ABSTRACT

The security system is basically an embedded one. Embedded stands for hardware controlled by software. Here, the software using a microcontroller controls all the hardware components. The microcontroller plays an important role in the system. RFID, Radio Frequency Identification is an inexpensive technology, can be implemented for several applications such as security, asset tracking, people tracking, inventory detection, access control applications. The main objective of this project is to design and implement a digital security system which can deploying secured zone where only authentic person can enter. We implemented a security system containing door locking system using passive type of RFID which can activate, authenticate, and validate the user and unlock the door in real time for secured access. The advantage of using passive RFID is that it functions without a battery and passive tags are lighter and are less expensive than the active tags. A centralized system manages the controlling, transaction and operation task. The door locking system functions in real time as the door open quickly when user put their tag in contact of reader.This report provides a clear picture of hardware and software used in the system. It also provides an overall view with detailed discussion of the operation of the system.

Key Words: RFID Reader, Automatic Door Lock System, Authentication, Security.

INDEX

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

BSN	Body Sensor Network
ECG	Electrocardiogram
EDA	Electro Dermal Activity
GSM	Direct Current
GPL	General Public License
LGPL	Lesser General Public License
GPS	Global Positioning System
USB	Universal Serial Bus
IDE	Integrated Development Environment
PCB	Printed Circuit Board
TTL	Transistor Transistor Logic
ADC	Analod To Digital Converter
BiMOS	Bipolar Metal Oxide Semiconductor
BJT	Bipolar Junction Transistor
MOSFET	Metal Oxide Semiconductor Field Effect Transistor
BPM	Beats Per Minute
HRM	Heart Rate Monitor
LSD	Light Sensitive Detector
GPS	Global Positioning System
UTC	Universal Coordinated Time
GNNS	Global Navigation Satellite System
DOD	Department Of Defense
IOC	Initial Operational Capability
SPS	Super Positioning Service
OCS	Operation Control Segment
AFSPC	Air Force Space Command
PPS	Precise Positioning Service
OCX	Operational Control System
RAIM	Receiver Autonomous Integrity Monitoring
MCS	Master Control System
AFSCN	Air Force Satellite Control Network
NGA	National Geospatial-Intelligence

CHAPTER-1

INTRODUCTION

1.1 INTRODUCTION OF PROJECT

In contemporary military operations, real-time wireless embedded electronics are essential for safeguarding the security of the troops. As a result of the real-time monitoring and communication capabilities offered by these embedded electronics, which are included into troops' gear and uniforms, situational awareness, threat identification, and communication with other soldiers and command posts are all improved. With a focus on real-time wireless embedded electronics for soldier security, this article attempts to provide a thorough analysis of the field's present level of study while also outlining the obstacles to and potential directions for future development in this crucial field of military technology. The field of soldier security has been transformed by wireless embedded electronics, which offer real-time monitoring, tracking, and communication capabilities that improve situational awareness, safety, and operational effectiveness. These state-of-the-art technologies have been incorporated into the gear and equipment that soldiers use on the battlefield, enabling them to receive and share crucial information, communicate with command posts and other soldiers, and react quickly to changing circumstances. The nation’s security is monitored and kept by army, navy and air-force. There are many concerns regarding the safety of the soldier. Soldiers in battlefield often lose their lives due to lack of connectivity, it is very vital for the army base station to known the location as well as health status of all soldiers. To avoid life-threatening situations, it is helpful to continuously monitor soldiers suffering from harsh conditions. The Wireless Sensor Network (WSN) plays a crucial role in health monitoring, since it enables us to connect sensors to collect soldiers' health and environmental data and process it to prevent critical events. Major research is being done by some of the world’s largest militaries like Russian and U.S. Army to build wearable embedded device which could monitor the physical and environmental factors of soldiers, like in TALOS Exoskeleton (Tactical Assault Light Operator Suit) project which involves 56 corporations, 16 governments agencies, 13 universities, and 10 national laboratory for research and development purpose [1]. In-depth analysis regarding smart wearable clothing has been provided by Scataglini et al. [2], about the application and importance of smart wearable clothing in the Army. A comprehensive survey has been provided by Islam et al. [3] which provides information regarding the impact of IoT on e-health monitoring, monitored parameters and provided services. Existing IoT-based healthmonitoring systems suffer from three main constraints. First, they often make use of relatively high cost communication links, such as 3G/4G [4, 5]. Second, they typically do not deal with data privacy issues [6, 7]. Third, most of them do not analyze monitored health parameters to prevent critical situations [6, 7]. In this paper, we propose an IoT-based health monitoring approach that addresses above mentioned issues. Ahmed et al. [6] have proposed an architecture for e-health monitoring systems. The authors [8-10], had discussed about various wearable, portable, light weighted and small sized sensors that have been developed in order to monitor physiological parameters of the human. The Body Sensor Network (BSN) consists of many biomedical and physiological sensors which can be placed on human body for health monitoring in real time. GSM is used for communication which may not be useful at places with high altitude or in remote areas where network connectivity would be a big challenge. A message is sent after regular intervals the health status of the soldier using GSM. In paper [11], authors implementedmonitoring system including data privacy using blockchain which is an important factor, but the use of GSM can be troublesome in the war-field. Another IOT-based system is described in the paper [12] which uses the Wi-Fi module to communicate with control room.

which can be costly in terms of power consumption. Gondalia et al. [13] described the system that tracks the location and monitors the health of the soldiers. The data collected from sensors will be transmitted wirelessly using ZigBee module among the fellow soldiers. Furthermore, IOTWAN network has been proposed to be used between the squadron leader and the control unit in high altitude warzones where cellular network coverage is either absent or does not allow data transmission. Mdhaffar et al. [14], has proposed, IoT-based Health Monitoring via IOTWAN in which collected medical sensor data is sent to an analysis module IOTWAN (Long Range Wide Area Network) network infrastructure. Power consumption of their monitoring system is claimed to be ten times lower than other long-range cellular solutions, such as GPRS/3G/4G. Previously, similar work has been done by our group using Arduino [15], but due to limited processing power of Arduino and lacking USB port for camera and microphone connection, we have used Raspberry Pi to overcome the above mentioned controller constraints. In our model, the Journal of Engineering Sciences Vol 14 Issue 02,2023

1.2 LITERATURE REVIEW:

During, wars and military search operations, soldiers get injured and sometimes become lost. To find soldiers and provide health monitoring, army base stations need GPS device for locating soldiers, WBASNs to sense health related parameters of soldiers and a wireless transceiver to transmit the data wirelessly. Hock Beng Lim, Di Ma, Bang Wang, ZbigniewKalbarczyk, Ravishankar K. Iyer, Kenneth L. Watkin [1] had discussed on recent advances in growing technology, and on various wearable, portable, light weighted and small sized sensors that have been developed for monitoring of the human physiological parameters. The Body Sensor Network (BSN) consists of many biomedical and physiological sensors such as blood pressure sensor, electrocardiogram (ECG) sensor, electro dermal activity (EDA) sensor which can be placed on human body for health monitoring in real time. In this paper, we describe an idea to develop a system for real time health monitoring of soldiers, consisting of interconnected BSNs. We describe the basic prototype of the system and present a blast source localization application. In this paper, we have completed only an initial design of individual sensor nodes and developed a basic prototype of the system to collect the sensed data. In future, we will try to develop an integrated data management system and a web portal which will enable users to have easy access of data. P.S. Kurhe, S.S. Agrawal [4] had introduced a system that gives ability to track the soldiers at any moment. Additionally, the soldiers will be able to communicate with control room using GPS coordinate information in their distress

The future works in this system may include the optimization of the hardware components, by choosing a suitable and more accurate GPS receiver. By improving the routing algorithm can be make this system more powerful and energy efficient. Upgrading this system is easy which makes it open to an advanced future. ShrutiNikam, SupriyaPatil, PrajktaPowar, V. S. Bendre [5] had presented an idea for the safety of soldiers. There are many instruments which can be used to view the health status of soldiers as well as ammunitions on them. The Bio sensor which consists of various types of small physiological sensors, transmission modules have great processing capabilities and can facilitates the low-cost wearable solutions for health monitoring GPS module can be used to log the longitude and the latitude by which directions and location can be traceable easily. RF module can be used for high speed, short-range data transmission.

Thus, we can help the soldiers in panic condition from army control room by communicating with them during war. Rubina.A.Shaikh [10] had investigated for the care of critically ill patients. Considering in India, everyday many people get affected by heart attack, and many of them become more serious, because they did not get proper and timely help of doctors. This paper is based on monitoring the health of remote patients, when they get discharged from hospital. I have tried to design and develop an energy efficient and reliable health monitoring system which is able to send the parameters of patients in real time because of the use of ARM 7 microprocessor. This system enables the doctors to monitor module as a wireless transmission device. Additionally, if doctor will not present in clinic or hospital, then too, they will able to receive SMS on their mobile phone, in case of any health parameter increases beyond the normal range using GSM technology. But, to get the more accurate and correct ECG readings, the leads of the ECG sensor should be stick properly on the body of patient, fails to do so; ECG readings will not be accurate.

EXISTING SYSTEM

In this Existing system the soldier Health and Position Tracking System allows military to track the current GPS position of soldier and also checks the health status including body temperature and heartbeats of soldier. The System also consists extra feature with the help of that soldier can ask for help manually or send a distress signal to military if he is in need. The GPS modem sends the latitude and longitude position with link pattern with the help of that military can track the current position of the soldier. The system is very helpful for getting health status information of soldier and providing those instant help for that they are using Zigbee module on LPC1768 ARM Microcontroller.

PROPOSED SYSTEM

In This Proposed System the soldier Health and Position Tracking System allows military to track the current GPS position of soldier and also checks the health status including body temperature and heartbeats of soldier. The System also consists extra feature with the help of that soldier can ask for help manually or send a distress signal to military if he is in need. The GPS modem sends the latitude and longitude position with link pattern with the help of that military can track the current position of the soldier. The system is very helpful for getting health status information of soldier and providing them instant help and here we are using Arduinouno microcontroller and GSM module for Sending message on Health condition and the location of the Soldier to the military.

SIGNIFICANCE OF WORK

These are more secure and fast responded as compared to other system like biometric. This is contact-less and works without line of sight. It is easy to access and works very quickly while burning the code it is like plug and play device. User can Change the function accordingly by using micro controller. It is easier to use and accurate also. Security and access control systems is very convenient use at home. Used in office and commercial, buildings and industries.

ORGANISATION OF THESIS

The Smart Door Accessing System has been split up into seven chapters consisting of Introduction, Aim and Objective, Literature review, System Design, Results and Recommendations.

- Chapter 1 details introduction, aim and objective, methodology and significance of work.
- Chapter 2 includes the literature survey of the project.
- Chapter 3 includes the design and working principle.
- Chapter 4includes component description.
- Chapter 5includes result and discussion.
- Chapter 6 deals conclusion.
- Chapter 7 discusses the future scope.

The project report aims at providing an in-depth and accurate analysis and of intelligent speed bump system design and relevant theory. It is hoped that enough detail has been provided to allow a good understanding of the design.

CHAPTER-2

IMPLEMENTATION OF PROJECT

2.1 Block diagram

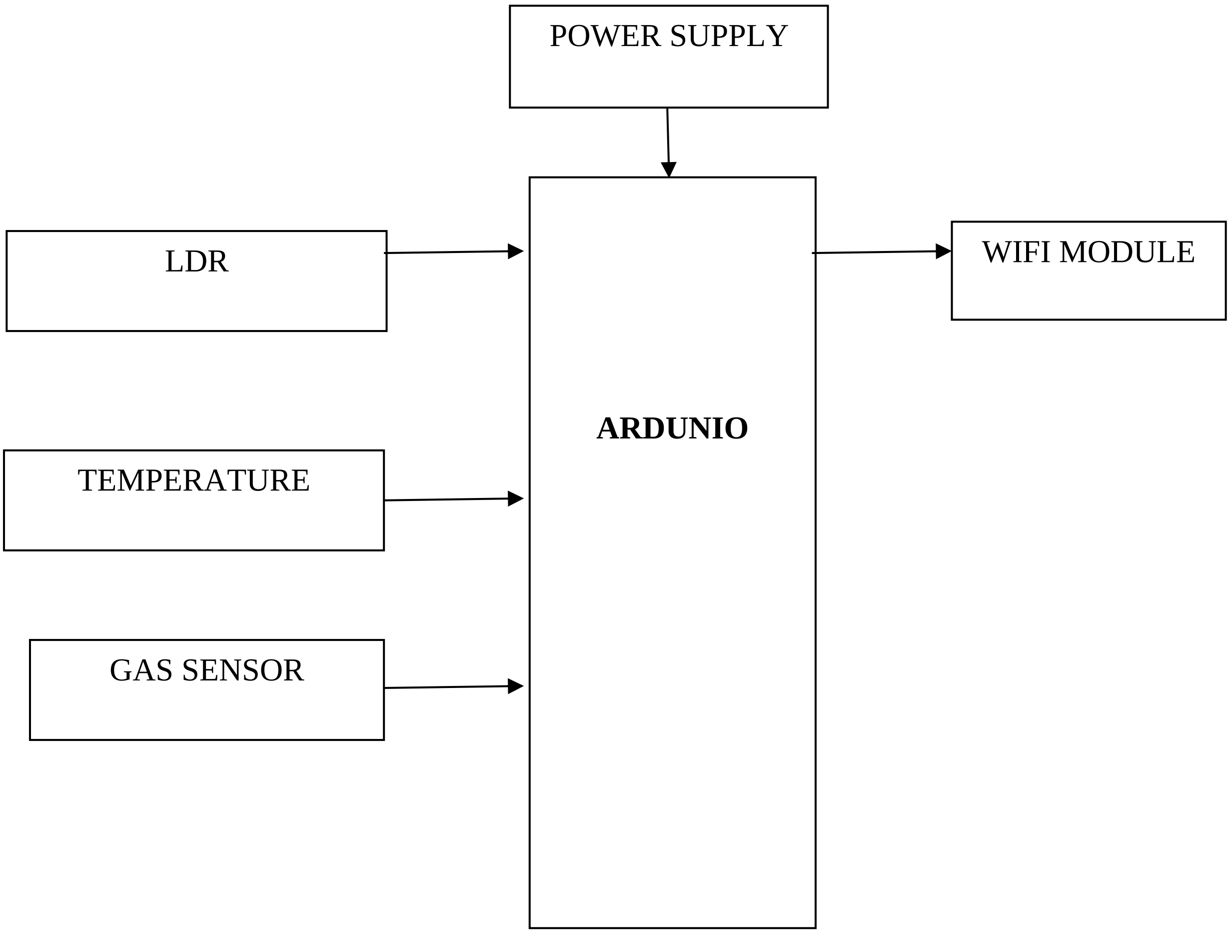

Fig 2.1.1 Block diagram

2.2 Description of the block diagram:

The ARDUNIO ships as a bare circuit board with standard connections humidity sensor, Temperature, rain sensor, relay, Motor and Lcd, fan with power supply.

AVR MICROCONTROLLER

Introduction:

Arduino is a computer hardware and software company, project, and user community that designs and manufactures 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.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of 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 a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

The Arduino project started in 2005 as a program for students at the Interaction Design Institute Ivrea in Ivrea, Italy,[2] aiming to provide a low-cost and easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors.

The name *Arduino* comes from a bar in Ivrea, Italy, where some of the founders of the project used to meet. The bar was named after Arduin of Ivrea, who was the margrave of the March of Ivrea and King of Italy from 1002 to 1014.

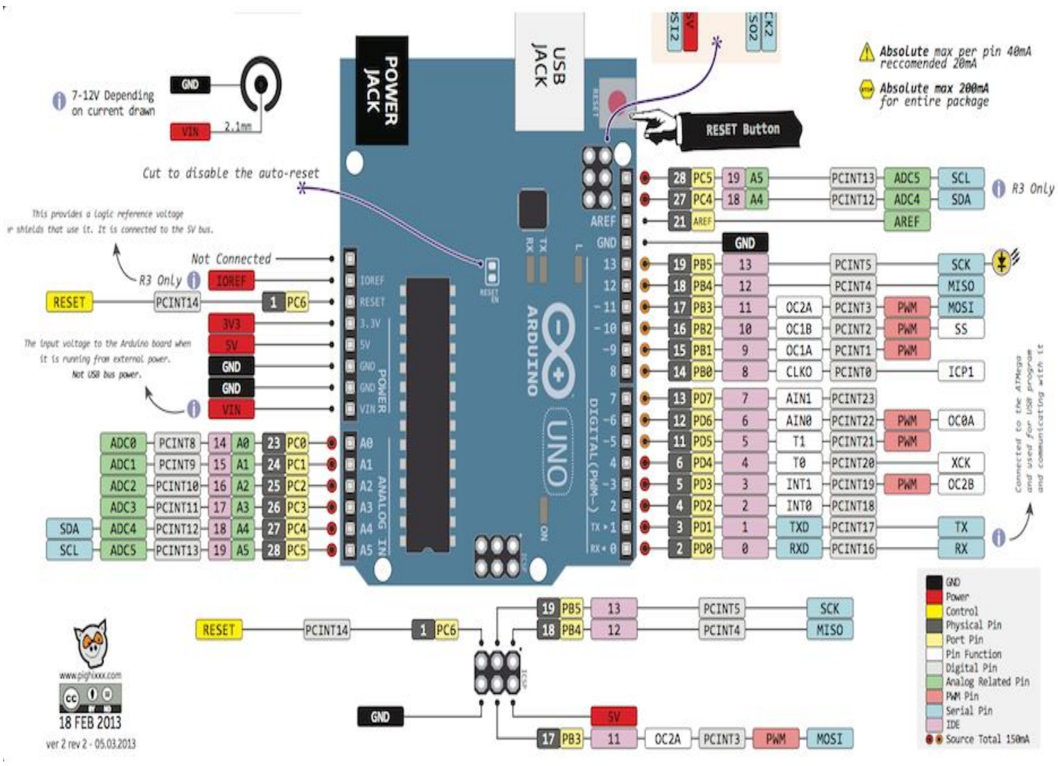

Fig 2.2: Arduino board

History:

The origin of the Arduino project started at the Interaction Design Institute Ivrea (IDII) in Ivrea, Italy.[2] At that time, the students used a BASIC Stamp microcontroller at a cost of $100, a considerable expense for many students. In 2004, Colombian student Hernando Barragán created the development platform *Wiring* as a Master's thesis project at IDII, under the supervision of Massimo Banzi and Casey Reas, who are known for work on the Processing language. The project goal was to create simple, low cost tools for creating digital projects by non-engineers. The Wiring platform consisted of a printed circuit board (PCB) with an ATmega168 microcontroller, an IDE based on Processing and library functions to easily program the microcontroller.

Adafruit Industries, a New York City supplier of Arduino boards, parts, and assemblies, estimated in mid-2011 that over 300,000 official Arduinos had been commercially produced, and in 2013 that 700,000 official boards were in users' hands.

2.3 Hardware:

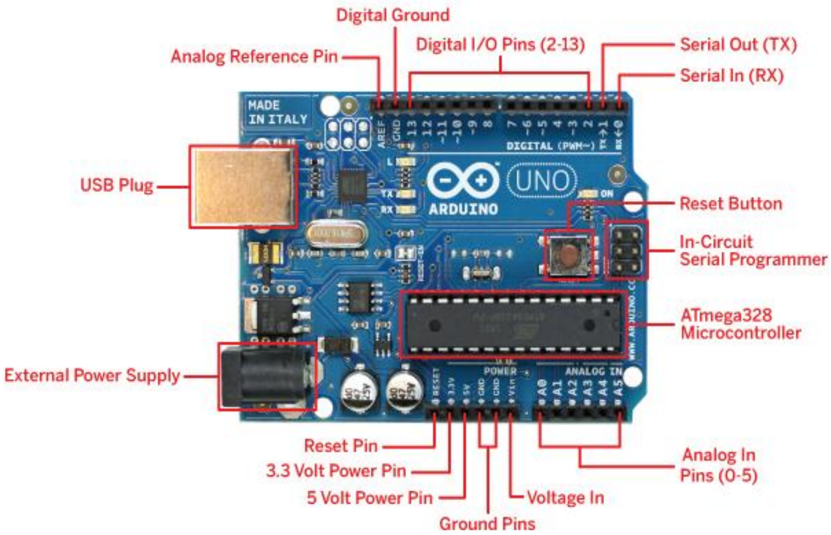

Fig 2.3: Hard ware parts

Arduino is open-source hardware. The hardware reference designs are distributed under a Creative Commons Attribution Share-Alike 2.5 license and are available on the Arduino website. Layout and production files for some versions of the hardware are also available. The source code for the IDE is released under the GNU General Public License, version 2. Nevertheless, an official Bill of Materials of Arduino boards has never been released by Arduino.

Although the hardware and software designs are freely available under copyleft licenses, the developers have requested that the name *Arduino* be exclusive to the official product and not be used for derived works without permission. The official policy document on use of the Arduino name emphasizes that the project is open to incorporating work by others into the official product.[9] Several Arduino-compatible products commercially released have avoided the project name by using various names ending in *-duino*.

Arduino microcontrollers are pre-programmed with a boot loader that simplifies uploading of programs to the on-chip flash memory. The default bootloader of the Aduino UNO is the optibootbootloader. Boards are loaded with program code via a serial connection to another computer. Some serial Arduino boards contain a level shifter circuit to convert between RS-232 logic le transistor–

transistor logic (TTL) level signals. Current Arduino boards are programmed via Universal Serial Bus (USB), implemented using USB-to-serial adapter chips such as the FTDI FT232. Some boards, such as later-model Uno boards, substitute the FTDI chip with a separate AVR chip containing USB-to-serial firmware, which is reprogrammable via its own ICSP header. Other variants, such as the Arduino Mini and the unofficial Boarduino, use a detachable USB-to-serial adapter board orcable, Bluetooth or other methods, when used with traditional microcontroller tools instead of the ArduinoIDE, standard AVR in-system programming (ISP) programming is used.

The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub *main()* into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program *avrdude* to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

The original Arduino hardware was produced by the Italian company Smart Projects.[15] Some Arduino-branded boards have been designed by the American companies SparkFun Electronics and Adafruit Industries. As of 2016, 17 versions of the Arduino hardware have been commercially produced.Software development .A program for Arduino may be written in any programming language for a compiler that produces binary machine code for the target processor. Atmel provides a development environment for their microcontrollers, AVR Studio and the newer Atmel Studio.

Official boards:

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Software development .A program for Arduino may be written in any programming language for a compiler that produces binary machine code for the target processor. Atmel provides a development environment for their microcontrollers, AVR Studio and the newer Atmel Studio.

The Arduino project provides the Arduino integrated development environment (IDE), which is a cross-platform application written in the programming language Java. It originated from the IDE for the languages *Processing* and *Wiring*. It includes a code editor with features such as text cutting and pasting, searching and replacing text, automatic indenting, brace matching, and syntax highlighting, and provides simple *one-click* mechanisms to compile and upload programs to an Arduino.

It also contains a message area, a text console, a toolbar with buttons for common functions and a hierarchy of operation menus.A program written with the IDE for Arduino is called a *sketch*.[40] Sketches are saved on the development computer as text files with the file extension *.ino*. Arduino Software (IDE) pre-1.0 saved sketches with the extension *.pde*.

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Applications:

- Xoscillo, an open-source oscilloscope[48]
- Arduinome, a MIDI controller device that mimics the Monome
- OBDuino, a trip computer that uses the on-board diagnostics interface found in most modern cars
- Ardupilot, drone software and hardware
- Gameduino, an Arduino shield to create retro 2D video games[49]
- ArduinoPhone, a do-it-yourself cellphone[50][51]
- Water quality testing platform
- Automatic titration system based on Arduino and stepper motor[53]
- Low cost data glove for virtual reality applications[54]
- Impedance sensor system to detect bovine milk adulteration[55]
- Homemade CNC using Arduino and DC motors with close loop control by Homofaciens
- DC motor control using Arduino and H-Bridge[

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	68.6 mm
Width	53.4 mm
Weight	25 g

Fig 3.1.1 Description of Atmega

Programming:

The Arduino/Genuino Uno can be programmed with the (Arduino Software (IDE)). Select "Arduino/Genuino Uno from the Tools > Board menu (according to the microcontroller on your board). For details, see the reference and tutorials.

The ATmega328 on the Arduino/Genuino Uno comes preprogrammed with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files).

You can also bypass the bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header using Arduino ISP or similar; see these instructions for details.

The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available in the Arduino repository. The ATmega16U2/8U2 is loaded with a DFU bootloader, which can be activated by:

- On Rev1 boards: connecting the solder jumper on the back of the board (near the map of Italy) and then reseing the 8U2.
- On Rev2 or later boards: there is a resistor that pulling the 8U2/16U2 HWB line to ground, making it easier to put into DFU mode

You can then use Atmel's FLIP software (Windows) or the DFU programmer (Mac OS X and Linux) to load a new firmware. Or you can use the ISP header with an external programmer (overwriting the DFU bootloader). See this user-contributed tutorial for more information.

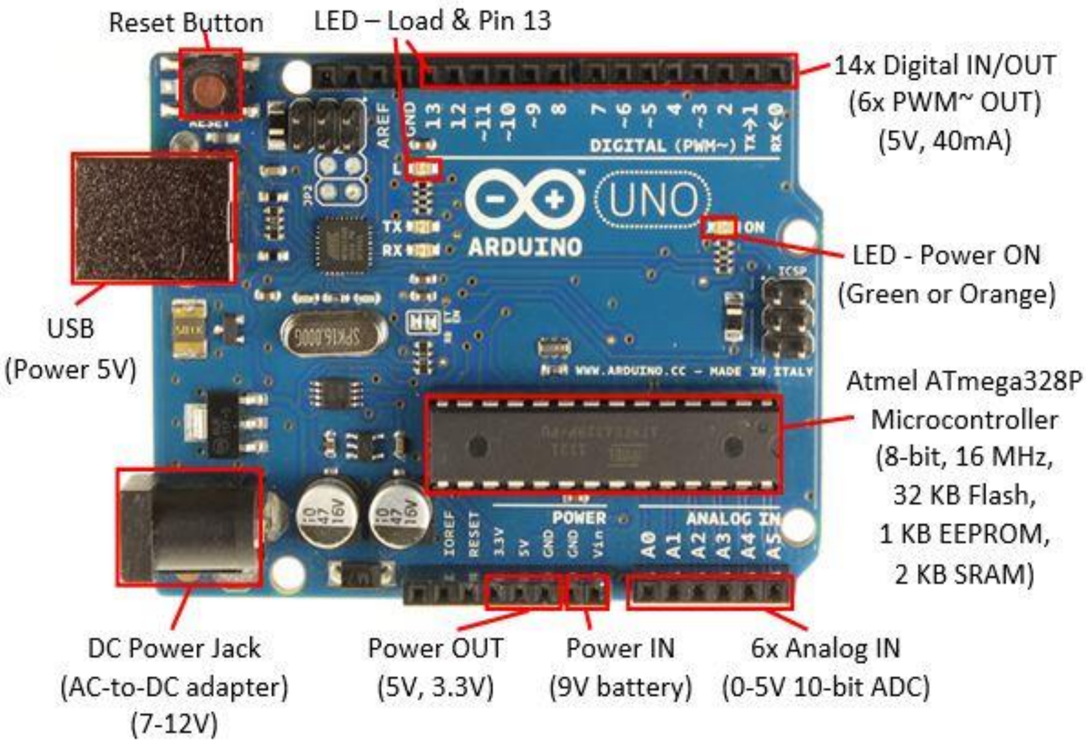


Fig 2.4: power pins

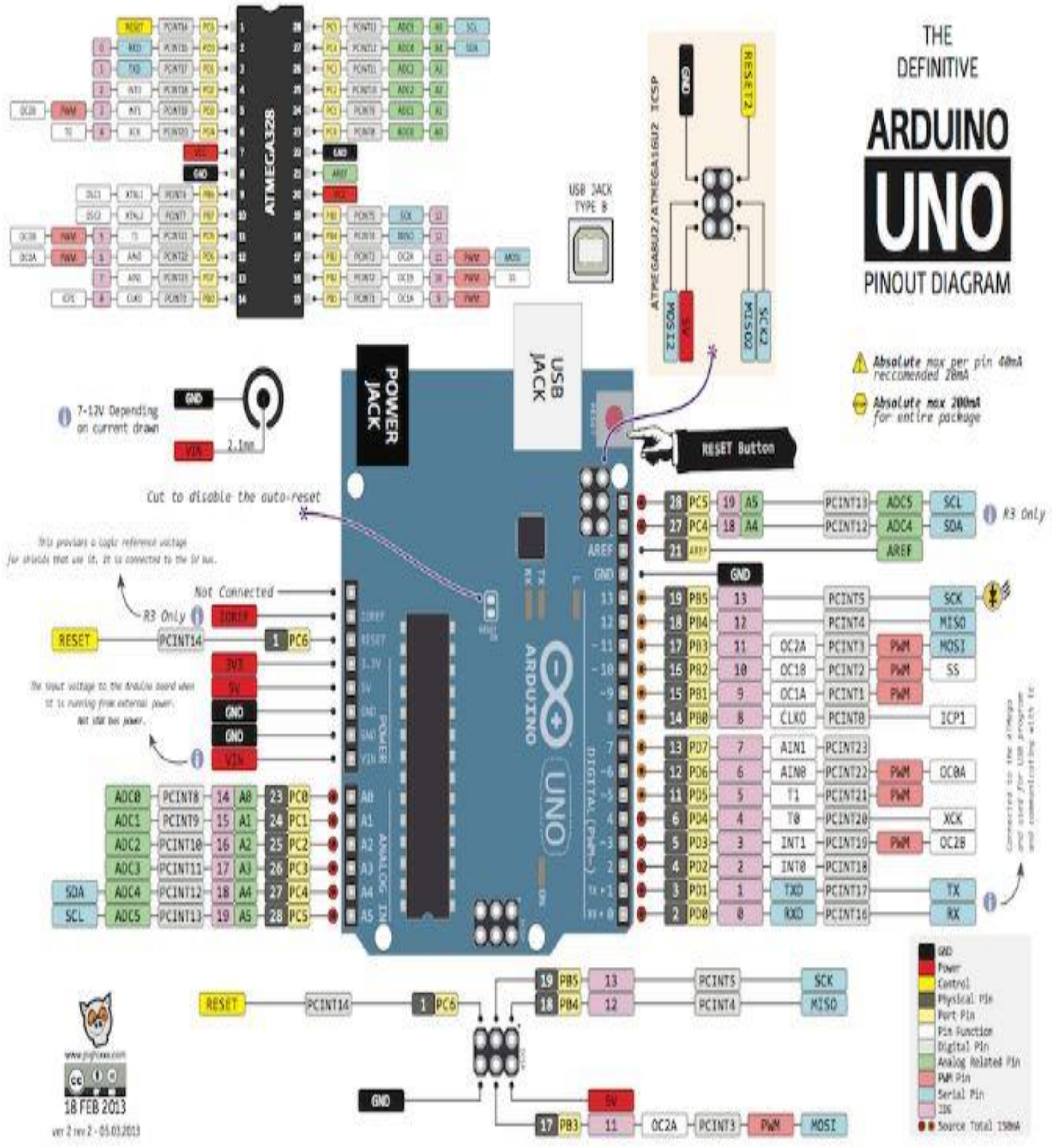


Fig 2.5: pinout diagram

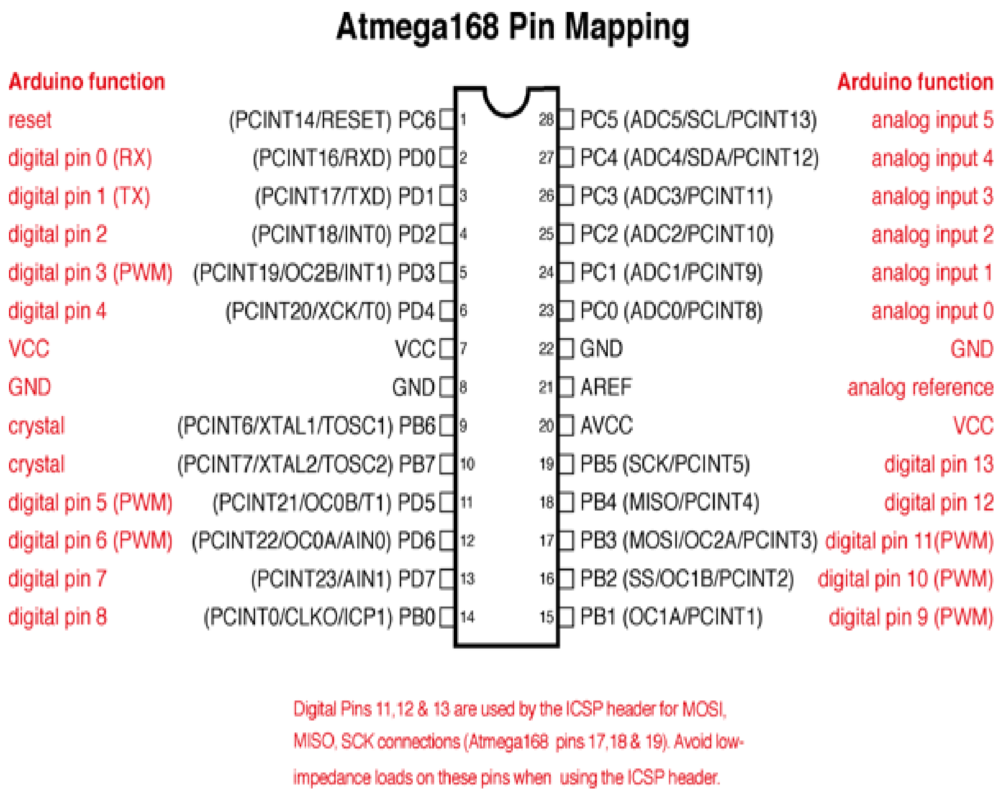


Fig 2.6: pin mapping diagram

The Arduino/Genuino Uno has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

Differences with other boards

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Power

The Arduino/Genuino Uno board can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the GND and Vin pin headers of the POWER connector.040 48576663

IOREF. This pin on the Arduino/Genuino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs to work with the 5V or 3.3V.

Memory

The ATmega328 has 32 KB (with 0.5 KB occupied by the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Input and Output

See the mapping between Arduino pins and ATmega328P ports. The mapping for the Atmega8, 168, and 328 is identical.

Each of the 14 digital pins on the Uno can be used as an input output using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive 20 mA as recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50k ohm. A maximum of 40mA is the value that must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller.

In addition, some pins have specialized functions:

- Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.
- External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.
- PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite() function.
- SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.
- LED: 13. There is a built-in LED driven by digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.
- TWI: A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library.

The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analogReference() function.

AREF. Reference voltage for the analog inputs. Used with analogReference().

- Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

Communication

Arduino/Genuino Uno has a number of facilities for communicating with a computer, another Arduino/Genuino board, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The 16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino Software (IDE) includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A SoftwareSerial library allows serial communication on any of the Uno's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino Software (IDE) includes a Wire library to simplify use of the I2C bus; see the documentation for details. For SPI communication, use the SPI library.

Automatic (Software) Reset

Rather than requiring a physical press of the reset button before an upload, the Arduino/Genuino Uno board is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2/16U2 is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino Software (IDE) uses this capability to allow you to upload code by simply pressing the upload button in the interface toolbar. This means that the bootloader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload. This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with whichit communicates waits a second after opening the connection and before sending this data.

The Uno board contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labeled"RESET-EN". You may also be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line; see this forum thread for details.

CHAPTER-3

FUNCTIONAL MODULES & SOFTWARE MODULES DESCRIPTION

Temperature Sensor - The LM35

The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in ^{o}C).

The LM35 - An Integrated Circuit Temperature Sensor

- Use of LM35s To Measure Temperature
  - You can measure temperature more accurately than a using a thermistor.
  - The sensor circuitry is sealed and not subject to oxidation, etc.
  - The LM35 generates a higher output voltage than thermocouples and may not require that the output voltage be amplified.

- LM35 Look Like
  - Here it is.

Fig 3.1: ADC sensor

- Working of LM35
  - It has an output voltage that is proportional to the Celsius temperature.
  - The scale factor is $.01V/^{o}C$

- The LM35 does not require any external calibration or trimming and maintains an accuracy of +/-0.4 °C at room temperature and +/- 0.8 °C over a range of 0 °C to +100 °C.
- Another important characteristic of the LM35DZ is that it draws only 60 micro amps from its supply and possesses a low self-heating capability. The sensor self-heating causes less than 0.1 °C temperature rise in still air.

- Use An LM35 (Electrical Connections)
  - Here is a commonly used circuit. For connections refer to the picture above.
  - In this circuit, parameter values commonly used are:
    - V_c = 4 to 30v
    - 5v or 12 v are typical values used.
    - $R_a = V_c / 10^{-6}$
    - Actually, it can range from 80 KW to 600 KW , but most just use 80 KW.

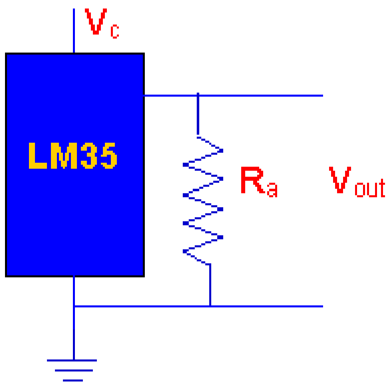


Fig 3.2 temperature sensor

- Here is a photo of the LM 35 wired on a circuit board.
  - The white wire in the photo goes to the power supply.
  - Both the resistor and the black wire go to ground.
  - The output voltage is measured from the middle pin to ground.l

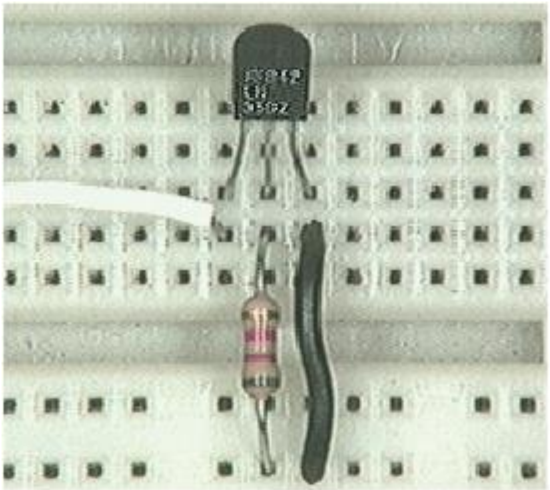


Fig:3.3 Bread board

- What Can You Expect When You Use An LM35
    - You will need to use a voltmeter to sense Vout.
    - The output voltage is converted to temperature by a simple conversion factor.
    - The sensor has a sensitivity of 10mV / ^{o}C.
    - Use a conversion factor that is the reciprocal, that is 100 ^{o}C/V.
    - The general equation used to convert output voltage to temperature is:
        - Temperature (^{o}C) = Vout * (100 ^{o}C/V)
        - So if Vout is 1V , then, Temperature = 100 ^{o}C
        - The output voltage varies linearly with temperature.

In order to calculate the Celsius reading from the analog value, we use the following formula to calculate the temperature in Celsius:

Tempc = 5.0*val*100/1024

Where

Val = is the value send to the computer by the serial port

Val = is the value send to the computer by the serial port

tempC= is the calculated temperature value (in Celsius)

5 is the reference we are using

1024 is the resolution of the 10 bit internal ADC

3.1 Power Supply:

The input to the circuit is applied from the regulated power supply. The a.c. input i.e., 230V from the mains supply is step down by the transformer to 12V and is fed to a rectifier. The output obtained from the rectifier is a pulsating d.c voltage. So in order to get a pure d.c voltage, the output voltage from the rectifier is fed to a filter to remove any a.c components present even after rectification. Now, this voltage is given to a voltage regulator to obtain a pure constant dc voltage. The block diagram of regulated power supply is shown in the figure 3.2

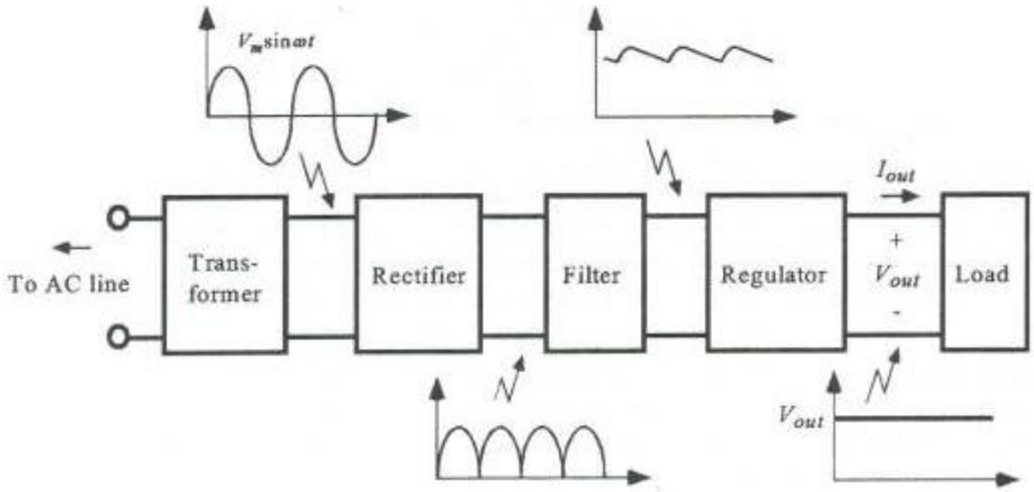


Fig 3.4 components of power supply

Transformer:

Usually, DC voltages are required to operate various electronic equipment and these voltages are 5V, 9V or 12V. But these voltages cannot be obtained directly. Thus the a.c input available at the mains supply i.e., 230V is to be brought down to the required voltage level. This is done by a transformer. Thus, a step down transformer is employed to decrease the voltage to a required level.

Rectifier:

The output from the transformer is fed to the rectifier. It converts A.C. into pulsating D.C. The rectifier may be a half wave or a full wave rectifier. In this project, a bridge rectifier is used because of its merits like good stability and full wave rectification.

Filter:

Capacitive filter is used in this project. It removes the ripples from the output of rectifier and smoothens the D.C. Output received from this filter is constant until the mains voltage and load is maintained constant. However, if either of the two is varied, D.C. voltage received at this point changes. Therefore a regulator is applied at the output stage.

Voltage regulator:

As the name itself implies, it regulates the input applied to it. A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. In this project, power supply of 5V and 12V are required. In order to obtain these voltage levels, 7805 and 7812 voltage regulators are to be used. The first number 78 represents positive supply and the numbers 05, 12 represent the required output voltage levels

INTRODUCTION TO HEART RATE SENSOR

What is Heart Beat Sensor?

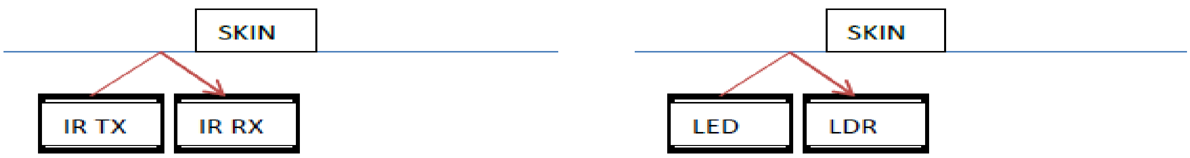
Methods for sensing heart beat are not old like, acoustically, mechanically, electrically, optically. Optical method exploits the fact that tiny subcutaneous blood vessels (capillaries) in any patch of skin (fingertip, ear lobe, behind the knee, ulnar artery, middle of dorsum of the foot, over the abdomen, chest, etc.) furnished with a good blood supply, alternately expand and contract in time with the heartbeat. When heart pumps blood through your body, it gets squeezed into the capillary tissues, and the volume of those tissues increases very slightly. Then, between heart beats, the volume decreases. Tissue's physical structure deforms every time the blood flows in and density of the portion of the tissue beneath skin varies. Normal human hearts usually beat at rates within the range of 50 to 200 beats per minute (bpm) ˜0.83 Hz to ˜3.3 Hz. The National Institutes of Health lists the following healthy zones for resting heart rates: Newborns: 100 - 160 beats per minute; children 1 to 10 years: 70 - 120 beats per minute; those 10 and over: 60 - 100 beats per minute; and well-trained,beats per minute; those 10 and over: 60 - 100 beats per minute; and well-trained athletes: 40 - 60 beats per minute 72 beats per minute is the typical bpm at normal condition and it need not to be same every time. Human heart rate depends on many things like, nutrition demands, exercise, age, daily activity, strong emotions, hypertension, blood pressure etc.

When light is made to fall on the skin two things happen;

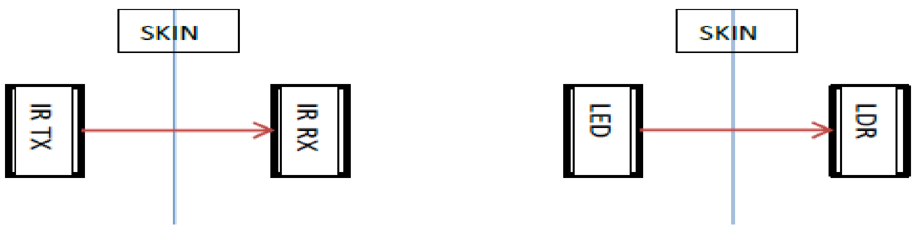
Light reflects from the skin
Light passes through the skin

Reflected light can be gathered using photodiode of frequency same as transmitter. This method yields good accuracy, device can made small as possible and portab Below is the pictorial representation of the two methods discussed above.

Method one:



Method two:



The Smart Q Heart Rate Sensor monitors the light level transmitted through the vascular tissue of the fingertip or the ear lobe and the corresponding variations in light intensities that occurs as the blood volume changes in the tissue. The Easy Sense unit can detect that the Smart Q Heart Rate Sensor is connected and the range it is set to.

What is Electrocardiogram?

The heart functions as a pump for circulating blood to the body by repetition of contraction and enlargement. The cardiac electric potential is produced in the body during heart contraction.

Electrocardiogram can be measured by leading these electrical signals to other body position and amplify.

Electrocardiography (ECG) is the interpretation of the electrical activities of the heart over a period of time. The biosignal are extracted right from the body by the electrodes placed on different locations. The signal measured and monitored a biological being is commonly used to refer to an electrical signal called biosignal. Bio electrical signals (biosignal) are the electrical currents generating the electrical potential difference across a tissue, organs or cell system called nervous system. In the heart muscle cell, electric activation takes place by means of the same mechanism as in the nerve cell from the inflow of Na ions across the cell membrane.

The amplitude of the action potential is also similar, being 100 mV for both nerve and muscle. The duration of the cardiac impulse is, however, two orders of magnitude longer than in either nerve cell or skeletal muscle cell. As in the nerve cell, re polarization is a consequence of the outflow of K ions. The duration of the action impulse is about 300 ms V.

Connecting:

- Hold the Heart Rate Sensor housing with the Smart Q label showing on the top.
- Push one end of the sensor cable (supplied with the EasySense unit) into the
- socket at the end of the Sensor housing with the locating arrow on the cable facing upwards.
- Connect the other end of the sensor cable to the Input socket on the EasySense
- unit (with the locating arrow facing upwards).
- Insert the jack plug from the finger/ear lobe clip (Pleth) into the jack socket at the end of the Sensor housing.
- The EasySense unit will detect that the Heart Rate Sensor is connected. Select the range required.

DESIGN CONSIDERATIONS:

The selection and placement of the electrodes have been considered for the single channel ECG system. These are electrodes which can measure the weak signal less than 8mV. The typical electrocardiogram (ECG) signal has voltage of 0.05 to 5mV.

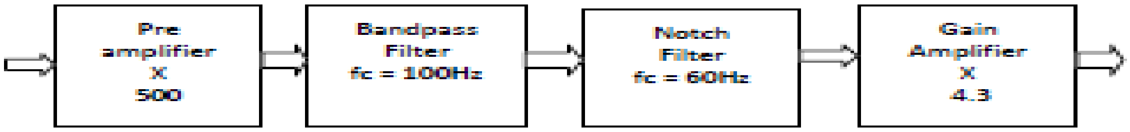


Fig 3.5: ECG conditioning block diagram

The ECG signal is detected by ECG probe that converts it into an electrical signal which is pre amplified at the first stage. The signals that are captured from the electrodes have some amount of noise. It needs the proper signal analysis to remove these errors and noise. Hence, the second stage consists of the bandpass filter and notch pass filter

which is designed to suppress the unwanted signal (noise) The third stage has the gain amplifier which sets the appropriate level of signal to be read by the analog to digital convertor (ADC) and microcontroller.

Pre Amplification

LM324 op amp[16] is selected in this work, because it is a bipolar metal oxide semiconductor (BiMOS) op amp BiMOS technology has the circuit design that uses both bipolar junction transistor (BJT) and metal oxide semiconductor field effect transistor (MOSFET) Hence LM324 op amp does not allow the leakage of currents that may affect the signal as in BJT op amp (741). It produces real ideal response for biometric signals.

Band Pass Filter

The signal from the instrumentation amplifier is filtered by the bandpass filter for the bandwidth of 1 to102 Hz [22]. The transfer function of the bandpass filter is

fc = cut off frequency.

Notch Filter

Proper protecting and safety consideration are considered to ease the external noise such electromagnetic interference, it is preferred to get rid of this type of noise in the preprocessing stage. The notch (band stop) filtering with cut off frequency fc = 60 Hz is designed to suppress such noise.

Gain Amplifier

The amplification stage as shown in Error! Reference source not found. has the only purpose to boost the amplitude of the bioelectric signal up to be understood by the microcontroller.

Power Supply

The system components are set use +5V at their positive terminals and -5V at their negative terminals, and reference voltage set to ground.

Modern heart rate monitors usually comprise two elements: a chest strap transmitter and a wrist receiver or mobile phone (which usually doubles as a watch or phone). In early plastic straps water or liquid was required to get good performance. Later units have used conductive smart fabric with built-in microprocessors which analyse the EKG signal to determine heart rate. Heart rate is the number of heartbeats per unit of time, typically expressed as beats per dioxide changes during exercise or sleep. The measurement of heart rate is used by medical professionals to assist in the diagnosis and tracking of medical conditions. It is also used by individuals, such as athletes, who are interested in monitoring their heart rate to acquire maximum efficiency. The wave interval is the inverse of the heart rate .

Heartbeat rate is one of the very important parameters of the cardiovascular system. The heart rate of a healthy adult at rest is around 72 bpm. Athletes normally have lower heart rates than less active people. Babies have a much higher heart rate at around 120 bpm, while older children have heart rates at around 90 bpm. The heart rate rises gradually during exercises and returns slowly to the rest value after exercise. The rate at which the pulse returns to normal is an indication of the fitness of the person. Lower than normal heart rates are usually an indication of a condition known as bradycardia, while higher than normal heart rates are known as tachycardia 0. Most HRM devices use a design where the signal is acquired from the subject and a filtering function is applied to remove the high order harmonics and noise from the signal. This is then followed by a hardware or software that uses a zero crossing algorithms to count the number of beats during a given time interval (e.g. 0 and 0). The zero-crossing algorithm may lead to false readings caused by local noise that may result in multiple local zero crossings.

FINGERTIP SENSOR:

The sensor consists of an IR light emitting diode transmitter and an IR photo detector acting as the receiver. The IR light passes through the tissues. Variations in the volume of blood within the finger modulate the amount of light incident on the IR detector. Two practical configurations could be implemented to achieve this function. In the first configuration, the finger can be placed between the transmitter and the receiver as shown in Fig. 2. In the second design, both the IR transmitter and receiver could be placed on the same plane and the finger would function as a reflector of the incident light instead. The IR receiver monitors the reflected signal in this case. The IR filter of the photo transistor reduces interference from the mains 50Hz noise.The IR LED is forward biased through a resistor to create a current flow. The values of resistors are chosen so that they produce the maximum amount of light output. The photo-resistor is placed in series with the resistor to reduce the current drawn by the detection system and to prevent short-circuiting the power supply when no light is detected by the photo resister.

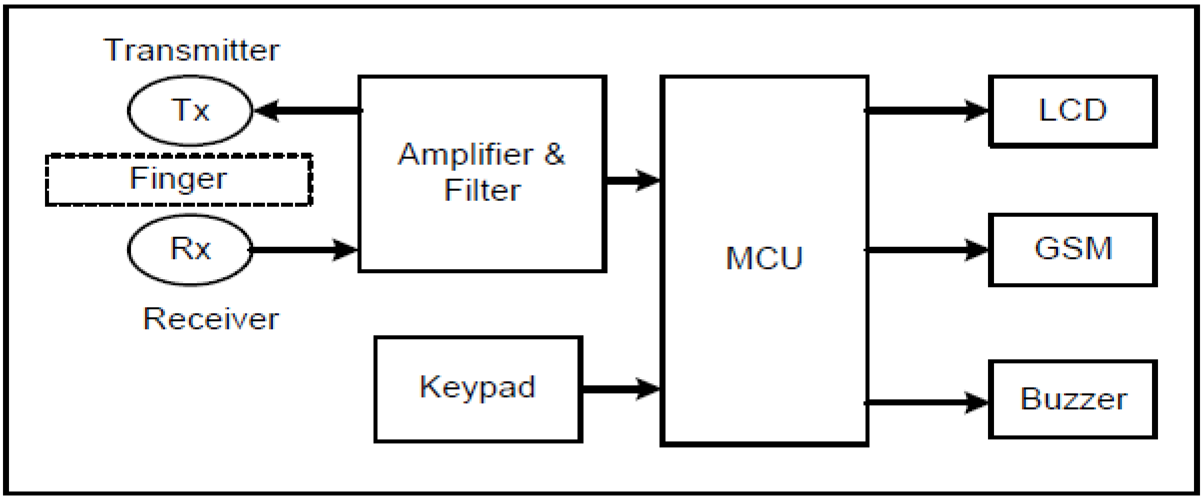
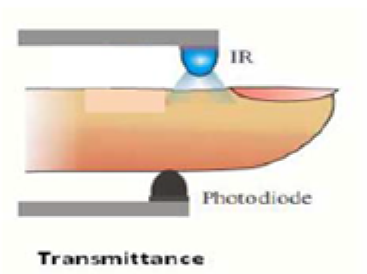


Fig 3.6: Block diagram of HRM



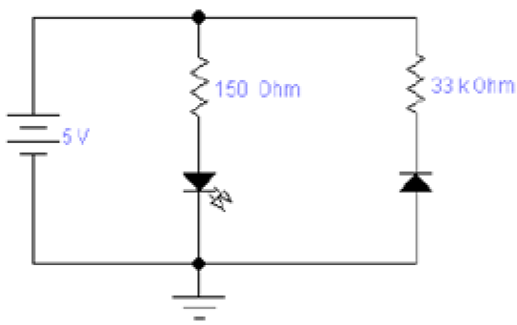


Fig 3.7: Fingertip sensor

Fig 3.8: sensor circuit

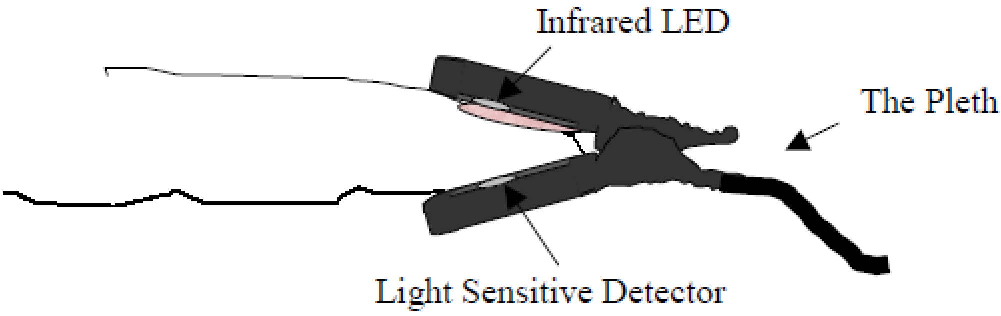


Fig 3.9: light sensitive detector

1. Attach the Pleth (finger/ear lobe clip) to either the fingertip or to the ear lobe. Note: Do not apply pressure to the Pleth as this could affect the signal.

2. Wait for a short while for the signal to stabilize. The subject should stay reasonably still – muscle movements will influence the signal. The red LED on the Sensor housing will start to flash in time with the heartbeat. If used on the finger the subject may feel a throbbing sensation.

Note for Easy Sense Advanced and Logger users: if the red LED does not start to flash, and the LCD display on the Easy Sense unit is blank, press any of the buttons on the top panel of the Easy Sense unit to wake it up.

3. Once a regular heart rate is detected, begin recording data.

The Pleth consists of:

1) An infrared LED which illuminates the tissue and

2) A light sensitive detector (LSD), which has been tuned to the same color frequency as the LED, and detects the amount of light transmitted from the tissue.

The Pleth supplied with this sensor is a transmission mode plethysmographic signal (PPG) device, which uses transmitted light to estimate absorption The infrared LED and the light sensitive detector (LSD) are mounted in a spring-loaded device that can be clipped onto the fingertip or ear lobe.

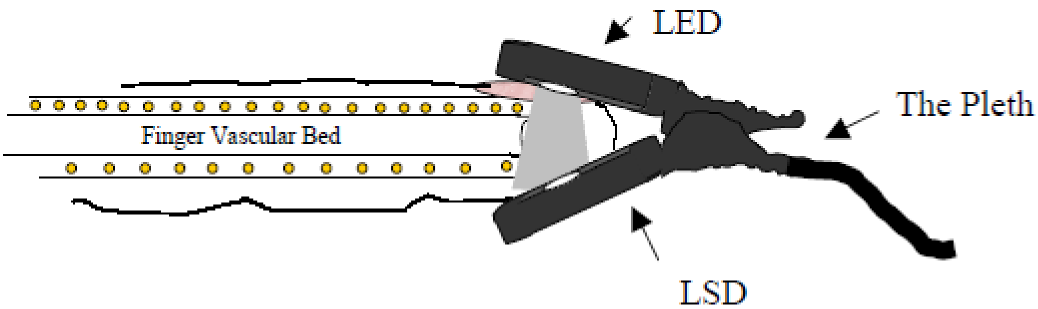


Fig 3.10: Fingertip sensor

The infrared light emitted by the LED is diffusely scattered through the fingertip or ear lobe tissue. A light sensitive detector positioned on the surface of the skin on the opposite side can measure light transmitted through at a range of depths. Infrared light is absorbed well in blood and weakly absorbed in tissue. Any changes in blood volume will be registered since increasing (or decreasing) volume will cause more or less absorption. Assuming the subject does not move, the level of absorption of the tissue and non-pulsating fluids will remain the same.

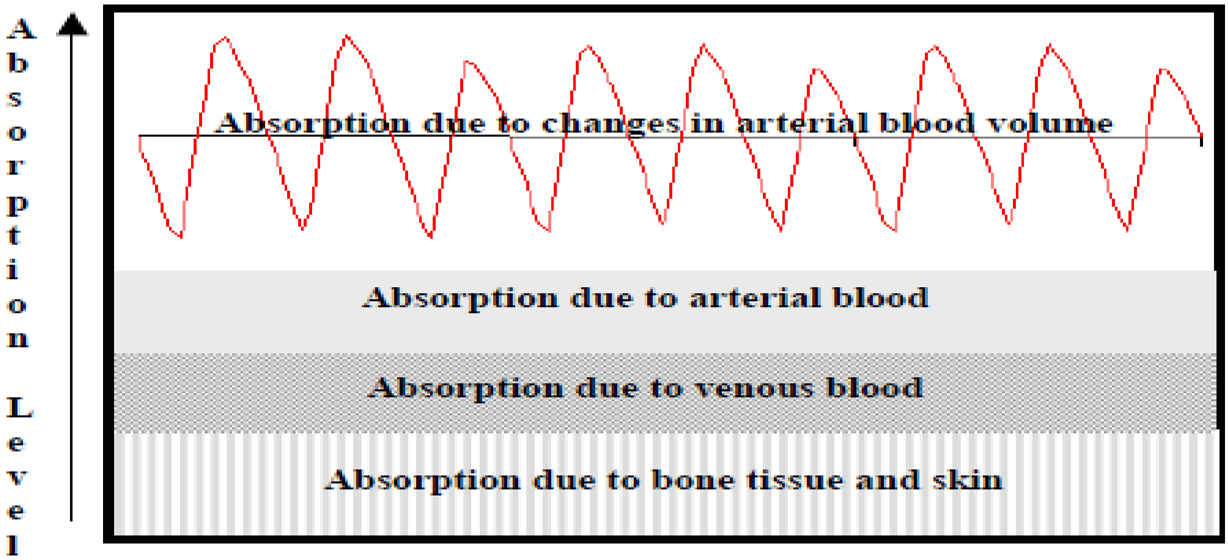


Fig 3.11: Absortion level waveform

Heart rate can vary with age as shown below:

Age	Average Heart Rate (beats per minute)
Newborn	140
7 years	85 – 90
14 years	80 – 85
Adult	70 – 80

Safe Pulse Rates:

During experiments the safe heart rate should not be exceeded. The safe level is given as the maximum heart rate for age, minus 20 beats per minute
Maximum heart rate = 210 – (0.65 x age)

Age	Maximum Heart Rate	Safe Heart Rate
12	202	182
13	202	182
14	201	181
15	200	180
16	199	179
17	199	179
18	198	178

Table 1. Heart beat rate measurement using the deeloped device and via an oscilloscope

Gender	Age	HR on display	HR on scope	Error %
Male	22	97	96	1.03
Male	22	83	81	2.41
Male	20	78	78	0
Male	22	90	87	3.33
Male	20	80	79	1.25
Female	22	77	77	0
Female	22	104	103	0.96
Female	19	75	75	0
Female	20	69	71	2.81

GPS Technology
Basic Principles of GPS

3.2 What is GPS?

The **Global Positioning System**, usually called **GPS**, and originally named **NAVSTAR**, is a satilight navigation system used for determining one's precise location almost anywhere on Earth . A GPS unit receives time signal transmissions from multiple satellites, and calculates its position by triangulating this data. The GPS was designed by and is controlled by the United States Department of Defence and can be used by anybody for free. The cost of maintaining the system is approximately $400 million per year.

Measurement uncertainty of the majority of commercial GPS receivers varies from 10^{-11} to 10^{-13} by the frequency scale, and from 100 ns to 50 ns by the time scale, being dependent on the receiver design. The main sources of uncertainty in GPS measurements are the GPS receiver position error, the orbital error, the satellite and receiver clock errors, the ionosphere and the troposphere delays, the receiver internal delay, the satellite antenna and cable delay, the receiver noise, and the multipath error. The frequency uncertainty for a GPS receiver is larger than that for Cs-standard by 2-3 orders within a short-time interval (1 – 1000 s), and by one order within a long-term interval of about one week. A GPS receiver’s time scale bias from the Universal Coordinated Time (UTC) can be in order of microseconds. Not every GPS receiver is suitable for use as a traceable primary frequency and/or time standard. Therefore, GPS receiver calibration against the primary time and frequency standard (the Cs-atomic clock traceable to UTC) is of great importance and implies the calibration of both output frequencies and time scale. The frequencies calibration is performed through comparison of one of the outputs (1 pps, 10 MHz, and/or 5 MHz) with the corresponding reference frequency of the cesium atomic standard. The user’s GPS receiver time scale calibration is fulfilled through comparison between 1 pps signals of the user’s GPS receiver and those of the Cs-atomic standard.

GPS is a system of satellites, ground control stations, and receivers that allows users to determine their position. By capturing and storing that position, GPS receivers “digitize” spatial data as they walk, drive, or otherwise traverse the land. For this reason the term “rover” receiver unit is often used to describe a GPS field receiver. For the sake of consistency, the term “GPS receiver” or “receiver” will be used to identify the GPS “rover” receiver from this point forward. Perhaps the most important characteristic that GIS data developers need to realize about GPS is that it is a highly dynamic system with new satellites being launched and old ones being retired. The constellation of satellites available to users throughout the day is constantly changing as the satellites move through their orbits. Occasionally, satellites are shifted into new orbits. Collecting GPS data in Vermont often adds the complications of vegetative cover, topography.and relatively northern latitude to the inherent variability in the system. Receivers differ in their ability to receive and process GPS signals and users can have a huge affect on accuracy depending on the methods used to collect and process data.

How does GPS work?

Satellites

The United States **Global Positioning System** (GPS) is the first fully operational **Global Navigation Satellite System** (GNSS). Each satellite broadcasts a signal that is used by receivers to determine precise position anywhere in the world. The receiver tracks multiple satellites and determines a pseudo range measurement (a range measurement based on time) that is then used to determine the user location. A minimum of four satellites is necessary to establish an accurate three-dimensional position.

The **Department of Defense** (DOD) is responsible for operating the GPS satellite constellation and monitors the GPS satellites to ensure proper operation. Every satellite's orbital parameters (ephemeris data) are sent to each satellite for broadcast as part of the data message embedded in the GPS signal. The GPS coordinate system is the Cartesian earth-centered earth-fixed coordinates as specified in the World Geodetic System reference system 1984 (WGS-84).

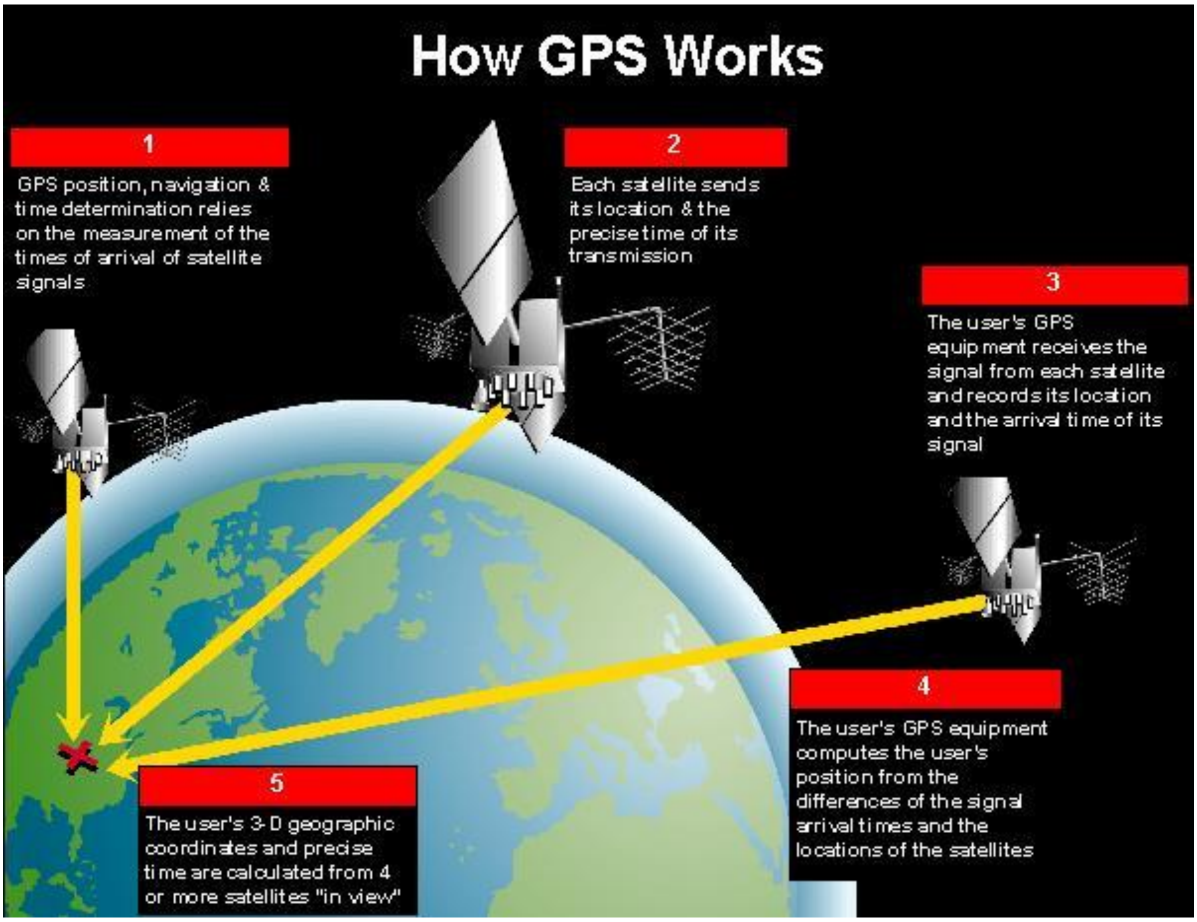


Fig 3.12 Gps working

List of GPS satellite launches

- In 1972, the USAF Central Inertial Guidance Test Facility (Holloman AFB), conducted developmental flight tests of two prototype GPS receivers over White Sands Missile Range, using ground-based pseudo-satellites.
- In 1978, the first experimental Block-I GPS satellite was launched.
- In 1983, after Soviet interceptor aircraft shot down the civilian airliner KAL 007 that strayed into prohibited airspace because of navigational errors, killing all 269 people on board, U.S. President Ronald Reagan announced that GPS would be made available for civilian uses once it was completed although it had been previously published [in Navigation magazine] that the CA code (Coarse Acquisition code) would be available to civilian users.
- By 1985, ten more experimental Block-I satellites had been launched to validate the concept. Command & Control of these satellites had moved from Onizuka AFS, CA and turned over to the 2nd Satellite Control Squadron (2SCS) located at Falcon Air Force Station in Colorado Springs, Colorado
- On February 14, 1989, the first modern Block-II satellite was launched.

- The Gulf War from 1990 to 1991, was the first conflict where GPS was widely used.
- In 1992, the 2nd Space Wing, which originally managed the system, was de-activated and replaced by the50th Space Wing.
- By December 1993, GPS achieved initial operational capability (IOC), indicating a full constellation (24 satellites) was available and providing the Standard Positioning Service (SPS).
- Full Operational Capability (FOC) was declared by Air Force Space Command (AFSPC) in April 1995, signifying full availability of the military's secure Precise Positioning Service (PPS).
- In 1996, recognizing the importance of GPS to civilian users as well as military users, U.S. President Bill Clinton issued a policy directive declaring GPS to be a dual-use system and establishing an Interagency GPS Executive Board to manage it as a national asset.
- In 1998, United States Vice President Al Gore announced plans to upgrade GPS with two new civilian signals for enhanced user accuracy and reliability, particularly with respect to aviation safety and in 2000 the United States Congress authorized the effort, referring to it as *GPS III*.
- On May 2, 2000 "Selective Availability" was discontinued as a result of the 1996 executive order, allowing users to receive a non-degraded signal globally.
- In 2004, the United States Government signed an agreement with the European Community establishing cooperation related to GPS and Europe's planned Galileo system.
- In 2004, United States President George W. Bush updated the national policy and replaced the executive board with the National Executive Committee for Space-Based Positioning, Navigation, and Timing.

On May 21, 2009, the Air Force Space Command allayed fears of GPS failure saying "There's only a small risk we will not continue to exceed our performance standard."

- On January 11, 2010, an update of ground control systems caused a software incompatibility with 8000 to 10000 military receivers manufactured by a division of Trimble Navigation Limited of Sunnyvale, Calif.
- On February 25, 2010. the U.S. Air Force awarded the contract to develop the GPS Next Generation Operational Control System (OCX) to improve accuracy and availability of GPS navigation signals, and serve as a critical part of GPS modernization.

- A GPS satellite was launched on May 28, 2010. The oldest GPS satellite still in operation was launched on November 26, 1990, and became operational on December 10, 1990.
- The GPS satellite, GPS IIF-2, was launched on July 16, 2011 at 06:41 GMT from Space Launch Complex 37B at the Cape Canaveral Air Force Station.
- The GPS satellite, GPS IIF-3, was launched on October 4, 2012 at 12:10 GMT from Space Launch Complex 37B at the Cape Canaveral Air Force Station.

3.3 GPS receivers:

GPS receivers can calculate a position on the earth by measuring the travel time of radio signals from the satellites to the receiver. The calculations depend on highly accurate clocks. The satellites have atomic clocks that are accurate to a nanosecond but due to cost, the clocks in most GPS receivers are not that accurate. Using three satellites, each measurement of time generates a sphere. Where these three spheres intersect is a point that indicates a place on the earth. The fourth satellite can then be used to eliminate any clock errors in the ground-based receiver. Even a small clock error can create a large error in location.

When **Global Navigation Satellite System** (GNSS) equipment is not using integrity information from **Wide Area Augmentation Systems (**WAAS) or **Local Area Augmentation Systems** (LAAS), the GPS navigation receiver using **Receiver Autonomous Integrity Monitoring** (RAIM) provides GPS signal integrity monitoring. RAIM is necessary since delays of up to two hours can occur before an erroneous satellite transmission can be detected and corrected by the satellite control segment. The RAIM function is also referred to as fault detection. Another capability, fault exclusion, refers to the ability of the receiver to exclude a failed satellite from the position solution and is provided by some GPS receivers and by WAAS receivers.

The GPS receiver verifies the integrity (usability) of the signals received from the GPS constellation through **Receiver Autonomous Integrity Monitoring** (RAIM) to determine if a satellite is providing corrupted information. At least one satellite, in addition to those required for navigation, must be in view for the receiver to perform the RAIM function; thus, RAIM needs a minimum of five satellites in view, or four satellites and a barometric altimeter (baro-aiding) to detect an integrity anomaly.

For receivers capable of doing so, RAIM needs six satellites in view (or five satellites with baro-aiding) to isolate the corrupt satellite signal and remove it from the navigation solution. Baro-aiding is a method of augmenting the GPS integrity solution by using a no satellite input source. GPS derived altitude should not be relied upon to determine aircraft altitude since the vertical error can be quite large and no integrity is provided. To ensure that baro-aiding is available, the current altimeter setting must be entered into the receiver as described in the operating manual.

RAIM Capability

Many VFR GPS receivers and all hand-held units have no RAIM alerting capability. Loss of the required number of satellites in view, or the detection of a position error, cannot be displayed to the pilot by such receivers. In receivers with no RAIM capability, no alert would be provided to the pilot that the navigation solution had deteriorated, and an undetected navigation error could occur. Only a systematic cross-check with other navigation techniques would identify this failure, and prevent a serious deviation.

CLASSES OF RECEIVERS:

GPS receivers and software can be used to obtain positions with accuracies from centimeter to tens of meters. The mapping/resource grade receivers that are the focus of this document are generally able to obtain positions with accuracies from five decimeters to ten meters. Some mapping/resource grade receivers can also be used as remote base stations. There are estimated to be over 500 GPS receiver models available from over 100 different manufacturers around the world. Competition has improved the products and reduced the cost, but has also confused the buyer. The table, illustrated in Part D below, is offered as a generic guideline to available GPS products.

A civilian GPS receiver is generally categorized as (1) recreational grade, (2) mapping/resource grade, or (3) survey grade, based on its functionality. The characteristics of each of these GPS "grades" are briefly described below, and then listed in a table for easier comparison.

Recreational Grade GPS

Recreational grade GPS receivers are the least expensive and the simplest to use, because they have less functionality (and less associated software and hardware) than the other grades. As the name implies, these "handheld" GPS receivers are intended primarily for recreational purposes. These are useful for general navigation and surveillance purposes because they can quickly collect the *x-y* coordinates of point features, and can be used to pre-plan routes and/or navigate to specific locations using waypoints. They are not, however, recommended for most data field collection or mapping activities. Though some of the more expensive recreational grade receivers come with a communication port that allows for the download and post-processing of data or come with a radio receiver that provides for real-time differential correction of data, most receivers in this class do not. This fact not only limits the accuracy of features collected but also prevents the user from downloading captured features digitally. The only recourse to creating spatial data with these receivers is to manually transcribe feature coordinates into a format that can be imported into a GIS.

Mapping/Resource Grade GPS

This guideline recommends that GPS data being collected for GIS utilize mapping/resource grade receivers. Mapping/resource GPS tools capture data of higher positional accuracy than recreational receivers, and all have post-processing differential correction capabilities. Unlike recreational GPS, these receivers also collect locations for features represented as points (e.g., sample point), lines (e.g., trail), and areas (e.g., field boundary), complimenting GIS database organization schemes. Mapping/resource GPS equipment required in the field ranges from “handheld” to “backpack” systems. The more expensive mapping/resource grade GPS receivers are designed to: (1) collect and store large volumes of data, (2) be used in extreme environmental conditions, (3) perform real-time differential correction of data; and 4) act as a field reference base station. The average accuracy for this grade of GPS receivers varies and changes as technology develops, but at this time accuracy is generally between .5-5 meters when data is “post-processed” or acquired “real time”, under typical data collection constraints.

Survey Grade GPS

This document does not address survey grade activities. Survey grade GPS tools are only used for surveying-related activities requiring a high degree of accuracy. For example, licensed land surveyors use these GPS tools for geodetic surveys, and to measure elevations. These systems produce data of the highest horizontal and vertical positional accuracy, but are very expensive and complex. The use of a survey grade system requires specialized training, and one or more dedicated staff to oversee its use and maintenance. Survey grade GPS data are almost always post-processed to increase their accuracy.

Structure:

The current GPS consists of three major segments. These are the space segment (SS), a control segment (CS), and a user segment (US). The U.S. Air Force develops, maintains, and operates the space and control segments. GPS satellites broadcast signals from space, and each GPS receiver uses these signals to calculate its three-dimensional location (latitude, longitude, and altitude) and the current time.

Space segment

The space segment (SS) is composed of the orbiting GPS satellites or Space Vehicles (SV) in GPS parlance. The GPS design originally called for 24 SVs, eight each in three approximately circular orbits, but this was modified to six orbital planes with four satellites each. The orbits are centered on the Earth, not rotating with the Earth, but instead fixed with respect to the distant stars. The six orbit planes have approximately 55° inclination (tilt relative to Earth's equator) and are separated by 60° right ascension of the ascending node (angle along the equator from a reference point to the orbit's intersection).[47] The orbital period is one-half a sidereal day, i.e., 11 hours and 58 minutes. The orbits are arranged so that at least six satellites are always within line of sight from almost everywhere on Earth's surface.[49] The result of this objective is that the four satellites are not evenly spaced (90 degrees) apart within each orbit. In general terms, the angular difference between satellites in each orbit is 30, 105, 120, and 105 degrees apart which, of course, sum to 360 degrees.

Control segment

The control segment is composed of

- a master control station (MCS),
- an alternate master control station,
- four dedicated ground antennas and
- six dedicated monitor stations

The MCS can also access U.S. Air Force Satellite Control Network (AFSCN) ground antennas (for additional command and control capability) and NGA (National Geospatial-Intelligence Agency) monitor stations. The flight paths of the satellites are tracked by dedicated U.S. Air Force monitoring stations in Hawaii, Kwajalein, Ascension Island, Diego Garcia, Colorado Springs, Colorado and Cape Canaveral, along with shared NGA monitor stations operated in England, Argentina, Ecuador, Bahrain, Australia and Washington DC.[53]The tracking information is sent to the Air Force Space Command MCS at Schriever Air Force Base 25 km (16 mi) ESE of Colorado

Springs, which is operated by the 2nd Space Operations Squadron (2 SOPS) of the U.S. Air Force. Then 2 SOPS contacts each GPS satellite regularly with a navigational update using dedicated or shared (AFSCN) ground antennas (GPS dedicated ground antennas are located at Kwajalein, Ascension Island, Diego Garcia, and Cape Canaveral). These updates synchronize the atomic clocks on board the satellites to within a few nanoseconds of each other, and adjust the ephemeris of each satellite's internal orbital model. The updates are created by a Kalman filter that uses inputs from the ground monitoring stations, space weather information, and various other inputs.[54]

The new capabilities provided by OCX will be the cornerstone for revolutionizing GPS's mission capabilities, and enabling [55] Air Force Space Command to greatly enhance GPS operational services to U.S. combat forces, civil partners and myriad of domestic and international users. The GPS OCX program also will reduce cost, schedule and technical risk. It is designed to provide 50% [56] sustainment cost savings through efficient software architecture and Performance-Based Logistics. In addition, GPS OCX expected to cost millions less than the cost to upgrade OCS while providing four times the capability. The GPS OCX program represents a critical part of GPS modernization and provides significant information assurance improvements over the current GPS OCS program.

- OCX will have the ability to control and manage GPS legacy satellites as well as the next generation of GPS III satellites, while enabling the full array of military signals.
- Built on a flexible architecture that can rapidly adapt to the changing needs of today's and future GPS users allowing immediate access to GPS data and constellations status through secure, accurate and reliable information.
- Empowers the warfighter with more secure, actionable and predictive information to enhance situational awareness.
- Enables new modernized signals (L1C, L2C, and L5) and has M-code capability, which the legacy system is unable to do.
- Provides significant information assurance improvements over the current program including detecting and preventing cyber attacks, while isolating, containing and operating during such attacks.
- Supports higher volume near real-time command and control capabilities

User segment

The user segment is composed of hundreds of thousands of U.S. and allied military users of the secure GPS Precise Positioning Service, and tens of millions of civil, commercial and scientific users of the Standard Positioning Service. In general, GPS receivers are composed of an antenna, tuned to the frequencies transmitted by the satellites, receiver-processors, and a highly stable clock (often acrystal oscillator). They may also include a display for providing location and speed information to the user. A receiver is often described by its number of channels: this signifies how many satellites it can monitor simultaneously. Originally limited to four or five, this has progressively increased over the years so that, as of 2007, receivers typically have between 12 and 20 channels.

A typical OEM GPS receiver module measuring 15×17 mm.

GPS receivers may include an input for differential corrections, using the RTCM SC-104 format. This is typically in the form of an RS-232port at 4,800 bit/s speed. Data is actually sent at a much lower rate, which limits the accuracy of the signal sent using RTCM[*citation needed*]. Receivers with internal DGPS receivers can outperform those using external RTCM data[*citation needed*]. As of 2006, even low-cost units commonly include Wide Area Augmentation System (WAAS) receivers.

Factors that affect data quality:

Satellite geometry and PDOP

PDOP, or Position Dilution of Precision, is a measure of how well the satellites are distributed in the sky – the lower the number the more accurate the reading. A minimum of four GPS satellites are required to compute accurate three dimensional GPS positions. The best satellite geometry, and therefore the lowest PDOP, has at least four satellites, three evenly spaced around the horizon, but above 15 degrees, and one directly overhead. With the current number of satellites available, collecting data in 2D is never recommended. When “only three satellites” are available, an accurate “project elevation” must be determined and input into the receiver.

Signal to Noise Ratio (SNR)

Also called signal level or signal strength. Arbitrary strength units used to determine the strength of a satellite signal. SNR ranges from 0 (no signal) to around 35. Higher-elevation satellites have SNRs in the high teens to low 20’s.

Multipath

Another possible source of error is interference, similar to ghosts on a television screen, that occurs when GPS signals arrive at an antenna having traversed different paths. The signal traversing the longer path causes an error in the position fix. Multiple paths can arise from reflections off structures and other obstructions near the antenna.

Accuracy of the data under different conditions (PDOP and SNR)

Canopy cover can adversely effect accuracy in two ways. It can reduce the number of satellites the receiver can use and can cause the signal to bounce off of nearby surfaces before reaching the receiver, causing errors in location. Topographic position Steep canyons can limit the number of satellites the receiver can use. They can also limit the spread of satellites across the sky causing poor satellite geometry.

Ability to “turn off” data collection when predicted error is high.

On the Trimble Geo Explorers, Pro XRs and other higher end receivers there is a setting for PDOP that will cause the receiver to not log positions when the PDOP is too high due to poor satellite constellation or when SNR is poor. The recreational units do not have the ability to set these filters and thus will log positions regardless of their accuracy.

The use of Trimble Pathfinder Office Planning Software (which comes with the purchase of a Trimble GPS unit) to predict satellite availability is important for those using GPS receivers under less than ideal conditions, such as under tree canopy or in steep terrain. The number of satellites and

Recommendations for GPS data collection:

Data to be used outside GIS

For data that will never be put into GIS, you can use whatever equipment or method gives you acceptable accuracy for your project (see above accuracy table).

Data to be incorporated into GIS

Project layers

For data that is not used in conjunction with any other corporate data, is used only at a very small scale, or is very time-sensitive, you may use whatever method will give you an acceptable accuracy. This would include things such as firelines, points for a small-scale map (such as the location of a timber sale on a forest-wide map), or for a personal project such as tracking your path of travel during a survey.

Corporate layers

Landlines or legal boundaries must be GPSed with survey-grade GPS units. For other corporate layers, if recreational grade GPS data is all that’s available, it may be incorporated into the corporate data, but must be designated as “>5 meter accuracy” in the metadata for the features you GPSed (see below). This will allow us to exclude this data from applications requiring highly accurate features, like PBS updates. If more accurate data is available from another source it should be used instead.

Metadata for GSPed features

Metadata is necessary to identify the source and accuracy of the data you are adding to GIS. Any GPS data that may eventually be added to a Primary Base Series quad map must have metadata attached. In addition, some GPS data, such as public land survey and ownership boundaries, must meet survey-grade requirements and have metadata to back it up.

National Map Accuracy Standards

The 2003 GIS Data Dictionary requires the horizontal accuracy of most layers to meet the National Standard for Spatial Data Accuracy. At the scale of 1:24,000, this standard is 40 feet or 12.2 meters.

Source Codes for GPS Data

Three source codes for GPS data have been specified in the Guidelines for Digital Base Map Updates. The Draft GPS Data Accuracy Standard (USFS) also refers to these same codes to use for GPS accuracy. CSA 2 has added a fourth code to address greater than 5 meter accuracy (such as data collected with a Garmin). A detailed description of the codes is attached to this document in Appendix A.

How to Record the Metadata

Record the source of your GPS data, using the codes from Appendix A, in the item listed in the table below. The item should be added to the coverage if it is not already there. You will need to coordinate this with a GIS person on your district or Forest (item_width 2, output width 2, item type C.) In addition, an item called source_code_memo can be added to record additional information or explanatory notes about the data, such as the model of the receiver used.

<u>Satellite frequencies:</u>

The L4 band at 1.379913 GHz is being studied for additional ionospheric correction.[citation needed] The L5 frequency band at 1.17645 GHz was added in the process of GPS modernization. This frequency falls into an internationally protected range for aeronautical navigation, promising little or no interference under all circumstances. The first Block IIF satellite that would provide this signal is set to be launched in 2009. The L5 consists of two carrier components that are in phase quadrature with each other. Each carrier component is bi-phase shift key (BPSK) modulated by a separate bit train. "L5, the third civil GPS signal, will eventually support safety-of-life applications for aviation and provide improved availability and accuracy."

A conditional waiver has recently been granted to LightSquared to operate a terrestrial broadband service near the L1 band. Although LightSquared had applied for a license to operate in the 1525 to 1559 band as early as 2003 and it was put out for public comment, the FCC asked LightSquared to form a study group with the GPS community to test GPS receivers and identify issue that might arise due to the larger signal power from the LightSquared terrestrial network. The GPS community had not objected to the LightSquared (formerly MSV and SkyTerra) applications until November 2010, when LightSquared applied for a modification to its Ancillary Terrestrial Component (ATC) authorization. This filing (SAT-MOD-20101118-00239) amounted to a request to run several orders of magnitude more power in the same frequency band for terrestrial base stations, essentially repurposing what was supposed to be a "quiet neighborhood" for signals from

CIVILIAN

Many civilian applications use one or more of GPS's three basic components: absolute location, relative movement, and time transfer.

- Cartography: Both civilian and military cartographers use GPS extensively.
- Cellular telephony: Clock synchronization enables time transfer, which is critical for synchronizing its spreading codes with other base stations to facilitate inter-cell handoff and support hybrid GPS/cellular position detection for mobile emergency calls and other applications. The first handsets with integrated GPS launched in the late 1990s. The U.S. Federal Communications Commission (FCC) mandated the feature in either the handset or in the towers (for use in triangulation) in 2002 so emergency services could locate 911 callers. Third-party software developers later gained access to GPS APIs from Nextel upon launch, followed by Sprint in 2006, and Verizon soon thereafter.
- Clock synchronization: The accuracy of GPS time signals (±10 ns) is second only to the atomic clocks upon which they are based.
- Disaster relief/emergency services: Depend upon GPS for location and timing capabilities.
- Fleet Tracking: The use of GPS technology to identify, locate and maintain contact reports with one or more fleet vehicles in real-time.

- Geofencing: Vehicle tracking systems, person tracking systems, and pet tracking systems use GPS to locate a vehicle, person, or pet. These devices are attached to the vehicle, person, or the pet collar. The application provides continuous tracking and mobile or Internet updates should the target leave a designated area.
- Geotagging: Applying location coordinates to digital objects such as photographs and other documents for purposes such as creating map overlays.
- GPS Aircraft Tracking
- GPS tours: Location determines what content to display; for instance, information about an approaching point of interest.
- Navigation: Navigators value digitally precise velocity and orientation measurements.
- Phasor measurements: GPS enables highly accurate timestamping of power system measurements, making it possible to computephasors.
- Recreation: For example, geocaching, geodashing, GPS drawing and waymarking.
- Robotics: Self-navigating, autonomous robots using a GPS sensors, which calculate latitude, longitude, time, speed, and heading.

Restrictions on civilian use

The U.S. Government controls the export of some civilian receivers. All GPS receivers capable of functioning above 18 kilometres (11 mi)altitude and 515 metres per second (1,001 kn) are classified as munitions (weapons) for which State Department export licenses are required. These limits attempt to prevent use of a receiver in a ballistic missile. They would not prevent use in a cruise missile because their altitudes and speeds are similar to those of ordinary aircraft. This rule applies even to otherwise purely civilian units that only receive the L1 frequency and the C/A (Coarse/Acquisition) code and cannot correct for Selective Availability (SA), etc. Disabling operation above these limits exempts the receiver from classification as a munition. Vendor interpretations differ. The rule refers to operation at both the target altitude and speed, but some receivers stop operating even when stationary. This has caused problems with some amateur radio balloon launches that regularly reach 30 kilometres (19 mi). These limits only apply to units exported from (or which have components exported from) the USA - there is a growing trade in various components, including GPS units, supplied by other countries, which are expressly sold as ITAR-free.

Military

As of 2009, military applications of GPS include:

- Navigation: GPS allows soldiers to find objectives, even in the dark or in unfamiliar territory, and to coordinate troop and supply movement. In the United States armed forces, commanders use the *Commanders Digital Assistant* and lower ranks use the *Soldier Digital Assistant*.
- Target tracking: Various military weapons systems use GPS to track potential ground and air targets before flagging them as hostile.[*citation needed*] These weapon systems pass target coordinates to precision-guided munitions to allow them to engage targets accurately. Military aircraft, particularly in air-to-ground roles, use GPS to find targets (for example, gun camera video fromAH-1 Cobras in Iraq show GPS co-ordinates that can be viewed with specialized software).
- Missile and projectile guidance: GPS allows accurate targeting of various military weapons including ICBMs, cruise missiles, precision-guided munitions and Artillery projectiles. Embedded GPS receivers able to withstand accelerations of 12,000 *g* or about 118 km/s^2 have been developed for use in 155 millimeters (6.1 in) howitzers.
- Search and Rescue: Downed pilots can be located faster if their position is known.
- Reconnaissance: Patrol movement can be managed more closely.
- GPS satellites carry a set of nuclear detonation detectors consisting of an optical sensor (Y-sensor), an X-ray sensor, a dosimeter, and an electromagnetic pulse (EMP) sensor (W-sensor), that form a major portion of the United States Nuclear Detonation Detection System.

Conclusions:

Due to performance differences, two user's GPS receivers can yield different frequency results even when connected to the same antenna at the same location. The frequency uncertainty for user's GPS receiver is larger than that for Cs-standard by 2-3 orders for a short-time interval (1 – 1000 s), and by one order for a long-term interval of about two weeks.

3.4 GSM Technology

Fig 3.13 Gps module

<u>Introduction:</u>

Time-Division Multiple Access (TDMA)

What is TDMA?

TDMA (time division multiple access) is a technology used in digital cellular telephone communication to divide each cellular channel into three time slots in order to increase the amount of data that can be carried.

How it Works?

TDMA works by time-division multiplexing: sending multiple signals (each of which has its own time slot) simultaneously on a single carrier in the form of a complex signal, and then recovering the separate signals at the receiving end. For TDMA, the carrier is divided into three time slots, each of which serves one subscriber. The information is broken into tiny data packets, which are transmitted in timed bursts in the 30-megahertz range. At the receiving end, the separate information streams are recovered. See also FDMA (frequency division multiple access) and CDMA (code-division multiple access).

TDMA was developed in response to the basic wireless network problem:

large numbers of users and limited frequency allotments. TDMA increases network efficiency

Code Division Multiple Access (CDMA):

The term CDMA refers to any of several protocols used in so-called second-generation (2G) and third-generation (3G) wireless communications. As the term implies, CDMA is a form of multiplexing, which allows numerous signals to occupy a single transmission channel, optimizing the use of available bandwidth. The technology is used in ultra-high-frequency (UHF) cellular telephone systems in the 800-MHz and 1.9-GHz bands. CDMA employs analog-to-digital conversion (ADC) in combination with spread spectrum technology. Audio input is first digitized into binary elements. The frequency of the transmitted signal is then made to vary according to a defined pattern (code), so it can be intercepted only by a receiver whose frequency response is programmed with the same code, so it follows exactly along with the transmitter frequency. There are trillions of possible frequency-sequencing codes; this enhances privacy and makes cloning difficult.

Global System for Mobile communication (GSM):

What is GSM?

The Global System for Mobile communication, usually called GSM, Telecommunications Standards Institute (ETSI) to describe protocols for second generation (2G) digital cellular networks used by mobile phones. The GSM standard was developed as a replacement for first generation (1G) analog cellular networks, and originally described a digital, circuit switched network optimized for full duplex voice telephony. This was expanded over time to include data communications, first by circuit switched transport, then packet data transport via GPRS (General Packet Radio Services) and EDGE (Enhanced Data rates for GSM Evolution or EGPRS). Further improvements were made when the 3GPP developed third generation (3G) UMTS standards followed by fourth generation (4G)LTE Advanced standards. "GSM" is a trademark owned by the GSM Association.

GSM is a cellular network, which means that mobile phones connect to it by searching for cells in the immediate vicinit

The ubiquity of the GSM standard makes international roaming very common between mobile phone operators, enabling subscribers to use their phones in many parts of the world. GSM differs significantly from its predecessors in that both signalling and speech channels are Digital call quality, which means that it is considered a *second generation* (2G) mobile phone system. This fact has also meant that data communication was built into the system from the 3rd Generation Partnership Project (3GPP).

GSM is a digital mobile telephone system that is widely used in Europe and other parts of the world. GSM uses a variation of time division multiple access (Time Division Multiple Access) and is the most widely used of the three digital wireless telephone technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1800 MHz frequency band.

The Generations of Mobile Networks

The idea of cell-based mobile radio systems appeared at Bell Laboratories in the United States in the early 1970s. However, mobile cellular systems were not introduced for commercial use until a decade later. During the early 1980's, analog cellular telephone systems experienced very rapid growth in Europe, particularly in Scandinavia and the United Kingdom. Today, cellular systems still represent one of the fastest growing telecommunications systems. During development, numerous problems arose as each country developed its own system, producing equipment limited to operate only within the boundaries of respective countries, thus limiting the markets in which services could be sold.

First-generation cellular networks, the primary focus of the communications industry in the early 1980's, were characterized by a few compatible systems that were designed to provide purely local cellular solutions. It became increasingly apparent that there would be an escalating demand for a technology that could facilitate flexible and reliable mobile communications. By the early 1990's, the lack of capacity of these existing networks emerged as a core challenge to keeping up with market demand. The first mobile wireless phones utilized analog transmission technologies, the dominant analog standard being known as "AMPS", (Advanced Mobile Phone System). Analog standards operated on bands of spectrum with a lower frequency and greater wavelength than subsequent standards, providing a significant signal range per cell along with a high propensity for interference. Nonetheless, it is worth noting the continuing persistence of analog (AMPS) technologies in North America and Latin America through the 1990's.

History of GSM:

Early European analog cellular networks consisted of a mix of technologies and protocols that varied from country to country, meaning that phones did not necessarily work on different networks. In addition, manufacturers had to produce different equipment to meet various standards across the markets.

In 2000, the first commercial GPRS services were launched and the first GPRS compatible handsets became available for sale. In 2001 the first UMTS (W-CDMA) network was launched and worldwide GSM subscribers exceeded 500 million. In 2002 the first multimedia messaging services

(MMS) were introduced and the first GSM network in the 800 MHz frequency band became operational. EDGE services first became operational in a network in 2003 and the number of worldwide GSM subscribers exceeded 1 billion in 2004.

Architecture of the GSM network:

A GSM network is composed of several functional entities, whose functions and interfaces are specified. Figure 1 shows the layout of a generic GSM network. The GSM network can be divided into three broad parts. The Mobile Station is carried by the subscriber. The Base Station Subsystem controls the radio link with the Mobile Station. The Network Subsystem, the main part of which is the Mobile services Switching Center (MSC), performs the switching of calls between the mobile users, and between mobile and fixed network users. The MSC also handles the mobility management operations. The Mobile Station and the Base Station Subsystem communicate across the Um interface, also known as the air interface or radio link. The Base Station Subsystem communicates with the Mobile services Switching Center across the A interface.

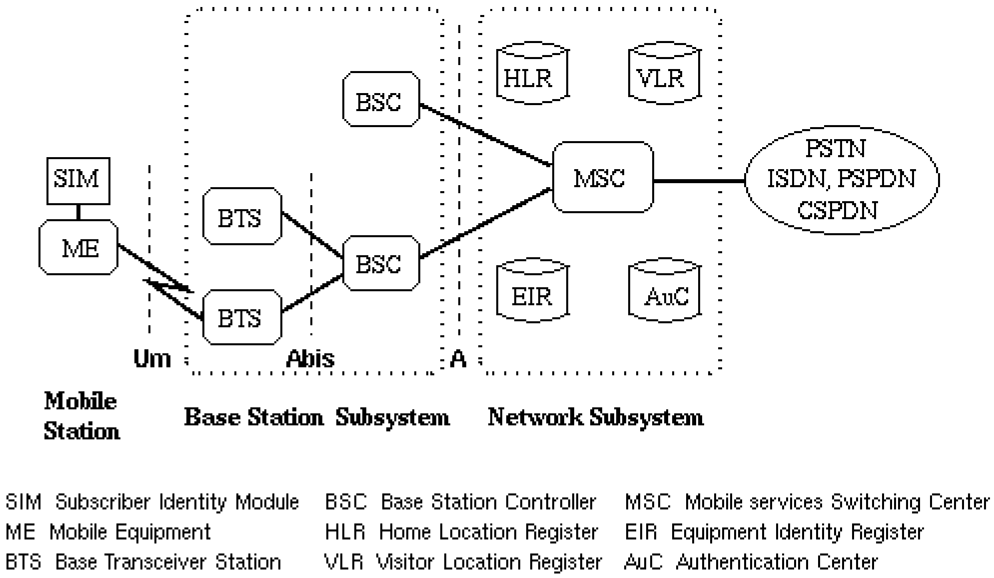


Figure 3.14 General architecture of a GSM network

Mobile Station

The mobile station (MS) consists of the mobile equipment (the terminal) and a smart card called the Subscriber Identity Module (SIM). The SIM provides personal mobility, so that the user can have access to subscribed services irrespective of a specific terminal. By inserting the SIM card into another GSM terminal, the user is able to receive calls at that terminal, make calls from that terminal, and receive other subscribed services.

Base Station Subsystem

The Base Station Subsystem is composed of two parts, the Base Transceiver Station (BTS) and the Base Station Controller (BSC). These communicate across the standardized Abis interface, allowing (as in the rest of the system) operation between components made by different suppliers.

Network Subsystem

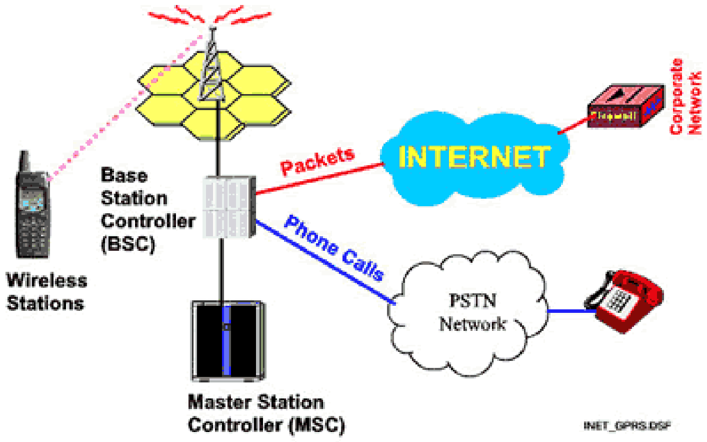
The central component of the Network Subsystem is the Mobile services Switching Center (MSC). It acts like a normal switching node of the PSTN or ISDN, and additionally provides all the functionality needed to handle a mobile subscriber, such as registration, authentication, location updating, handovers, and call routing to a roaming subscriber. The MSC provides the connection to the fixed networks (such as the PSTN or ISDN). Signaling between functional entities in the Network Subsystem uses Signaling System Number 7 (SS7), used for trunk signaling in ISDN and widely used in current public networks.

The Visitor Location Register (VLR) contains selected administrative information from the HLR, necessary for call control and provision of the subscribed services, for each mobile currently

GSM frequencies using around the world:

In North America, GSM operates on the primary mobile communication bands 850 MHz and 1,900 MHz. In Canada, GSM-1900 is the primary band used in urban areas with 850 as a backup, and GSM-850 being the primary rural band. In the United States, regulatory requirements determine which area can use which band.

In Brazil, the 1,900 MHz band is paired with 2,100 MHz to form the IMT-compliant 2,100 MHz band for 3G services. The result is a mixture of usage in the Americas that requires travelers to confirm that the phones they have are compatible with the band of the networks at their destinations.Frequency compatibility problems can be avoided through the use of multi-band (tri-band or, especially, quad-band) phones.



Africa, Europe, Middle East and Asia

GSM SECURITY:

The security features in the GSM network can be divided into three sub parts: subscriber identity authentication, user and signaling data confidentiality, and subscriber identity confidentiality. The security mechanisms include secret keys, algorithms and computed numbers.

Some definitions:

- Authentication – any technique that enables the receiver to automatically identify and reject messages that have been altered deliberately or by channel errors
- Confidentiality – only the sender and intended receiver should be able to understand the contents of the transmitted message.
- Cipher text – plaintext is encrypted to cipher text with the help of a key and an encryption algorithm

A3 is the algorithm used to authenticate the subscriber. Data transmitted between the MS (Mobile Station) and the BTS (Base Transceiver Station) is encrypted by the A5 algorithm. The A8 algorithm generates the needed ciphering key Kc used by A5.

Subscriber Identity Authentication. The procedure consists of three phases, (1) the network must identify the subscriber, (2) needed security parameters from the home network are asked for and (3) the actual authentication is taking place.

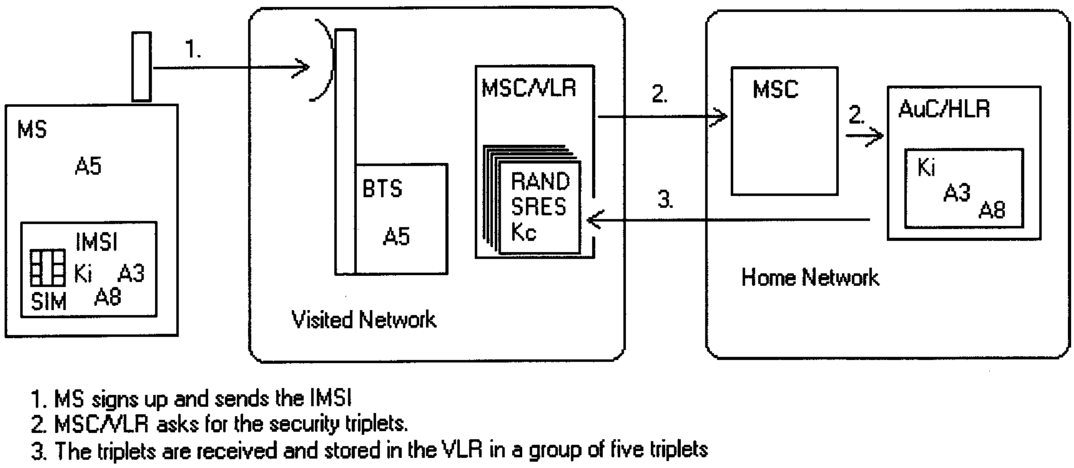


Figure.3.15 Subscriber identification process.

In order to identify the subscriber the MS sends the IMSI (International Mobile Subscriber Identity) to the visited network. With the IMSI the subscriber is identified to the system. The IMSI is up to 15 digits and comprises the following parts:

- A 3-digit Mobile Country Code (MCC). This identifies the country where the GSM system operates. Finland has number 244.
- A 2-digit Mobile Network Code (MNC). This uniquely identifies each cellular provider. Sonera has number 91.
- The Mobile Subscriber Identification Code (MSIC).This uniquely identifies each customer of the provider. The length is 10 digits.

So called security triplets are calculated in the AuC. The triplets consist of a random number (RAND), a signed response (SRES) and a ciphering key (Kc). The SRES is used to authenticate the subscriber and Kc is used as input by the ciphering algorithm A5

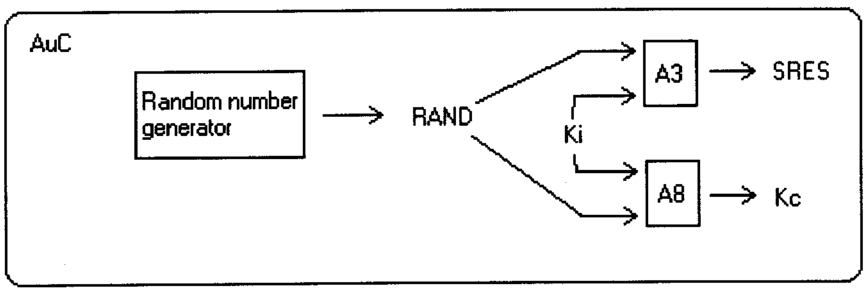


Figure 3.16. Calculating the security triplets

Subscriber Identity Confidentiality: The IMSI is the primary key for subscriber identification. However a temporary identity, TMSI (Temporary Mobile Subscriber Identity) can be given to a subscriber for identification. After initial registration done with the IMSI, the serving network stores the IMSI in the VLR and generates a TMSI for the subscriber. The TMSI is then transmitted back to the MS and it will be used for identification as long as the subscriber is registered in that specific network.

Solutions to Current Security Issues

A corrected version of the COMP 128 has been developed; however, the cost to replace all SIM chips and include the new algorithm is too costly to cellular phone companies. The new release of 3GSM will include a stronger version of the COMP 128 algorithm and a new A5 algorithm implementation. The A5/3 is expected to solve current confidentiality and integrity problems [4]. Fixed network transmission could be fixed by simply applying some type of encryption to any data transferred on the fixed network.

Channel structure:

Depending on the kind of information transmitted (user data and control signaling), we refer to different logical channels which are mapped under physical channels (slots). Digital speech is sent on a logical channel named TCH, which during the transmission can be a allocated to a certain physical channel. In a GSM system no RF channel and no slot is dedicated to a priori to the exclusive use of anything (any RF channel can be used for number of different uses).

Logical channels are divided into two categories:

i) Traffic Channels (TCHs)

ii)Control Channels.

Traffic Channels (TCHs)

A traffic channel (TCH) is used to carry speech and data traffic. Traffic channels are defined using a 26-frame multiform, or group of 26 TDMA frames. The length of a 26-frame multiform is 120 ms, which is how the length of a burst period is defined (120 ms divided by 26 frames divided by 8 burst periods per frame). Out of the 26 frames, 24 are used for traffic, 1 is used for the Slow Associated Control Channel (SACCH) and 1 is currently unused. TCHs for the uplink and downlink are separated in time by 3 burst periods, so that the mobile station does not have to transmit and receive simultaneously, thus simplifying the electronics.

TCHs carry either encoded speech or user data in both up and down directions in a point to point communication.

There are two types of TCHs that are differentiated by their traffic rates.

They are:

i. Full Rate TCH

ii. Half Rate TCH

Full Rate TCH(Also represented as Bm)

It carries information at a gross rate of 22.82 Kbps.

Half Rate TCH

It carries information with half of full rate channels.

Control Channel

Basic structure of Control channel

1	2	3	4	.	.	.	.	.	10	11	.	.	.	.	.					21					26

F	S	x	X	X	X	X	X	X	X	F	S	X	X	X	X	X	X	X	X	F	S	X	X	X	X

Actually in the above diagram S will be at slot 1 of next frame, F is frequency correction channel which occurs every 10th burst. The next frame to S contains service operator’s information.

Logical Control Channel (LCC) s are of three types

They are of the following types:

•Broadcast Control Channel(BCCH)

•Common Control Channel(CCCH)

• Dedicated Control Channel(DCCH)

Broadcast Control Channel (BCCH)

The BCCH is a point-to-multipoint unidirectional control channel from the fixed subsystem to MS that is intended to broadcast a variety of information to MSs, including information necessary for the MS to register in the system. BCCH has 51 bursts. BCCH is dedicated to slot1 and repeats after every 51 bursts.

The BCCH includes :

-- Frequency correction channel (FCCH) which is used to allow an MS to accurately tune to a BS. The FCCH carries information for the frequency correction of MS downlink. It is required for the correct operation of radio system. This is also a point-to multipoint communication. This allows an MS to accurately tune to a BS.

Common Control Channel (CCCH)

A CCCH is a point-to-multipoint (bi-directional control channel) channel that is primarily intended to carry signaling information necessary for access management functions (e.g., allocation of dedicated control channels).

The CCCH includes:

-- paging channel (PCH), which is used to search (page) the MS in the downlink direction

-- random access channel (RACH) which is used by MS to request of an SDCCH either as a page response from MS or call origination/ registration from the MS. This is uplink channel and operates in point-point mode(MS to BTS).This uses slotted ALOHA protocol. This causes a possibility of contention. If the mobiles request through this channel is not answered within a specified time the MS assumes that a collision has occurred and repeats the request. Mobile must allow a random delay before re-initiating the request to avoid repeated collision.

-- access grant channel(AGCH) which is a downlink channel used to assign a MS to a specificSDCCH or a TCH. AGCH operates in point-to-point mode. A combined paging and access grant channel is designated as PAGCH.

Dedicated Control Channel (DCCH)

A DCCH is a point to point, directional control channel.

Two types of DCCHs used are:

Standalone DCCH (SDCCH) is used for system signaling during idle periods and call setbefore allocating a TCH, for example MS registration, authentication and location updates through this channel. When a TCH is assigned to MS this channel is released. Its data rate Is one-eighth of the full rate speech channel which is achieved by transmitting data over the channel once every eighth frame. The channel is used for uplink and downlink and is meant for point-to-point usage.

The GSM standard also provides separate facilities for transmitting digital data. This allows a mobile phone to act like any other computer on the Internet, sending and receiving data via the Internet Protocol. The mobile may also be connected to a desktop computer, laptop, or PDA, for use as a network interface (just like a modem or Ethernet card, but using one of the GSM data protocols described below instead of a PSTN-compatible audio channel or an Ethernet link to transmit data). Some GSM phones can also be controlled by a standardised Hayes AT command set through a serial cable or a wireless link (using IRDA or Bluetooth). The AT commands can control anything from ring tones to data compression algorithms. In addition to general Internet access, other special services may be provided by the mobile phone operator, such as SMS.

Circuit-switched data protocols

A circuit-switched data connection reserves a certain amount of bandwidth between two points for the life of a connection, just as a traditional phone call allocates an audio channel of a certain quality between two phones for the duration of the call. Two circuit-switched data protocols are defined in the GSM standard: Circuit Switched Data (CSD) and High-Speed Circuit-Switched Data (HSCSD). These types of connections are typically charged on a per-second basis, regardless of the amount of data sent over the link. This is because a certain amount of bandwidth is dedicated to the connection regardless of whether or not it is needed. Circuit-switched connections do have the advantage of providing a constant, guaranteed quality of service, which is useful for real-time applications like video conferencing.

General Packet Radio Service (GPRS)

The General Packet Radio Service (GPRS) is a packet-switched data transmission protocol, which was incorporated into the GSM standard in 1997. It is backwards-compatible with systems that use pre-1997 versions of the standard. GPRS does this by sending packets to the local mobile phone mast (BTS) on channels not being used by circuit-switched voice calls or data connections. Multiple GPRS users can share a single unused channel because each of them uses it only for occasional short bursts. The advantage of packet-switched connections is that bandwidth is only used when there is actually data to transmit. This type of connection is thus generally billed by the kilobyte instead of by the second, and is usually a cheaper alternative for applications that only need to send and receive data sporadically, like instant messaging.

Short Message Service (SMS)

Short Message Service (more commonly known as text messaging) has become the most used data application on mobile phones, with 74% of all mobile phone users worldwide already as active users of SMS, or 2.4 billion people by the end of 2007. SMS text messages may be sent by mobile phone users to other mobile users or external services that accept SMS. The messages are usually sent from mobile devices via theShort Message Service Centre using the MAP protocol. The SMSC is a central routing hubs for Short Messages. Many mobile service operators use their SMSCs as gateways to external systems, including the Internet, incoming SMS news feeds, and other mobile operators (often using the de facto SMPP standard for SMS exchange).

STRUCTURE OF TDMA SLOT WITH A FRAME:

There are five different kinds of bursts in the GSM system.

They are

- Normal Burst
- Synchronization Burst
- Frequency Correction Burst
- Access Burst

NORMAL BURST

This burst is used to carry information on the TCH and on control channels. The lowest bit number is transmitted first. The encrypted bits are 57 bits of data or (speech + 1 bit stealing flag) indicating whether the burst was stolen for FACCH signaling or not. The reason why the training sequence is placed in the middle is that the channel is constantly changing. By having it there, the chances are better that the channel is not too different when it affects the training sequence compared to when the information bits were affected. If the training sequence is put at the beginning of the burst, the channel model that is created might not be valid for the bits at the end of a burst there are 8 training sequences shown at the diagram. The 26 bits equalization patterns are determined at the time of the call setup.

Tail Bits (TB) always equal (0,0,0), which has bit location from 0 to 2 and 145 to 147 . The Guard Period are the empty spaced bits and are used to synchronize the burst with exact accuracy and makes sure that different time slots does not overlap during transmission.

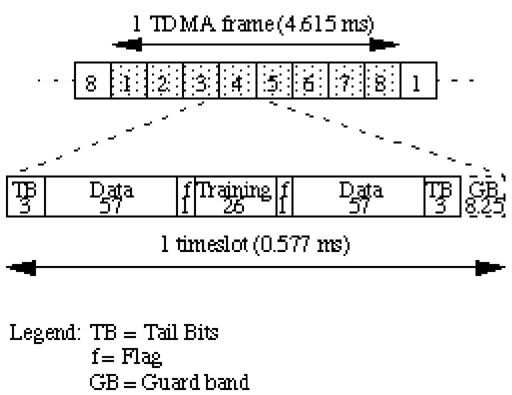


Figure 5: GSM TDMA structure and Normal Burst. Number of bits per field below the field legend.

SYNCHRONIZATION BURST

This burst is used for the time synchronization of the mobile. It contains 64 bit synchronization sequence. The encrypted 78 bits carry information of the TDMA frame number along with the BSIC. It is broadcast together with the correction burst. The TDMA frame is broadcast over SCH, in order to protect the user information against eavesdropping, which is accomplished is ciphering the information before transmitting. The algorithm that calculates the ciphering key uses a TDMA frame number as one of the parameters and therefore, every frame must have a frame number.

FREQUENCY CORRECTION BURST

This burst is used for frequency synchronization of the mobile. It is equivalent to an un-modulated channel with a specific frequency offset. The repetition of these bursts is called FCCH.

ACCESS BURST

This burst is used for random access and longer GP to protect for burst transmission from a mobile that does not know the timing advance when it must access the system. This allows for a distance of 35 km from base to mobile. In case the mobile is far away from the BTS, the initial burst will arrive late since there is no timing advance on the first burst. The delay must be shorter to prevent it from overlapping a burst in the adjacent time-slot following this.

DUMMY BURST

It is sent from BTS on some occasions as discussed previously which carries no information and has the format same as the normal burst.

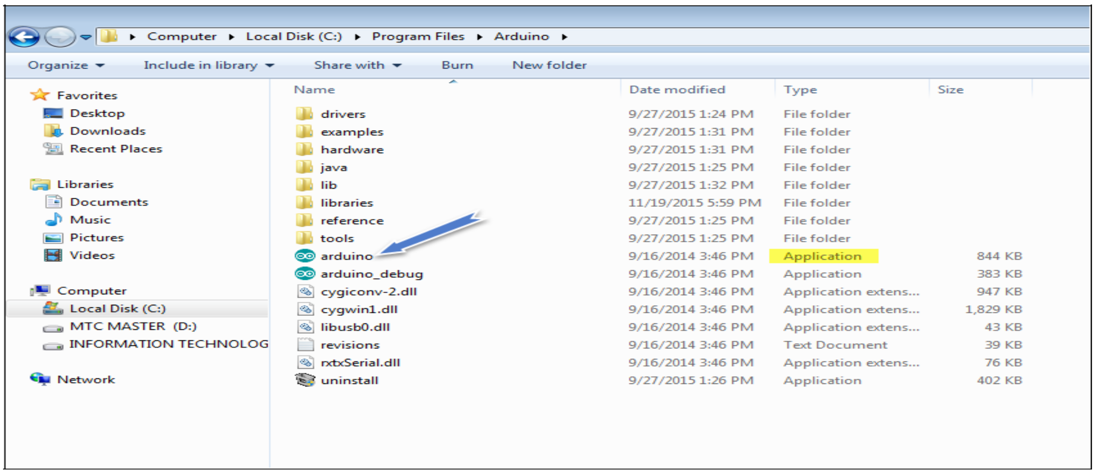
CONCLUSION

GSM has many benefits over current cellular systems. The main problem now involves the COMP 128 algorithm problem. This problem will be solved as newer technology gets phased in. The lack of extra encryption on the telecommunications network doesn’t pose as a major problem because any data transfer on there will have the same security as the current public switched telephone networks

3.5 SOFTWARE MODULES DESCRIPTION

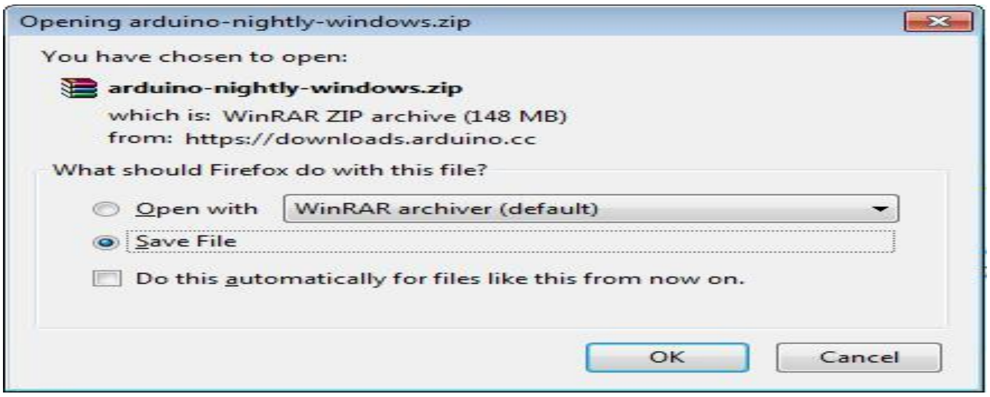
3.51 ARDUNIO INSTALLATION:

Step 1: First you must have your Arduino board (you can choose your favorite board) and aUSB cable. In case you use Arduino UNO, ArduinoDuemilanove, Nano, Arduino Mega 2560, or Diecimila, you will need a standard USB cable (A plug to B plug), the kind you would connect to a USB printer as shown in the following image.



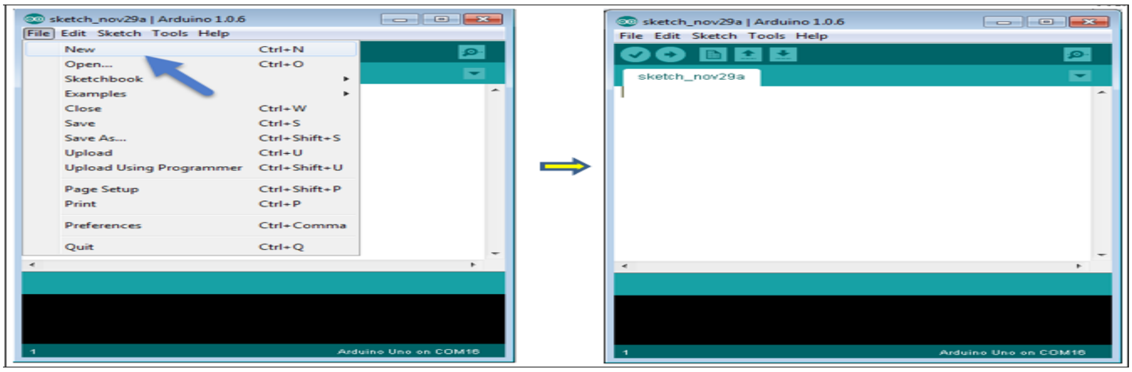
Step 2: Download Arduino IDE Software.

You can get different versions of Arduino IDE from the Download page on the Arduino Official website. You must select your software, which is compatible with your operating system (Windows, IOS, or Linux). After your file download is complete, unzip the file.



Step 3: Power up your board. The Arduino Uno, Mega, Duemilanove and Arduino Nano automatically draw power from either, the USB connection to the computer or an external power supply. If you are using an Arduino Diecimila, you have to make sure that the board is configured to draw power from the USB connection.

Step 4: Launch Arduino IDE. After your Arduino IDE software is downloaded, you need to unzip the folder. Inside the folder, you can find the application icon with an infinity label (application.exe). Double-click the icon to start the IDE.



Step 5: Open your first project.

Once the software starts, you have two options:

Create a new project.

Open an existing project example.

To create a new project, select File --> New

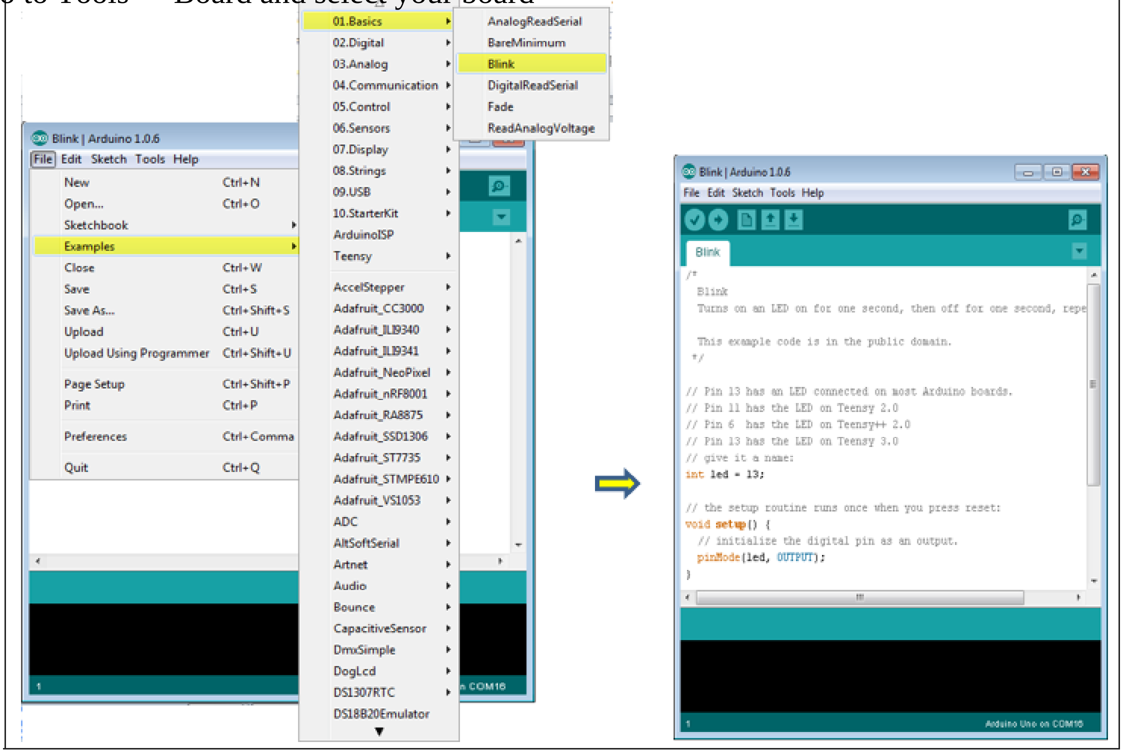
To open an existing project example, select File -> Example -> Basics -> Blink.

Here, we are selecting just one of the examples with the name **Blink**. It turns the LED on and off with some time delay. You can select any other example from the list.

Step 6: Select your Arduino board.

To avoid any error while uploading your program to the board, you must select the correct Arduino board name, which matches with the board connected to your computer.

Go to Tools -> Board and select your board



CHAPTER-4

PROJECT IMPLEMENTATION

4.1 Design and implementation:

Analysis of Requirements: List the necessary specifications for the military security system, such as the parameters to be tracked (heart rate, gas, smoke, position, temperature, tilt), the actions to be done (buzzer activation), and the communication capabilities (GSM). Choosing a technology Choose the proper Renesas microcontrollers and supporting hardware, including tilt, tilt angle, gas, smoke, location, and temperature sensors. Think about things like precision, dependability, power usage, and Renesas microcontroller integration simplicity.Develop the system architecture, which should include the microcontroller circuitry, sensor integration, and communication interfaces (such as UART for GSM). Create the software modules for collecting, analyzing, and controlling buzzer logic using sensor data. Create an actual prototype of the embedded electronics, including the Renesas microcontroller, sensors, and related components Create the software code required for sensor data collecting, processing, and buzzer activation control logic. Extensive testing should be done to validate the performance of the prototype system. To ensure precise and trustworthy data collection, test the tilt, tilt angle, heart rate, gas, smoke, location, and temperature sensors. Check the buzzer control logic for accuracy using sensor data. To deliver data to a distant server, test the GSM transmission. Refine the system iteratively as necessary in response to test findings. For the system to function better, be more dependable, or be more accurate, adjustments may need to be made to the hardware, software, or sensor integration. Integrate the embedded electronics into the soldier's kit or gear after the prototype system has been properly validated. This might entail incorporating the sensors and Renesas microcontroller into clothing or other army gear. Maintenance and Upgrades: To guarantee the system's ongoing operation and efficacy, undertake regular maintenance and upgrades. To resolve any problems or vulnerabilities that might occur during field use, this may entail routine monitoring, software upgrades, and device maintenance. Training and user support: Teach soldiers how to use the embedded electronics for their security in an efficient manner. To guarantee soldiers can use the system properly and take full advantage of its capabilities, this may entail offering user guides, training sessions, and continuing technical assistance.

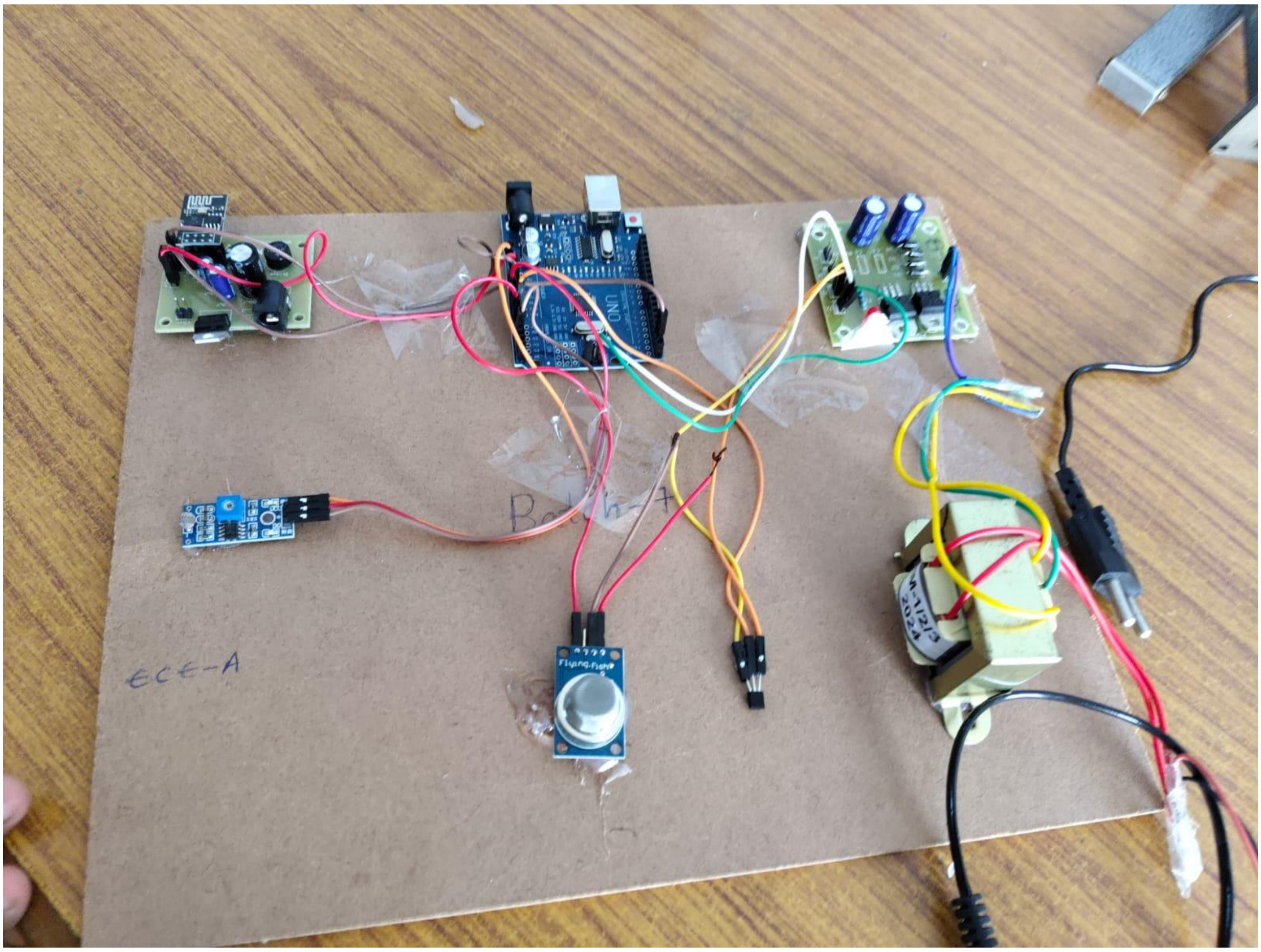


Fig 4.1.1 Implementation of project

4.2 ADVANTAGES AND APPLICATIONS

4.21 Advantages:

1) Low design time.

2) Low production cost.

3) This system is applicable for both the indoor and outdoor environment.

4) Setting the destination is very easy.

5) It is dynamic system.

6) Less space.

7) Low power consumption.

4.22 Applications

1) Remote Health Monitoring
2) Preliminary Diagnosis
3) Wearable Health Devices
4) First-Aid Assistance
5) Patient Data Logging
6) Emergency Alerts
7) Portable Medical Equipment
8) Health Tracking for the Elderly

CHAPTER-5

5.1 RESULT & DISCUSSION

System counting heartbeat and measuring body temperature correctly. When ever beat count increase or decrease to certain level or body temperature increases or decreases below certain level system will alert everyone by alert sound and sends exact location of soldier with the help of GSM GPS module in the form of sms . System also sends the exact location of the solder when he or she press the panic mode switch.

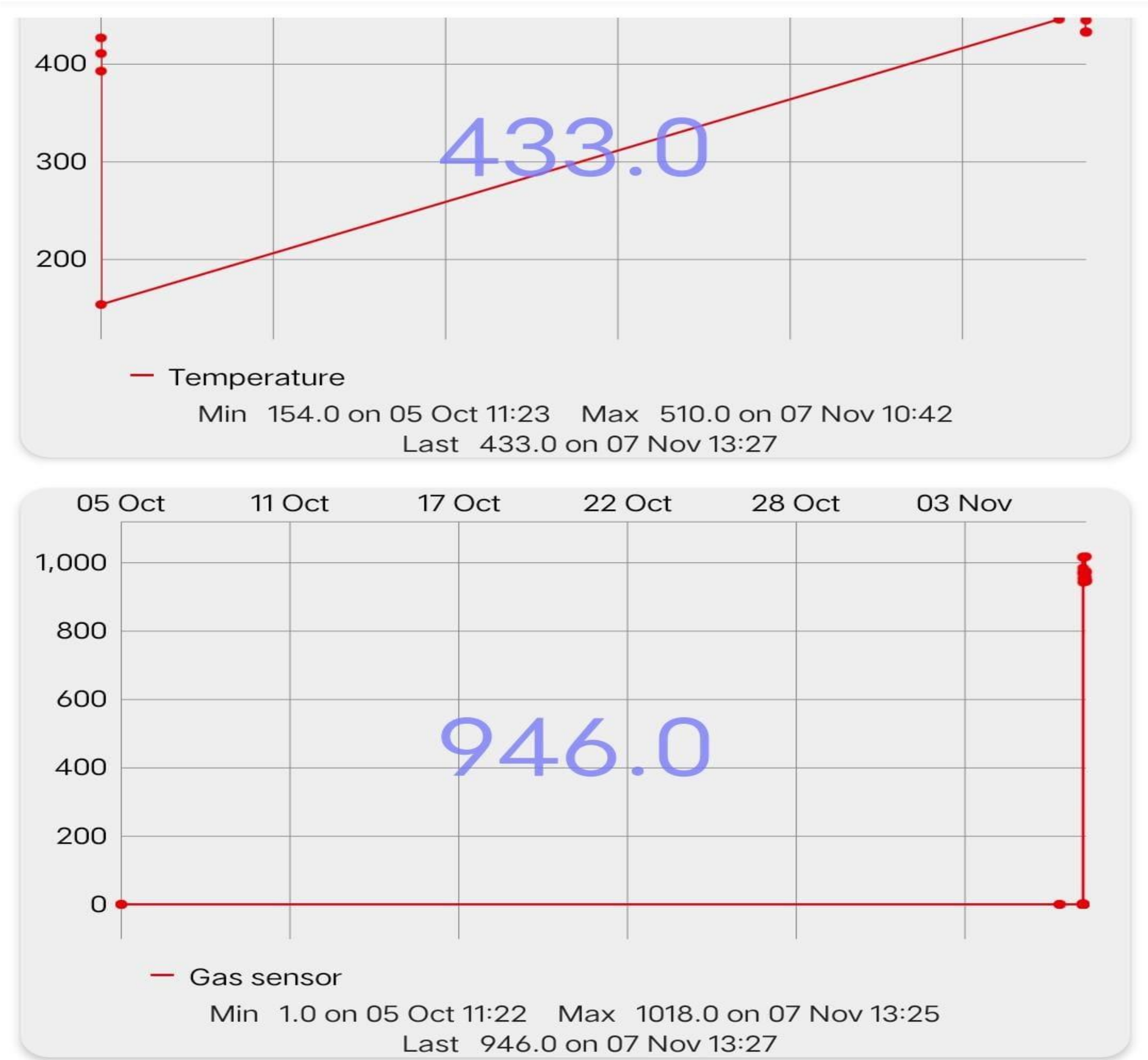


Fig 5.1.1 Readings of temperature sensor and gas sensor

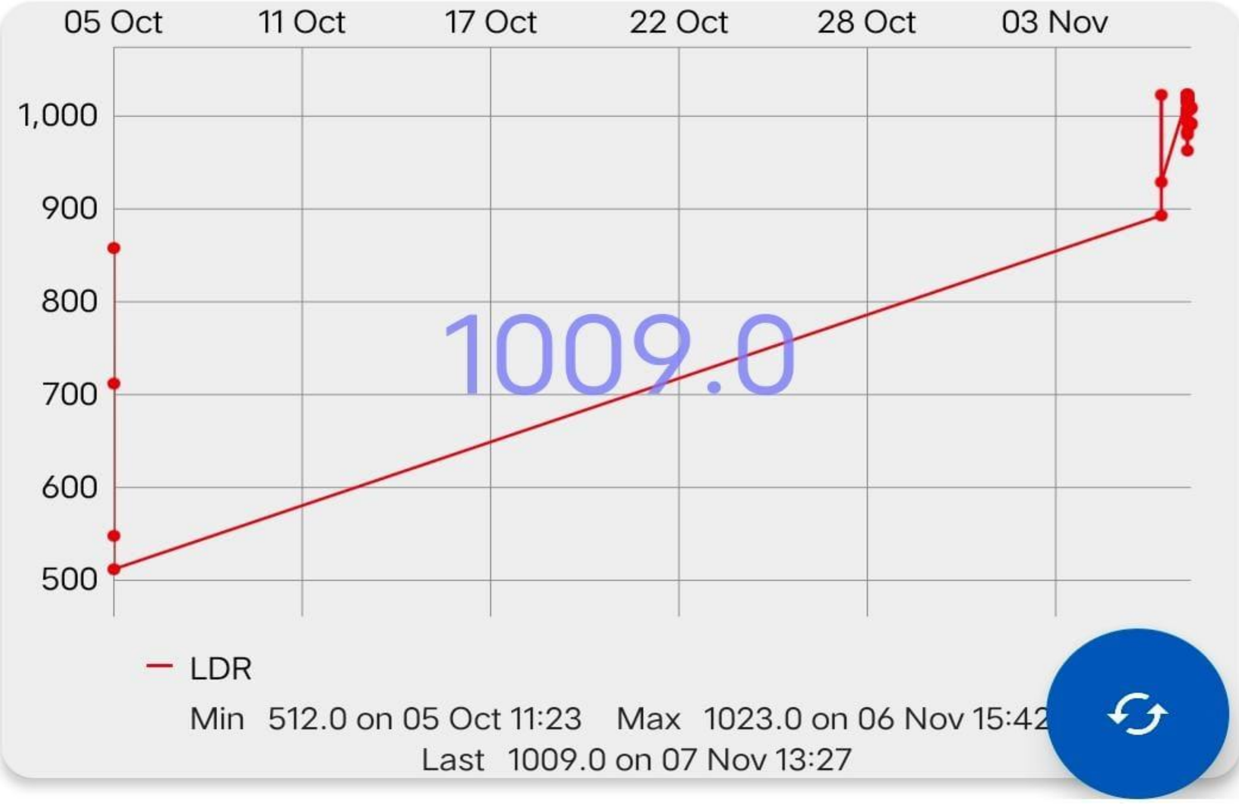


Fig 5.1.2 output of LDR sensor

CONCLUSION

Conclusion:

The smart soldier health monitoring system described in this study has been successfully implemented and has the potential to significantly enhance military operations. The ability to detect biohazards with the aid of a powerful algorithm allows it to gather information about each soldier's health status from the battlefield. By offering support or additional aid, this enables quick judgements and helps to avoid casualties. In addition, using a LoRa module for data transmission rather than a high-power-consuming GSM/GPRS module results in a system energy usage of only 3.2 Wh, which is significantly lower. Consequently, it can be stated that using the smart soldier health monitoring system significantly outperforms the conventional approaches to carrying out military operations.

Future scope:

Advanced Sensor Integration: Renesas microcontrollers provide strong interface support for a variety of sensors, including biometric, environmental, and situational awareness sensors. Future research might concentrate on utilising Renesas microcontrollers to incorporate sophisticated sensors into troop security systems for improved monitoring and data collection. For instance, integrating sensors that can recognise chemical, biological, and radioactive threats or sensors that can offer real-time physiological monitoring of a soldier's vital signs could significantly enhance situational awareness and response.

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APPENDIX

Code:

```
#include <LiquidCrystal.h>
const int rs = 13, en =12, d4 =11, d5 =10, d6 =9, d7 =8;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);
const int TEMPERATURE_PIN = A0;  // Analog input pin
const int HUMIDITY_PIN = A1;  // Analog input pin
const int LDR_PIN = A2;  // Analog input pin
const int SOILMOITURE_PIN = A3;  // Analog input pin
const int motorpin =  A4;      // the number of the LED p
int Temperature_value = 0,Soil_value=0,Humidity_value=0,Ldr_value=0;
int sec1=0,tst1=0;
int s;
void setup()
{
  Serial.begin(115200);  // Set it according to your esp's baudrate. Different esp's have different
baud rates.
  pinMode(motorpin, OUTPUT);
   pinMode(7, INPUT);
       lcd.begin(16, 2);
  // Print a messageeto the LCD.
    lcd.setCursor(0, 0);
  lcd.print("  Welcome To    ");
  // (note: line 1 is the second row, since counting begins with 0):
  lcd.setCursor(0, 1);
  // Print a message to the LCD.
  lcd.print("SMART FORMING SYS   ");
  // initialize serial:
  delay(5000);
}
void loop()
{
```

```
   lcd.clear();
   s=digitalRead(7);
  Temperature_value = analogRead(TEMPERATURE_PIN);
  Soil_value = digitalRead(SOILMOITURE_PIN);
  Humidity_value = analogRead(HUMIDITY_PIN);
   Ldr_value = analogRead(LDR_PIN);
   Serial.println(  Temperature_value);
 Send_Wifi();
if(s==0)
{
  Digital Write(motorpin,1);
}
if(s==1)
{
  Digital Write(motorpin,0);
}
if( Temperature_value>950)
{
  Digital Write(motorpin,1);
}
If ( Temperature_value<950)
{
  digitalWrite(motorpin,0);
}
}
void Send_Wifi()
{
     Serial.print("AT\r\n");
      delay(1000);
      Serial.print("AT+CWMODE=3\r\n");
      delay(2000);
      Serial.print("AT+CIPMUX=1\r\n");
      delay(2000);
```

```
    Serial.print("AT+CWJAP=\"VITS\",\"12345678\"\r\n"); //ssid and password
    delay(10000);
    Serial.print("AT+CIPSTART=4,\"TCP\",\"184.106.153.149\",80\r\n");
    delay(5000);
    Serial.print("AT+CIPSEND=4,106\r\n");
    delay(3000);
    Serial.print("GET /update?key=LGCHCXT0A9H3XP50&field1=");
    UARTWriteInt(Temperature_value,4);
    Serial.print("&field2=");
    UARTWriteInt( Soil_value,4);
    Serial.print("&field3=");
    UARTWriteInt( Humidity_value,4);
    Serial.print("&field4=");
    UARTWriteInt( Ldr_value,4);
    delay(300);
    Serial.print("\r\n");
}
void UARTWriteInt(long val,unsigned int field_length)
{
 char str[10]={0,0,0,0,0,0,0,0,0,0};
 int i=9,j=0;
 while(val)
 {
 str[i]=val%10;
 val=val/10;
 i--;
 }
 j=10-field_length;
 if(val<0) Serial.write(' ');
 for(i=j;i<10;i++)
 {

 Serial.write(48+str[i])
```