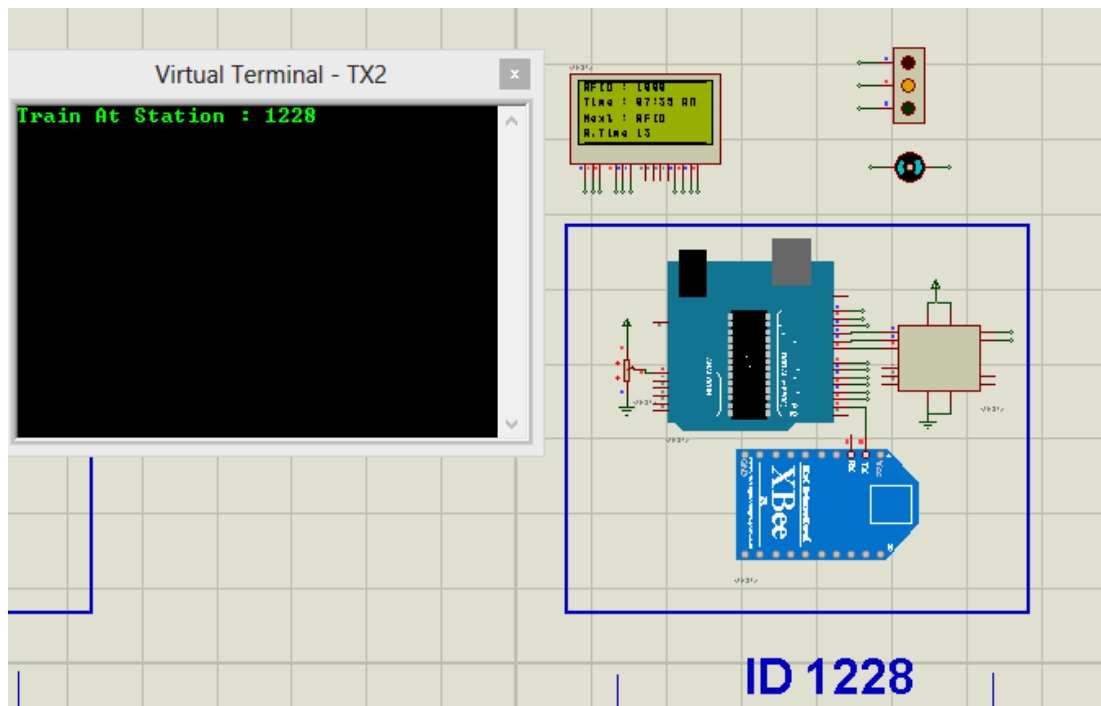
Figure 4.7: Node2 Position with the design.

Node3 read its position from RFID with the component of the circuit. as it show in the Figure (4.8)
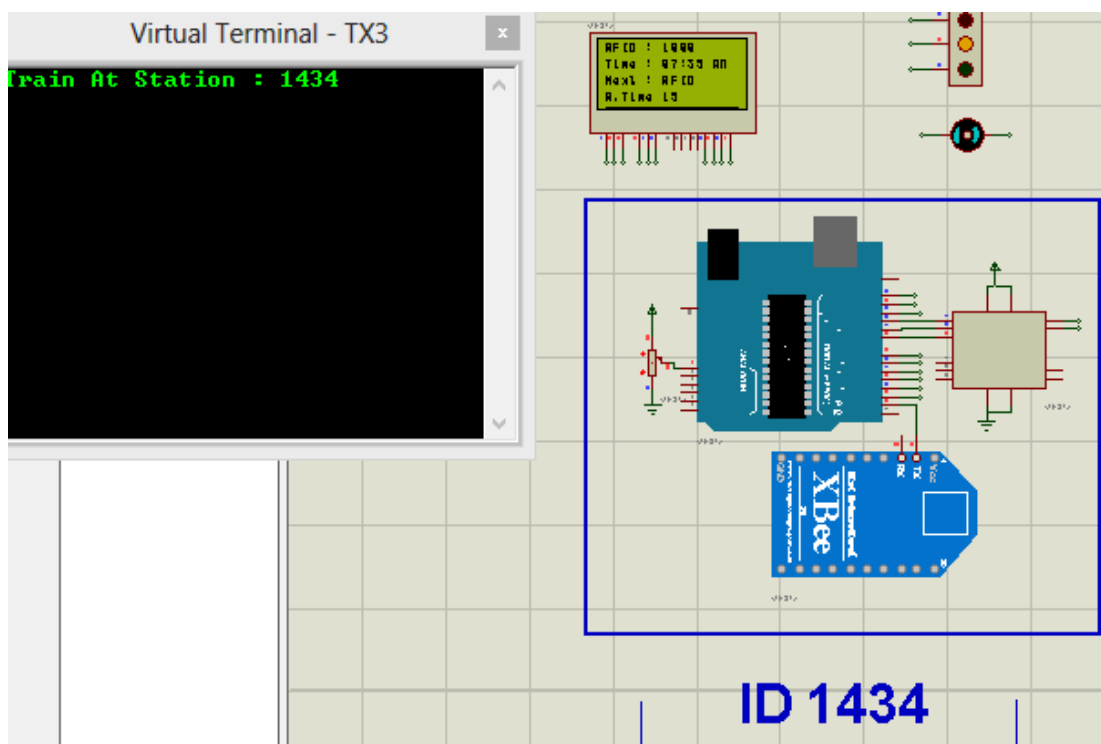
Figure 4.8: Node3 Position with the design.

Node4 read its position from RFID with the component of the circuit. as it show in the Figure (4.9)
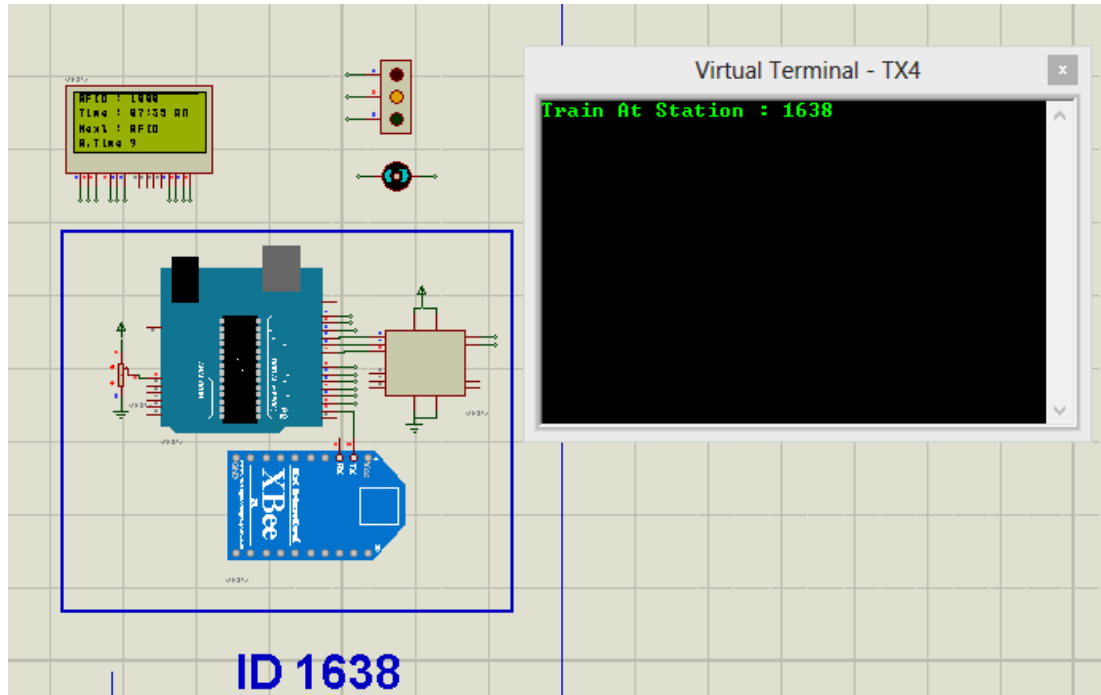

Figure 4.9: Node4 Position with the design.

Finally the all stations send their position identifiers by RFID detection that Arduino microcontroller analysis to extract all information about train departure time, arrival time, next station and so on, via wireless communication (Xbee) to the main unit for central management, Also to send all these information to all station (station1, station2, station3, station4) so at one time all station will have clear updated info about train moving.

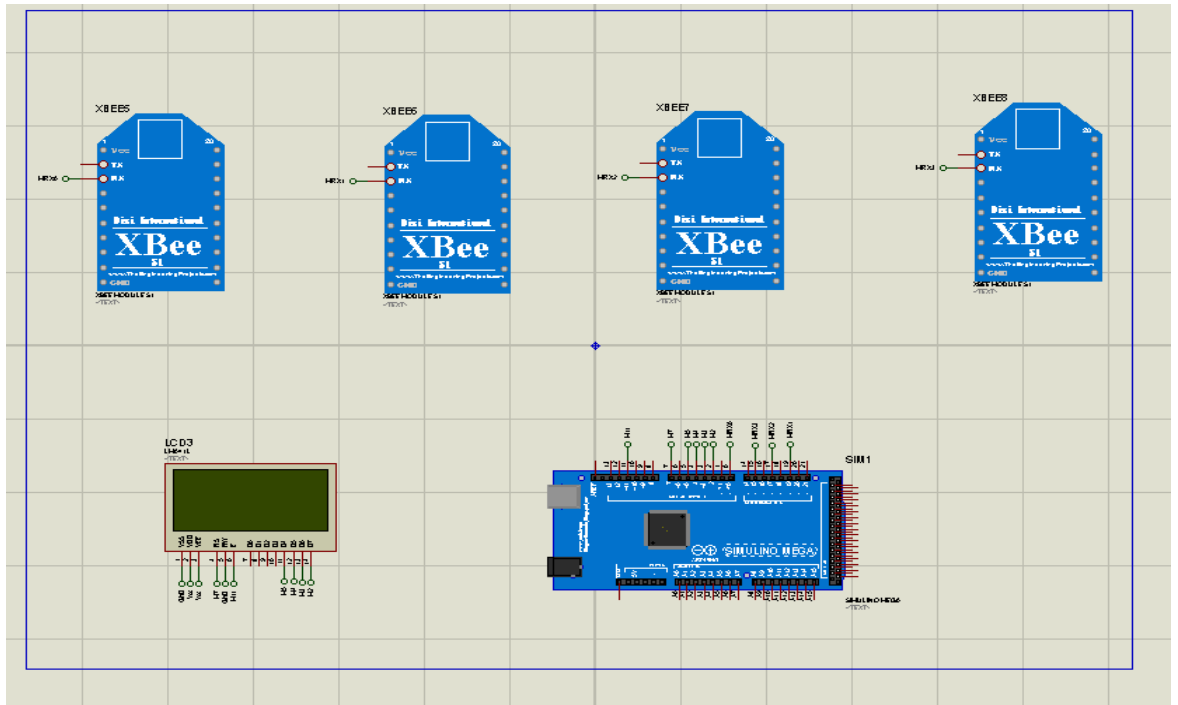This translates operation as shown as in Figure 4.10 here.

Figure 4.10: The position of each station in the main unit map.

When train passes any station will send current position and identifiers to main unit to display it via Xbee node.

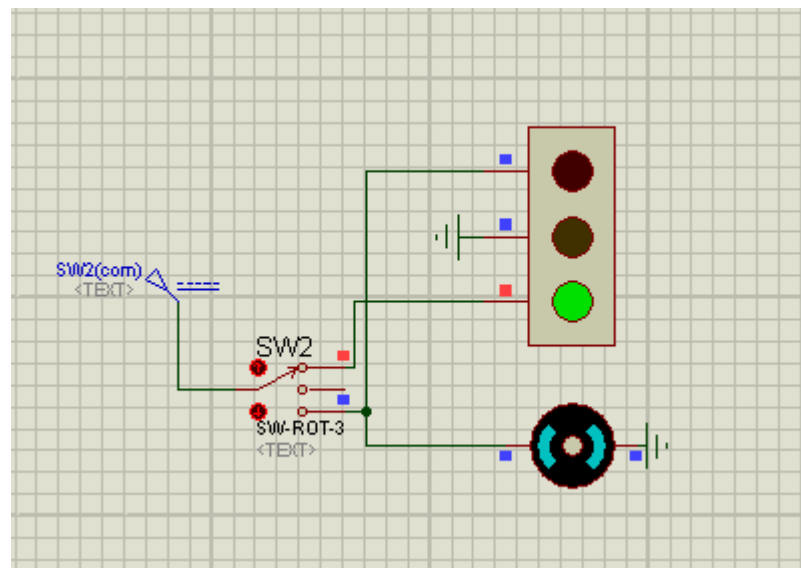Node5 gate unit with the component of the circuit. As it show in the Figure (4.11)

Figure 4.11: Node5 gate unit with the design.

Tow switches are positioned at each crossing road to detect the train arrival. each switch is implanted before and after the level crossing gate for signaling purpose. These sensors will function in association with the state of open and close of the gate mechanism. When the train arrives crossing road, the gate will close and stop other traffic automatically. So traffic light will be red and the motor will be closed by train movement on the switch that has put near road level. Will open after train passes anther switch and traffic light will be green.
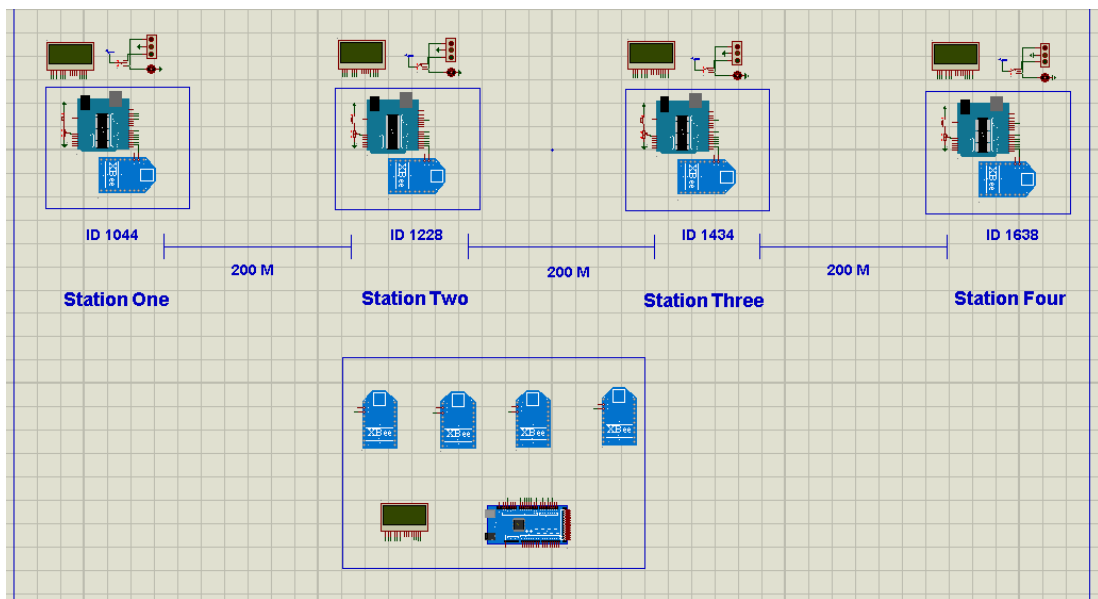

Figure 4.12: All stations after Received Position From main station.

4.2 Discussion

Here We Have Designed Advanced Railway Tracking System with remote station system using Zigbee Communication. Developed an embedded system to identifying rail track Railway has long been considered as the safest transportation media. To improve the efficiency of the transportation systems, it is necessary to investigate the accidents and find out the essential methodologies for optimum management of information and resources available in railway rescue operations. The statistics shows that a huge number of accidents occurred due to human

errors. Therefore, having a systematic way for railway operation management and reduction of human intervention, controlling activities, performances etc. may play a significant role to diminish the number and impact of accidents. Moreover, Reliable, accurate, precise, up-to-date and structured geospatial data is the key for decision making, Railway tracking design consists of some parts: station unit, main station unit and gate unit. These station units are collaborative with each other, the main station is one part that communicates with each station, and the gate unit communicates with train moving. Therefore, this system is very essential for the Khartoum city railway because it could bring an abrupt change to the existing train monitoring system.

After simulating the design there is several points must be considered:

- Train ID is supposed for RFID length (4 bits):

  ➢ Station 1: 1044.

  ➢ Station 2: 1228.

  ➢ Station 3: 1434.

  ➢ Station 4: 1638.

- All the previous communication of sending and receiving data happen in few second about 58 seconds:

  Case1:

  When train travel from station four to station one. In this situation, RFID tag in station one detect train information, extract other information by microcontroller, and display it in their LCD in passenger halls, and send to main station unit.

Case2:

In station two, three, and four microcontrollers receive information by zigbee nodes from main station unit and display the information about train on LCD in passenger halls.

Case3:

When train arrive level of crossing road, the gate will close and stop other traffic automatically. So traffic light will be red and the motor will be closed by train movement on the switch that has put near road level. Will open after train passes anther switch and traffic light will be green.

- To calculate the time that train takes to arrives station which visible by the LCD :

Supposed that train moved by13.333m/sec, and distance between stations is 200m. So train will arrived from station to other in 15sec.

Time = distance/ velocity.

$200 \div 13.333 = 15sec.$

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

By designing this project it shows the state of the practice in real-time train arrival information systems characteristics, including information about the underlying technology and extracts more info like departure time that become easy for the passengers to have full info about train moving, with automatic gate in crossing road that leads to save more people life. Finally more security in the land of the crossing by using gate system with the traffic lights, less used of complex circuit, power consumption and save cost.

The automation discussed here are useful for reducing manpower and thereby increasing efficiency without compromising security constraint and helps to avoid human error.

5.2 RECOMMENDATIONS

It is recommended that GPS system can be implemented and interfaced with the circuitry. GPS system ensures that the correct location of the obstacle can be sent to the nearby railway station through internet. This helps to get the exact location of the obstacle so that the work for the clearance of obstacle can be done faster.

Also, fiber optic system can be implemented in the real time operation. In real time operation sensors can be used in place of track for the detection of train faults.

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