A **MAJOR PROJECT** report on :

ADVANCED HEALTHCARE MONITORING AND RECOMMENDATION SYSTEM

submitted in partial fulfillment of the requirements for the degree of
B. Tech
In
Electronics and Electrical Engineering
By

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CERTIFICATE

This is to confirm that the project report "**ADVANCED HEALTHCARE MONITORING AND RECOMMENDATION SYSTEM**" provided by

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is true and correct.

A bonafide record of the work carried out under my(our) guidance and supervision at the School of Electronics Engineering, KIIT, in partial fulfilment of the requirements for the award of the Bachelor of Technology in Electronics and Electrical Engineering is submitted in partial fulfilment of the requirements for the award of the Bachelor of Technology in Electronics and Electrical Engineering from KIIT(Deemed to be University).

Signature of Supervisor 1

Prof.K.B.Ray

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The Project was evaluated by us on _____

EXAMINER 1 EXAMINER 2

EXAMINER 3 EXAMINER 4

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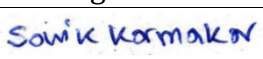
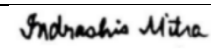
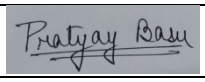
1807228	**Souvik Karmakar**	
1807274	**Indrashis Mitra**	
1807291	**Pratyay Basu**	

Date:-

ABSTRACT

Patients can be monitored outside of typical healthcare facilities, improving access to treatments and cutting costs.IoT not only helps in preventing the spread of disease but also in getting a proper diagnosis, even if the doctor is present at a remote distance . IoT has enabled us to build numerous complicated systems such as smart home appliances, smart traffic control systems, and so on by permitting effortless interaction among diverse modules.The COVID-19 pandemic had a terrible impact on healthcare, owing to a lack of planning. In some susceptible populations, such as the elderly, frail, or those with many chronic conditions, COVID-19 has a higher chance of catastrophic outcomes. The scarcity of medications was also a major role in the significant number of deaths we saw.

Hence our project proposes a method to resolve this, by applying machine learning techniques to stock up medicines, which have been observed to be of significant demand, so that there is no dearth and we can give them to those in need. In order to discover solutions to healthcare concerns, new technologies such as Big Data and Cloud are needed. New technologies, such as Big Data and Cloud, are required to discover answers to healthcare issues. Healthcare data is exploding these days, necessitating a quick, efficient, and cost-effective solution to lower mortality rates. In the development of the concept of business intelligence and analysis, the importance of data collection, integration, processing, and reporting of underlying knowledge has been emphasised, as well as how this knowledge can assist in making more appropriate business decisions and gaining a better understanding of market behaviour and trends. We may be able to use Big Data analysis for successful decision-making in the healthcare business by using current machine learning algorithms with minor tweaks. Choosing the right algorithm to forecast disease based on the data set supplied by the researcher, on the other hand, is always difficult.

PROPOSED SYSTEM: We intend to leverage Machine learning to aid in medicine supply. Using the support metrics of the Apriori algorithm, we plan to make a recommendation system of the medicine a particular customer is most likely to buy so that there is a win-win situation for both the customer and the shop owner - the customer gets the most appropriate medicine they want, at all times and do not have to face the hassles of out of

stock medicines; while the pharmacist also learns the particular combination of medicines, which is made available easily, will yield the maximum benefit in the upcoming future.

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LIST OF SYMBOLS / ABBREVIATIONS

Symbol / Abbreviations	Description
MLX	Melexis
MEMS	Micro-electromechanical systems
GPRS	General Packet Radio Service
Wifi	**Wireless Fidelity**
MAX	Maxim integrated
ESP	Espressif Systems
IC	Integrated Circuit
I2C	Inter-Integrated Circuit
ML	Machine learning

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

As the information and technology revolution continues, smartphone-based health monitoring solutions are becoming increasingly widespread. These gadgets may be used to collect real-time health data and give clinicians feedback. In the long run, the adoption of monitoring systems can help the government save money on medical costs. Due to broad availability to mobile internet services, combining mobile internet with a health-care system utilising an open-source architecture has become quite simple. Doctors and patients can use a smart gadget to continually monitor the heart rate, gather essential data, and take adequate precautions to avoid serious harm. Heart rate and body temperature are two of the most important characteristics of the human body, and they play a big role in determining a patient's health.

A healthy adult's pulse rate ranges from 60 to 100 beats per minute. Males have a pulse rate of 70 beats per minute, whereas girls have a pulse rate of 75 beats per minute. Females with a heart rate of 12 and higher have a quicker rate than males.

1.2 LITERATURE SURVEY

Healthcare big data is a collection of patient, hospital, doctor, and medical treatment records that is so huge, complicated, scattered, and expanding at such a rapid rate that it is impossible to keep track of and analyse using typical data analytics methods. To overcome these challenges, a big data analytics framework is used to apply machine learning algorithms to such a large quantity of data. [1] Technology has also progressed significantly in the discovery and development of novel pharmaceuticals that have the potential to benefit patients with complex illnesses.[11] Some large tech companies, such as IBM and Google, have developed machine learning tools to help patients find new therapy options.Precision medicine is an important concept in this discussion since it entails understanding mechanisms underlying complex disorders and developing new treatment options.

Although numerous semi-supervised strategies to give additional training data have been presented, automatically produced labels are typically too noisy to properly retrain models.[2] The impact of COVID-19 pandemic on healthcare was catastrophic,mainly due to lack of preparedness. Hence in this project we have tried to make things easier in whatever way we can. Mainly we propose a model to classify COVID-19 patients .The risk of severe complications from COVID-19 is higher for certain vulnerable populations, particularly people who are elderly, frail, or have multiple chronic conditions.[3] Using such a classification we can implement a variety of measures for their betterment,such as a vaccine scheduler. Or,as all of us know,shortage of medicines was a huge factor behind the large number of deaths we have witnessed. Hence our project also proposes a method to resolve this,by applying machine learning techniques to stock up medicines,which have been observed to be of significant demand,so that there is no dearth and we can give them to those in need. In addition to this,our IOT based healthcare monitoring system helps to monitor patient parameters and alert doctors when needed,so that people do not need to panic. By means of this technology,similar results can be obtained as reported in [4][5]. In addition to this,the fall detection mechanism of our system helps to alert caregivers on time,in case an elderly person suffers injury,as suggested in [6]. All these parameters,which have been collected using various sensors and processed using NodeMCU board,like in [7], and are then displayed on a web based dashboard,as well as mobile app through Blynk.[12]

Big Data and the Cloud are two examples of new technologies that are helping to solve healthcare issues. Healthcare data is expanding at an exponential rate these days, necessitating an efficient, effective, and timely solution to cut mortality rates.[8]

The importance of data collection, integration, processing, and reporting of underlying knowledge has been emphasised in the development of the concept of business intelligence and analysis, as well as how this knowledge can assist in making more appropriate business decisions and gaining a better understanding of market behaviours and trends.[13][14] We have been able to unearth hidden information from data thanks to the massive expansion of data. Using current machine learning algorithms with minimal modifications, we may employ Big Data analysis for

effective decision making in the healthcare industry.[9]According to our findings, many academics are motivated to study machine learning algorithms in the health-care industry. However, selecting the appropriate algorithm to predict disease based on the data set generated by the researcher is always tough.[10]

1.3 ORGANIZATION OF THE REPORT

This report has been divided into 6 chapters: -

Chapter 1 – Introduction

Chapter 2 – Embedded systems – Metrics monitoring

Chapter 3 A – IOT – Website monitoring

Chapter 3 B – IOT – Blynk

Chapter 4 - Machine Learning

Chapter 5 – Conclusion & Future Scope

Chapter 6 – Planning and References

CHAPTER 2

EMBEDDED SYSTEMS: METRICS MONITORING

OBJECTIVE: Monitor patient parameters remotely to increase the efficacy of healthcare management systems

IDEATION:

We need to monitor the patient parameters from remote distances using various sensors. The data given out by the sensors are then sent over to the cloud for further access via a Wi-Fi module (inbuilt or externally connected). This is being done to reduce the critical time of testing patient parameters before any major operation.

Here we are measuring the temperature and pulse parameter of a patient remotely.

2.1 Components required :-

1. MLX 90614 Temperature Sensor.
2. MAX 30102 Pulse Rate Sensor.
3. Jumper wires.
4. Nodemcu ESP8266 board

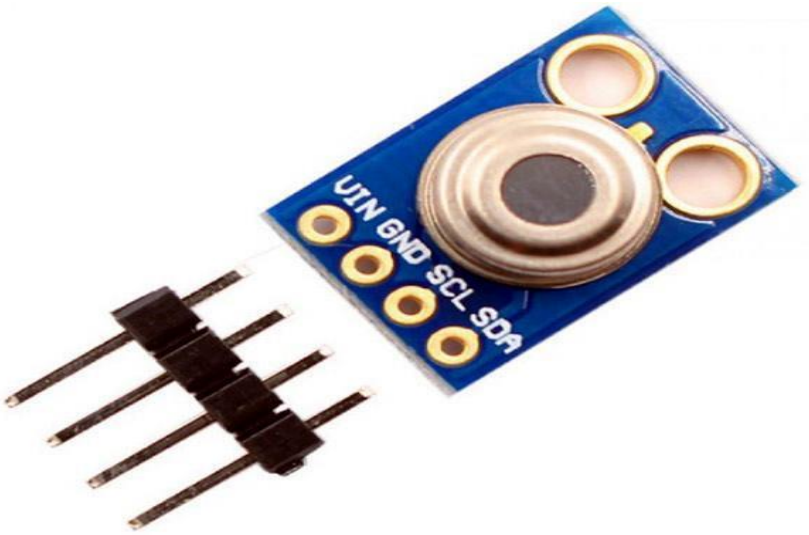


Fig 2.1 MLX90614 temperature sensor module

(a) Product Description: - (MLX90614)

A Contactless IR Digital Temperature Sensor, the MLX90614 It is used to determine the temperature of a certain item, which can range from -70° C to 382.2°C. It uses the I2C protocol to interact with the microcontroller and measures the temperature of the item without any physical touch.

(b) Module Features:-

- I2C interface with two pull-up resistors built in
- Can work with voltages ranging from 3 to 5 volts.
- It can work with a current of 2mA.
- Has an I2C protocol for communication:
- The temperature varies from -40 to +125 degrees Celsius.
- Temperature ranges from 70 to +380 degrees Celsius.
- While measuring the temperature, keep a space of 1 cm between you and the thermometer.
- The PCB Dimensions are as follows: 11 mm x 17 mm

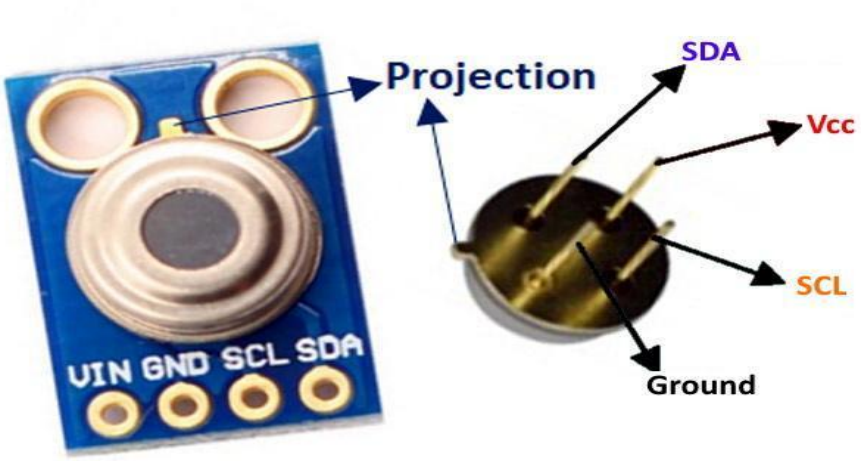


Fig 2.2 MLX90614 Pin-out Configuration

Pin No.	Pin Name	Description
1	**V_{dd} (Power supply)**	V_{dd} can be used to power the sensor, typically using 5V
2	**Ground**	The metal can also act as ground
3	**SDA – Serial Data**	Serial data pin used for I2C Communication
4	**SCL – Serial Clock**	Serial Clock Pin used for I2C Communication

Table 3.1

2.3 MLX90614 Features and Benefits

- The size is small and the cost is also low.
- Integration is easy.
- The factory calibrated in wide temperature ranges from -40 to 125 °C for sensor temperature and -70 to 380 °C for object temperature.
- High accuracy of 0.5°C over the wide temperature range (0 - +50 °C)
- Medical accuracy of 0.1°C in a limited temperature range available on request

- The measurement resolution of 0.01°C
- SMBus compatible digital interface for fast temperature readings and building sensor networks
- For continuous reading, customizable PWM output is there.
- Adaptation for 8 to 16V applications is simple
- Power saving mode
- Automotive-grade

2.4 Advantages of MLX90614:-

- Because our project is in the medical industry, we picked a temperature sensor with high accuracy. The precision of the MLX 90614 is about 0.02° C, which is significantly greater than conventional temperature sensors.

- It's a contactless infrared temperature sensor, which is the greatest alternative in this epidemic. It can detect an object's temperature from a distance of 2cm to 5cm.

- Its object temperature range is around -70 to 380 °C, allowing it to perceive a wide variety of temperatures.

- MLX 90614 is a low-voltage, low-current device. Its operational voltage is between 3 and 5 volts, and the needed supply current is around 2 milliamperes.

2.5 Applications:-

- ❖ It's for high-precision non-contact temperature readings.
- ❖ Mobile Air Conditioning Control System Thermal Comfort Sensor
- ❖ It is utilised in temperature sensor components for air conditioning in residential, commercial, and industrial buildings.

- Defogging of the windshield
- It can also identify the vehicle's blind spot.
- Temperature regulation of moving components in the industrial setting.
- Controlling the temperature in printers and copiers
- Temperature-controlling home appliances
- Healthcare
- Observation of livestock
- Detecting movement
- Temperature control for several zones - up to 127 sensors may be read using just two cables.
- A thermal relay/alert is a device that sends out a signal when
- Measurement of body temperature

2.6 Arduino UNO and Nodemcu interfacing with MLX 90614

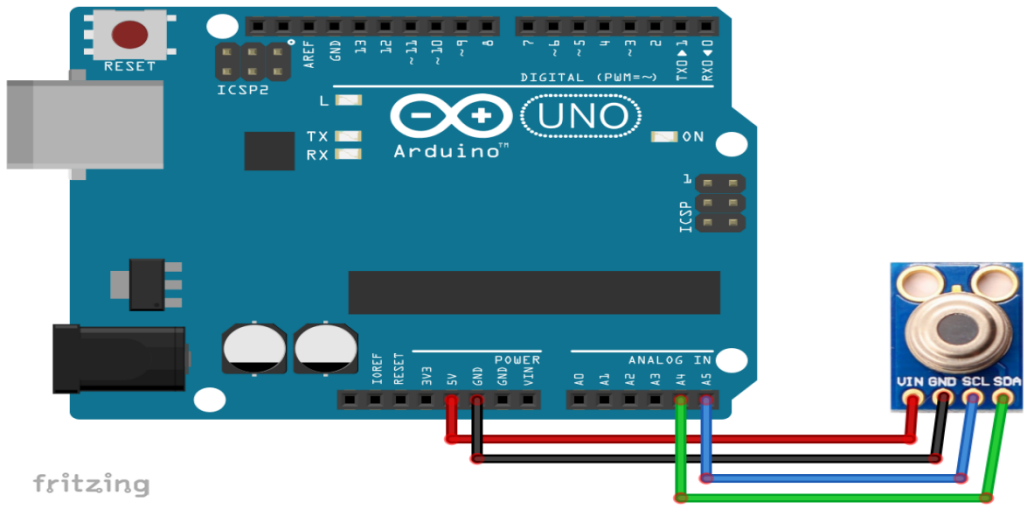


Fig 2.3 Arduino UNO and Nodemcu interfacing with MLX90614

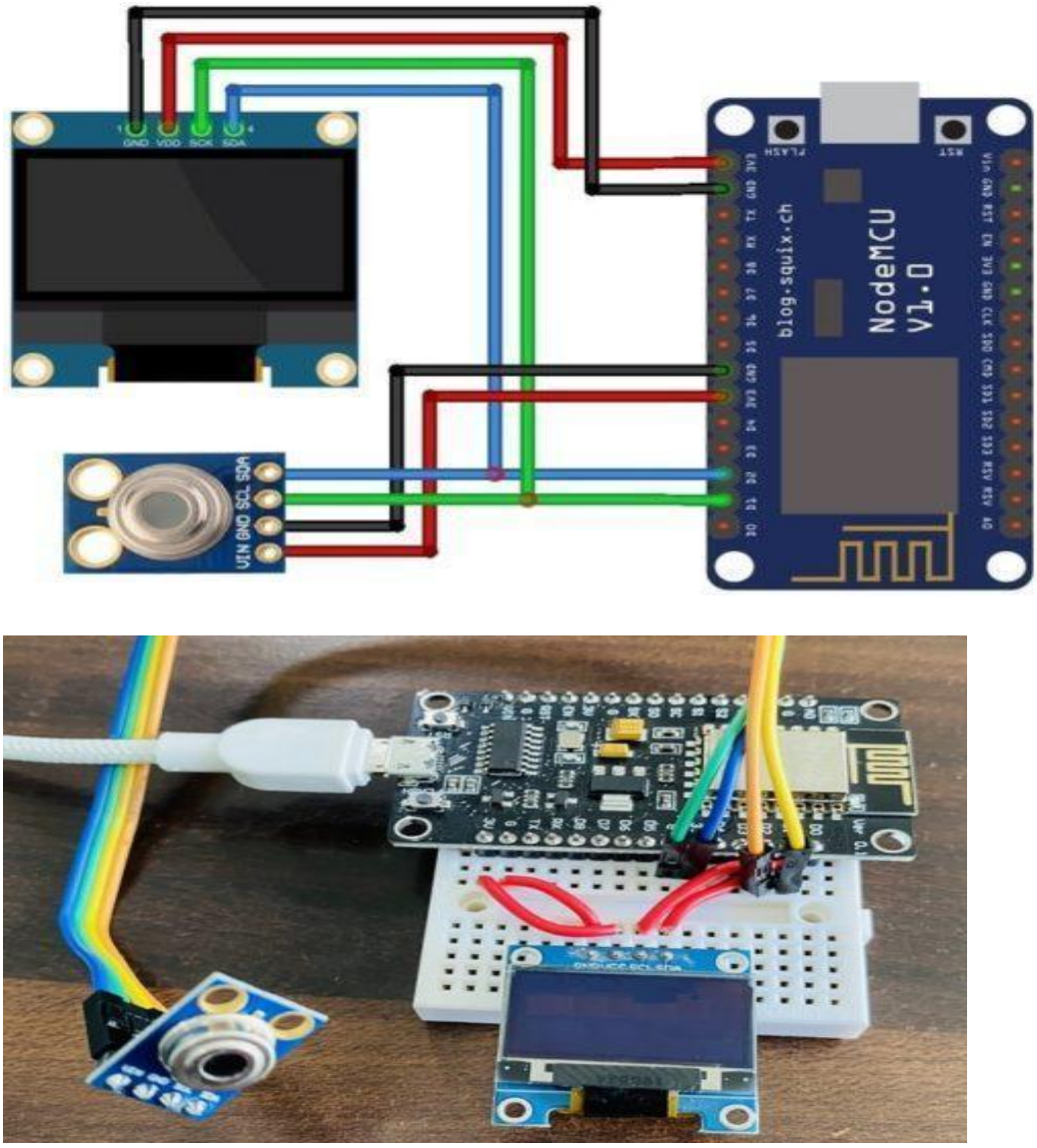


Fig 2.4 Connection diagram of MLX90614 with nodemcu board

SDA	D2
SCL	D1
VCC	3.3V
GND	GND

Table 3.2

2.7 Board Schematic representation:-

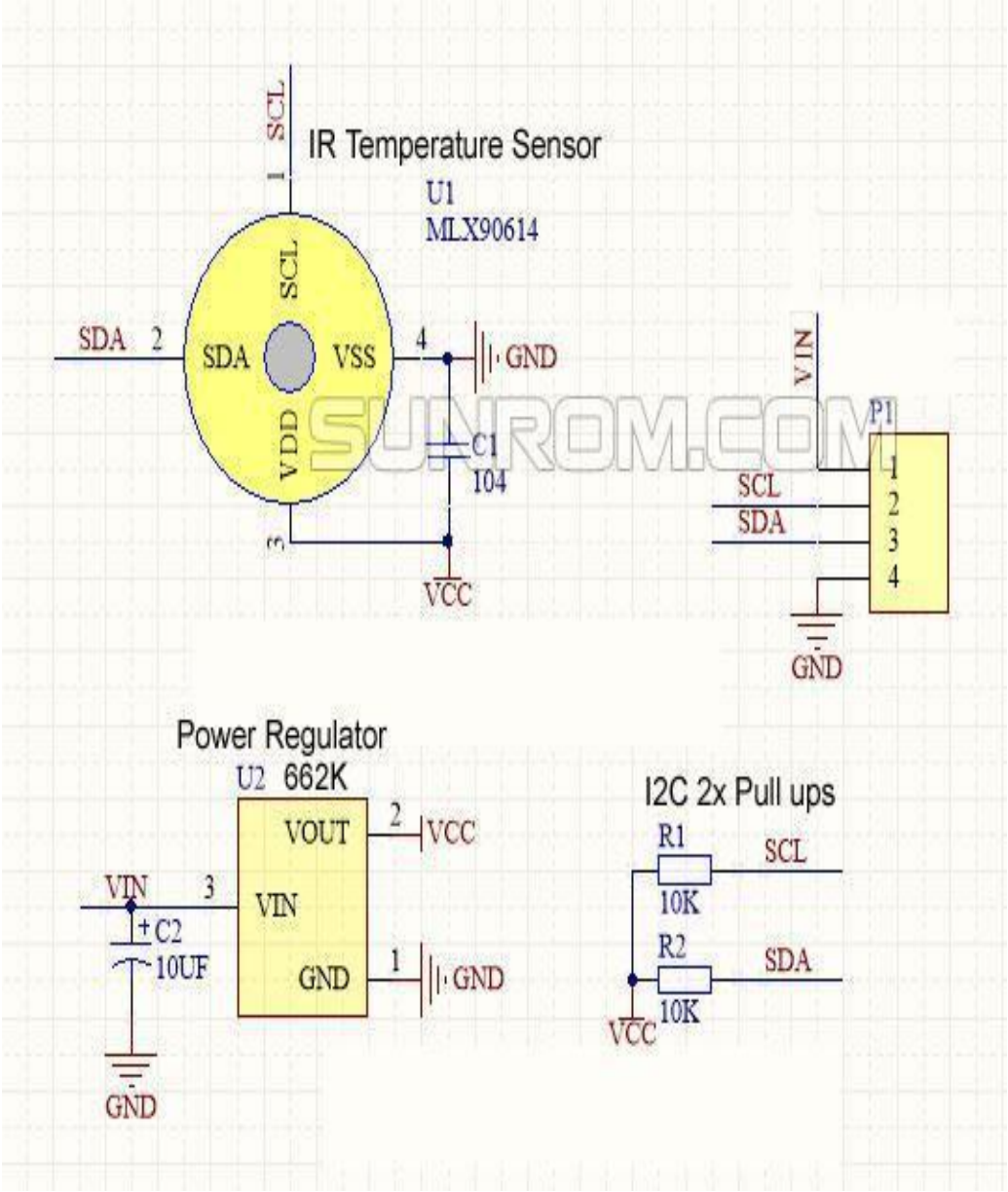


Fig 2.5 - Board schematic representation

2.6 MAX 30102 Pulse Rate Sensor:-

Product Description:-

The MAX30102 is a biosensor module that combines a pulse oximeter with a heart rate monitor. It consists of a red LED and an infrared LED, as well as a photodetector, optical components, and low-noise electrical circuitry that suppresses ambient light. The MAX30102 features a 1.8 V power supply as well as a separate 5.0V power supply for internal LEDs for heart rate and blood

oxygen monitoring in wearable devices worn on the fingers, earlobes, and wrist. The gathered readings may be sent to the KL25Z and other microcontrollers through an I2C-compatible communication interface for heart rate and blood oxygen calculations.Furthermore, the chip can software-shutdown the module, the standby current is near nil, and the power supply is constantly maintained. The chip is widely utilised in Samsung Galaxy S series mobile phones due to its high performance. The chip combines a glass cover to efficiently reduce external and internal light interference and has the highest dependable performance when compared to the previous generation MAX30100. The Most Important Parameters: Peak wavelength of LED: 660nm/880nm 3.3V is the voltage used to power LEDs. Light reflection signal is the sort of detection signal (PPG) I2C communication interface voltage: 1.83.3V5V output signal interface (optional).Size of the assembly hole on the board: 0.5 x 8.5mm Description of the pin VIN stands for the main power input terminal. Pad with a voltage range of 1.8 to 5 volts and a three-bit resolution: Select the bus's pull-up level, either 1.8v or 3 3v, depending on the pin master voltage (this terminal contains 3.3V and above) SDA: data connected to the I2C bus; SCL: the clock attached to the I2C bus INT: MAX30102 chip's interrupt pin; RD: MAX30102 chip's RED LED ground terminal, which is usually not connected; IRD: The MAX30102 chip's IR LED ground is usually not connected; GND stands for ground wire.

Fig 2.6 MAX 30102 pulse rate sensor

2.7 Detailed Pin description:-

Pin No.	Pin Name	Description
1	**Vin**	Main power supply input 1.8V-5V
2	**GND**	Ground Wire
3	**SDA – Serial Data**	Data connected to the I2C bus.
4	**SCL – Serial Clock**	The clock connected to the I2C bus.

Table 3.3

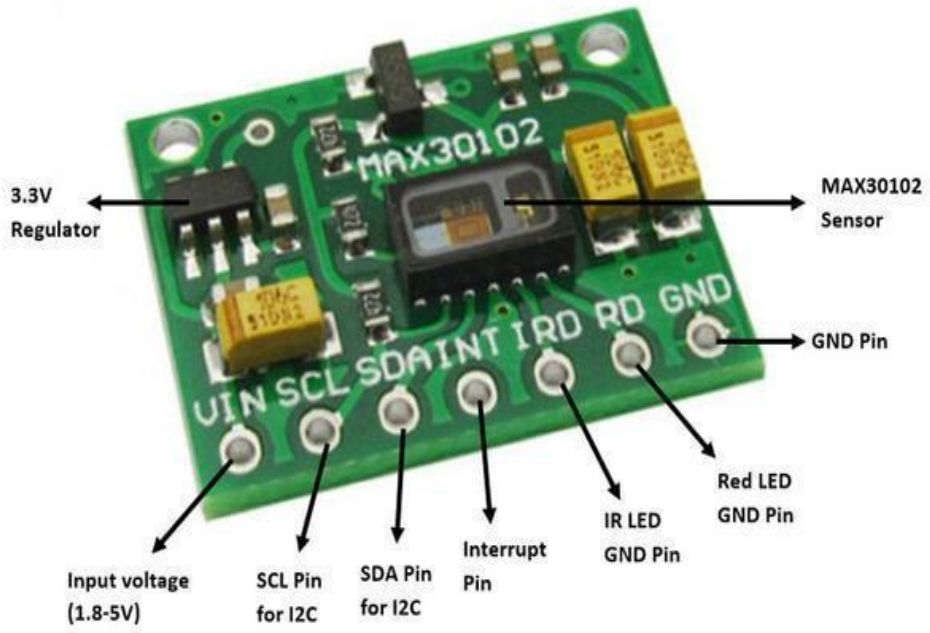


Fig 2.7 MAX 30102 Pinout configuration

2.8 Advantages of MAX3102 in comparison to other pulse rate sensors:-

● Red and infrared LEDs are used to regulate LED pulses for oxygen saturation (SpO2) and heart rate monitoring in MAX30102

● Space savings: Integrates internal LEDs, photodetectors, optical components, and low-noise electronics with ambient light rejection to maintain a very tiny solution size without losing optical or electrical performance.

2.9 Specifications:

- Small in size and also highly integrated.
- It can also detect non-chest based heart-rate/SpO_2 detection
- Power consumption is very low.
- The Peak Wavelength of LED is 660nm/880The supply voltage of LED is 3.3~5V
- Interface: I2C Interface
- Operating Temperature Range is between -40°C and +85°C
- Dimension: 20.3 x 15.2mm
- Weight is just 1.1g

2.10 Principle description: -

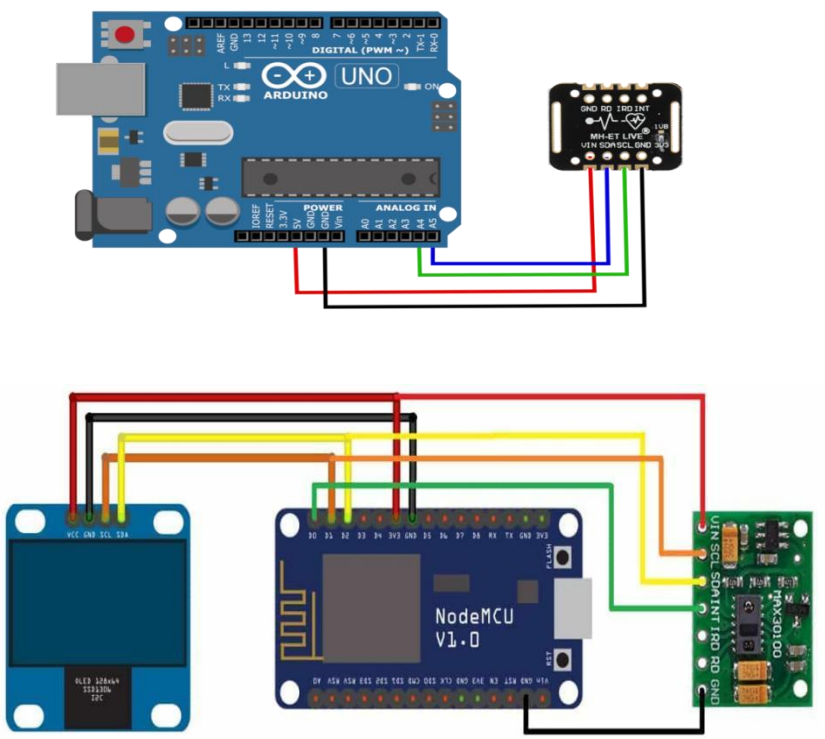
Photo-dissolution method:

Human tissue is used to create varying light transmittance as the blood vessel beats, which is used to quantify pulse and blood oxygen saturation.

Source of illumination: A light-emitting diode with a specified wavelength that is selective for oxyhemoglobin (HbO2) and haemoglobin (Hb) in arterial blood.

The volume of the arterial pulse changes the light transmittance of the light, which is turned into an electrical signal. The photoelectric transducer receives the light reflected by the human tissue at this moment, converts it into an electrical signal, amplifies it, and outputs it.

2.11 Arduino UNO and Nodemcu Interfacing:-



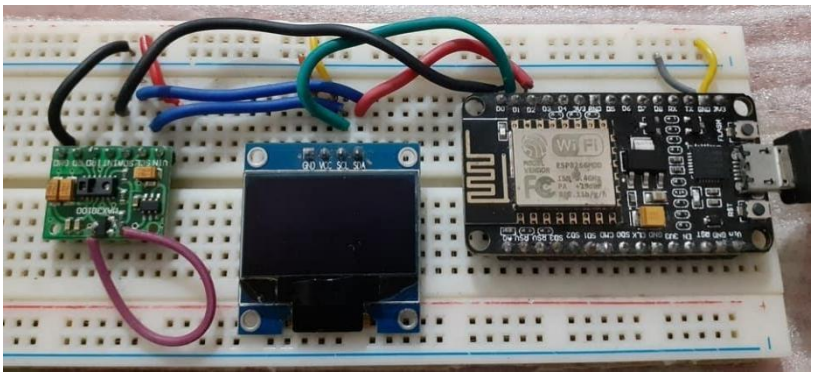


Fig 2.8 Connection diagram of MAX30102 with Nodemcu

SDA	D2
SCL	D1
VCC	3.3V
GND	GND

2.13 -

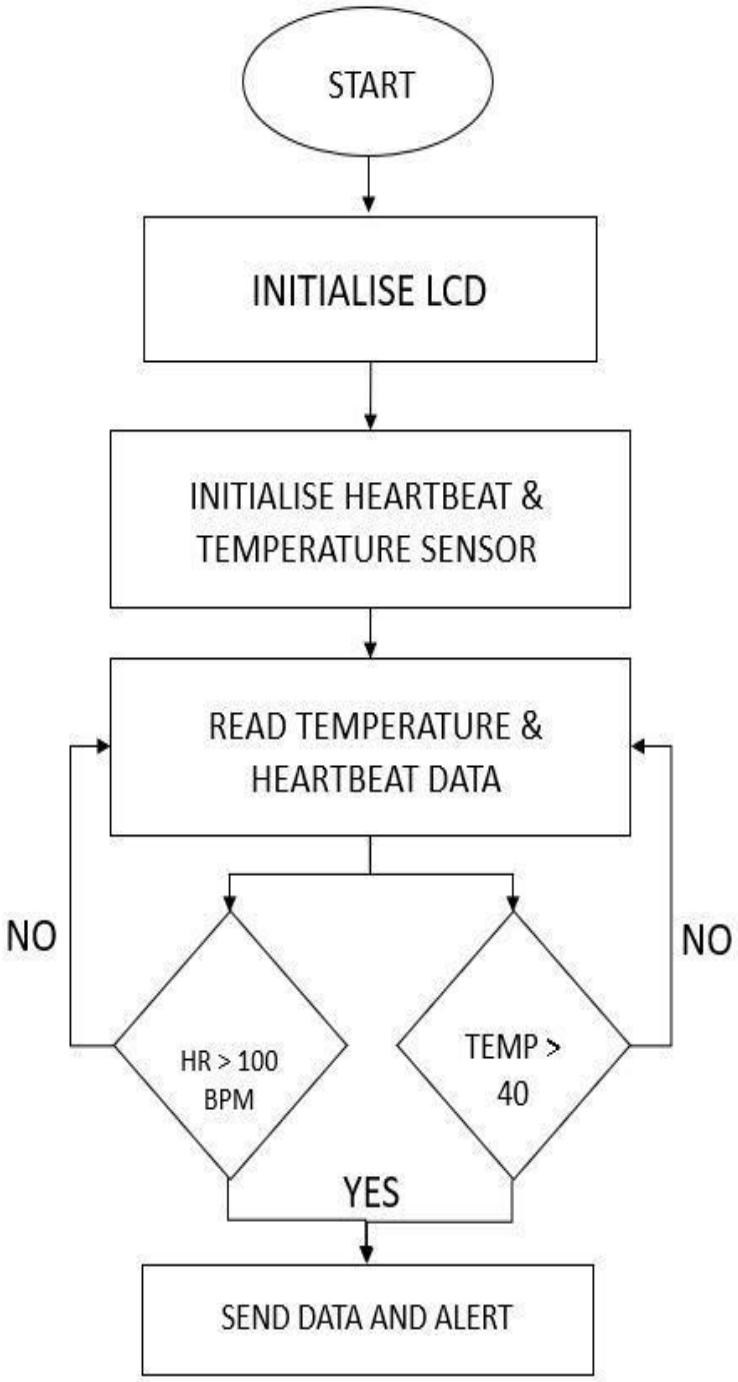


Fig 2.9 Flow diagram (For monitoring parameters)

CHAPTER-3(A)

IOT- WEBSITE MONITORING

Objective:- To effectively monitor the patient parameters via a website.

IDEATION:-The parameters that are being monitored by the sensors are checked via a website that will graphically display the sensor data for better understanding and to keep a check on the threshold limits of the parameters.

Thinger.io is a free, cloud IoT Platform that helps to prototype, scale and manage connected products in an easy way. The aim is to regularize IoT usage ,thereby making it reachable to the whole world, and modernizing the evolution of big IoT projects.

Thinger.io dashboard system is a property that lets us design data presentation interfaces easily. Eliminating the need of coding, it is made in such a way that various elements from an inventory can be selected and using point click methodology,the entire layout can be configured. Using the configuration forms, it is plausible to set the sampling interval, data sources and other characteristics for each widget .

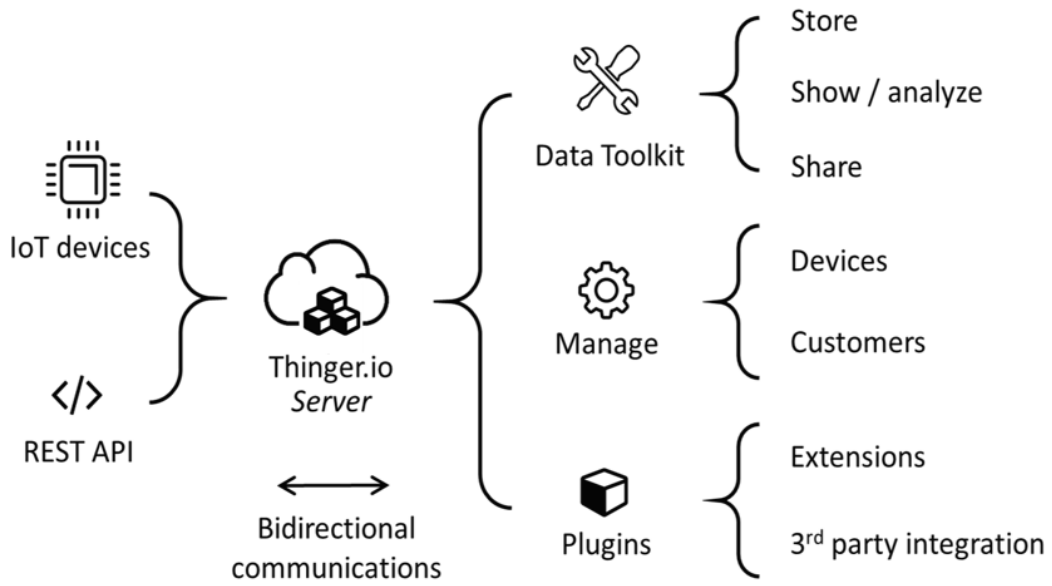


Fig 5 : Connectivity of thinger.io platform

We could have used normal website coding (using HTML,CSS) to design a website for displaying the parameters. But we preferred using this since we found that it was open source,easy to use and most importantly, it was convenient to create simple,attractive dashboards using this platform. Moreover, the array of devices supported by thinger.io is humongous. So, a wide variety of devices can be easily integrated in the project, irrespective of the manufacturers or properties.

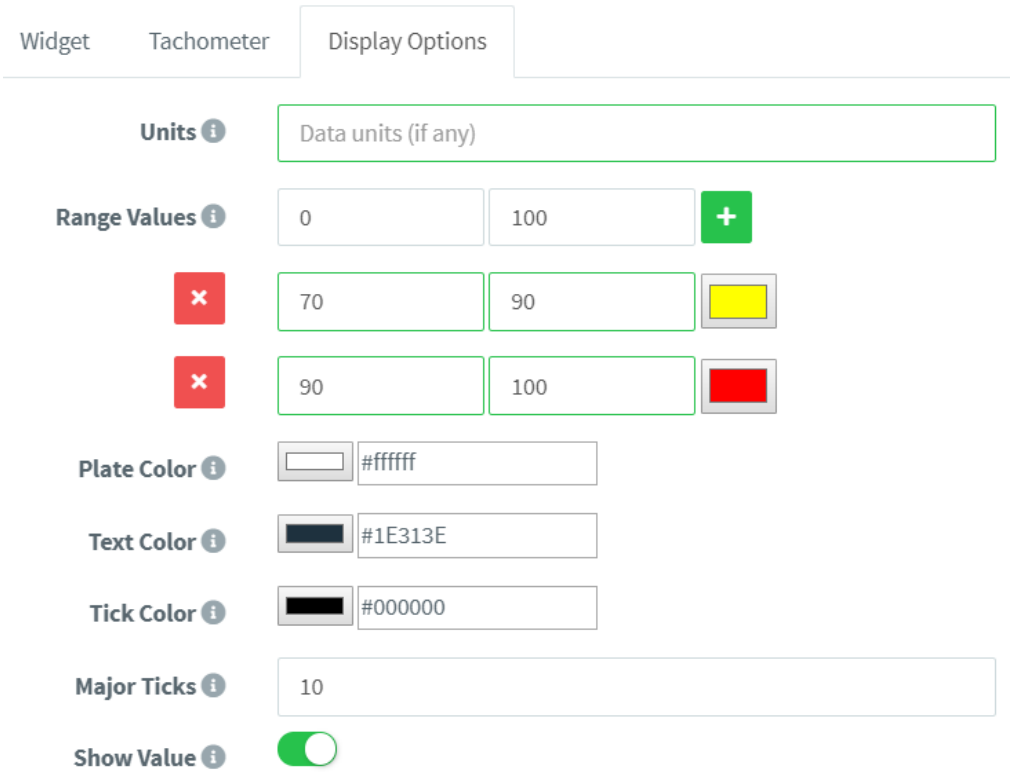


Fig 6 : Illustration of widget selection

Here is a specimen dashboard showing defined widgets, such as a time series chart and a circle graph with singular values. It is possible to share dashboards with others through a hyperlink. To analyse data from different devices of the same type,dashboards can be configured using appropriate templates.

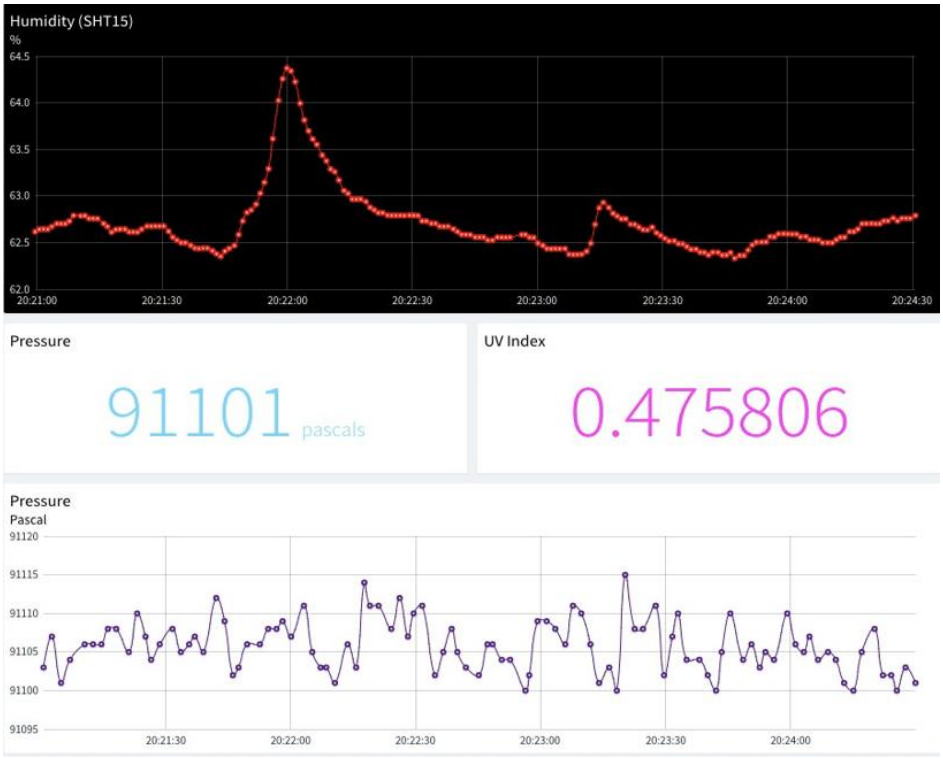


Fig 7 : An example of how a dashboard looks like

Following is a description of various widgets and their parameters :-

Time - series chart - A time-series chart is a depiction of variation in values with time. It is convenient to display time-series data. A single variable as well as multiple values can be depicted in the same chart.

Donut chart - is a graph that can show a value, rounded to the nearest percent. It is highly useful for a variable fluctuating between a largest and a smallest value. In such a scenario, it is appropriate to represent a single variable, whilst updating it in real-time from a data bucket or a gadget.

Text/Value - is a convenient widget to show random data, especially text that is unfit for representation with other widgets. It can display data from connected devices as well as data buckets.

Clock - can display the present time in the local time zone or in UTC. It is quite handy when processes are being monitored in real-time.

Dashboard Tab is an extra page that helps to simplify navigation between interlinked consoles and helps to arrange the data visualization . Each tab might have varying widgets and data sources but all the tabs have the same configuration settings (widgets border-radius, column index etc).

There is this added advantage of keeping all unused tabs open,so that the real-time data is not lost,while switching tabs

3(B)

OBJECTIVE:- Using Blynk interface to create a user-friendly GUI for the patient parameters

IDEATION:-

The parameters that are being monitored by the different sensors are visualized remotely via the Blynk app. This allows a quality GUI experience for the customers i.e. the relatives and family members of the patient. By using the Blynk app anyone who is shared with the QR code can download the app and it will contain the required project for metrics monitoring.

3.4 About Blynk Community:-

Blynk was created to deal with the burgeoning sector of the Internet of Things (IoT). It can control the hardware remotely, display sensor data, store data, visualise it, and perform a variety of other important tasks.

The Blynk platform is made up of three primary components:

- Blynk App - It allows us to use many types of widgets to develop nice interactive interfaces for our projects.

- The Blynk Server is in charge of all communications between the Android smartphone and the hardware. We have the option of using Blynk Cloud or running our own Blynk server locally. It's a free and open-source platform that can manage thousands of devices with ease. It may also be run on a Raspberry Pi Blynk Library, which contains all of the common hardware platforms, allowing it to communicate with the server and execute all incoming and outgoing commands.

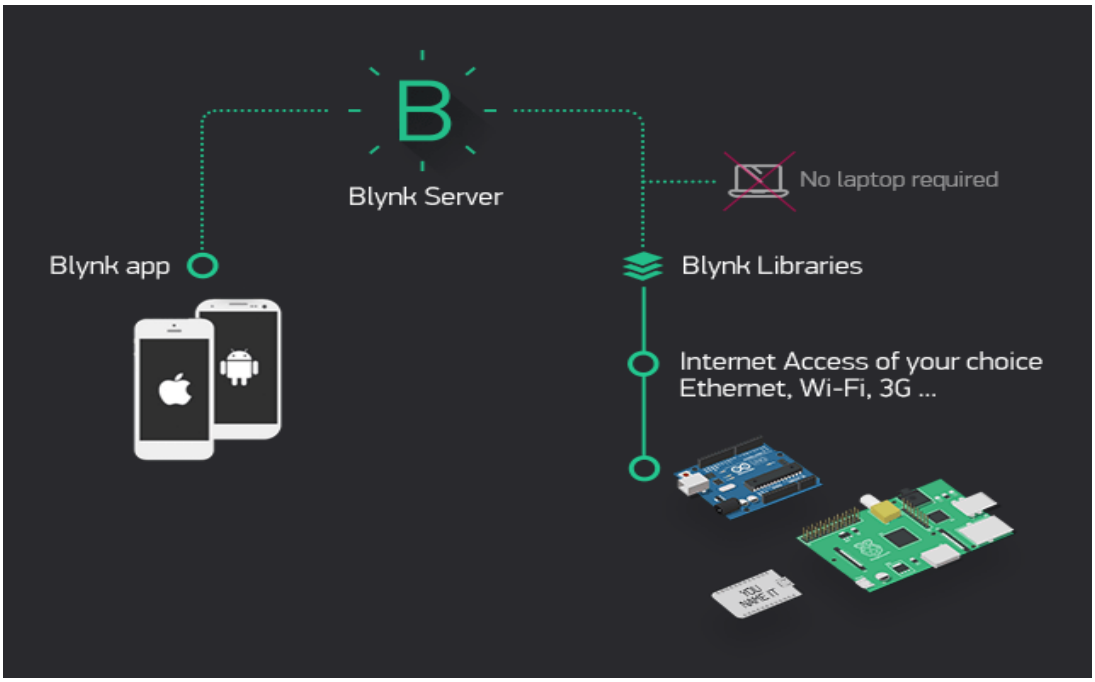


Fig 3.1 Organization of Blynk cloud

3.5 Blynk Features:-

- It has a similar API & UI for all the hardware & devices that it supports.
- It has the provision of connecting to the cloud by using:
- WiFi
- Bluetooth and BLE
- Ethernet
- USB (Serial)
- GSM
- It has a set of easy-to-use different widgets
- It has direct pin manipulation which requires no code to be written
- It is easily integrable and we can add new functional properties by using virtual pins
- It can monitor history data with the help of the SuperChart widget
- It is also capable of device-to-device communication using the Bridge Widget
- Blynk can be useful in sending emails, tweets, notifications, etc.

3.7 Blynk application in metrics monitoring

With Blynk we can plot the graphical representation of data which will be given by the sensors that we are using.

Blynk helps us to plot the graphical representation of data which will be given by the sensors that we are using. It uses a virtual **pin** concept through which we can push data from the nodemcu to the blynk **mobile app widgets** and also get the data from the widgets to the nodemcu via the ESP8266 Wi-Fi module present. **Virtual Pin** is a feature incorporated by Blynk Inc. that facilitates data exchange between hardware and Blynk mobile app

Operation/ Working:-

1. Open Blynk App on mobile and create an account.
2. Create a New Project
3. Select the working board (here NODEMCU)
4. Select the widget as per necessity (here it will be Super chart and Value Display widgets)
5. Tap the widgets for editing their properties. We can use digital or analog or virtual pins as per requirement in the project.
6. After uploading the sensors data in the NODEMCU from Arduino IDE we can monitor the patient parameters on the widgets on the smartphone at a remote distance.

The thing to understand here is every sensor connected to Nodemcu will send its data which we will store in a value and send it to the Blynk app via the virtual pin (V1 for eg.)

3.8 Blynk Community (My Apps)

- We need to enter the app name, icon style, theme, color, and other attributes for the app to look smart.
- Then we need to choose the projects we want to access inside the app.

- Blynk community comes up with exciting features of BlynkFaces which allows us to include multiple projects inside our customized app.
- Then we need to select the type of auth token (Dynamic or static)
- The static auth token is used for devices that connect to the internet over the Ethernet cable or cellular network.
- Auth token is sent to the registered email id in the project itself
- We can publish this app also for others to use and monitor my project readings.

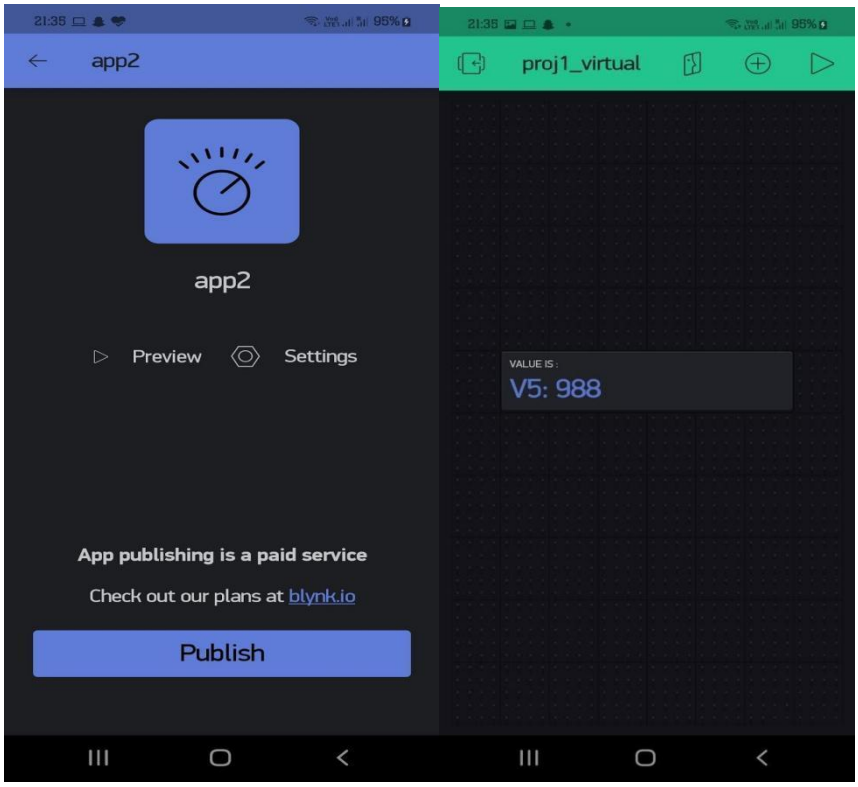


Fig 3.7 Blynk MyApp Layout

CHAPTER 4

MACHINE LEARNING

Objective - To leverage machine learning to predict customer behavior patterns concerning buying medicines

Introduction

Machine learning is a section of computer science that evolved from the analysis of pattern recognition in data as well as a computational learning theory in artificial intelligence. It rose from an environment that was the integration of the interaction between available data, computing power, and statistical methodologies. The perfect blend in these three widely differing and rapidly developing areas gave birth to what is now known as machine learning. Growth in available data compelled a spurt in computing power, which in turn stimulated the development of statistical methods to analyze large datasets, thus facilitating the collection and analysis of even larger and more complex, interesting data.

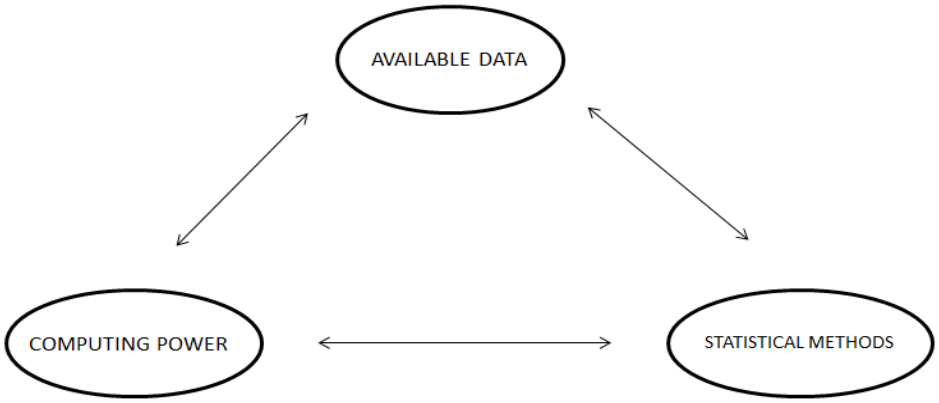


Fig 4.1 Development cycle

DATA PREPROCESSING :

The preprocessing of the dataset is very much required to support the regulations and syntax which the particular ML model asks for.

The different phases of the preprocessing include :

- Importing of libraries
- Importing the dataset
- Handling the missing data
- Encoding the categorical data
- Encoding the dependent variable
- Splitting the dataset (Training and test set)

- Feature scaling

IMPORTING THE LIBRARIES :

For general use cases the following libraries are imported to support the model structure:

1. **NUMPY**: It will allow us to work with arrays.
2. **MATPLOTLIB**: It will allow us to plot very attractive charts and graphs for visual representation.
3. **PANDAS**: It will allow us to not only import the datasets but also create the matrix of features and dependent variable vectors.

IMPORTING THE DATASET :

A new variable is to be created which will contain the exact copy of the dataset we are aiming to deploy. The next target will be creating a data frame. We need to call a function from the panda's library that is read_csv.

This data frame now created will be the same as the dataset variable.

This is not enough as we have to create two more entities that are:

Matrix of features and the dependent variable vector.

In most of the ML models, the dependent variable is at the end of the dataset and the beginning comprises the matrix of features.

HANDLING THE MISSING DATA :

We try to replace the missing values with the average of all the values in that particular column.

We take help from a reputed data science library that is SCIKIT LEARN.

Inside that, we take the help of a module named IMPUTE. We now create a tool/method in the object imputer to connect the object to the matrix of features.

Now the imputer transform replaces the missing values with the mean value and is stored or returned to the dataset portion which had the missing values.

ENCODING THE CATEGORICAL DATA

We try to encode the strings to certain numbers to let the ML model understand them and establish a correlation between them.

The encoding procedure used here is *ONE HOT ENCODING* (which allows the representation of categorical data to be more expressive)

ENCODING THE DEPENDENT VARIABLE

LabelEncoder is a class in the preprocessing module of the scikit learn library that has no arguments if the dependent variable had only 2 categories. So we can just encode them into 1 and 0.

SPLITTING THE DATASET

The dataset is generally split into the Training set and Test set.

Training set: To train the ML model with the sets of data to identify attributes and features and patterns of the data.

Test set: To test the ML model with the new feature data to do performance monitoring.

We need to specify the test size to clarify how much % of the dataset we want in the test set and the remaining in the training set.

We set the random_state as 1 to choose the data from the dataset randomly so that we just do not feel lucky just for this particular dataset.

FEATURE SCALING :

In ML models, some of the features dominate over some of the features. To tackle this problem feature scaling is important.

Feature scaling is not required for all ML models; it is a model-specific procedure.

The method of feature scaling is Standardisation and Normalisation.

Normalization is usually preferred and recommended where we have a normal distribution in most of the features.

We don't need feature scaling when the data is encoded or binary data.

WORKING OF ML :

Machine learning is made up of three components:

- a computer method that is at the heart of decision-making;
- Characteristics and factors that impact the decision
- The response is known for base knowledge, which aids(trains) the system in learning.

The model is given parameter data for which the solution is known at the start. The algorithm is then run, and changes are made until the output (learning) of the algorithm matches with the known solution. At this step, the system is given increasing volumes of data as input to help it learn and process higher computational judgments.

How do machines learn?

The fundamentals of learning are similar. It may be broken down into three sections:

• Data input: Observation, memory storage, and recall are used to give a factual foundation for subsequent reasoning.

• Abstraction: This is the process of transforming facts into more abstract representations.

• Generalization: It is a method of taking action based on abstracted facts.

Fig 4.2 Learning process

Types of ML Algorithms :

Based on the type of input available during the training process or the desired outcome, there are 4 main types of machine learning algorithms:-

1. Supervised learning - used in those situations where the output is known, for a particular input; i.e. trained on labeled examples

2. Unsupervised learning - used in those situations where the output is not known, for a particular input;i.e. trained on unlabelled examples
3. Semi-supervised learning - works in those situations in which the combination of supervised and unsupervised learning is required to generate appropriate function or classifier
4. Reinforcement learning - is like a reward/punishment kind of a scenario. Desired manners are rewarded, while undesired ones are punished. Thus the agent behaves in such a way that a sequence of actions that lead to desirable outcomes are produced more times.

ASSOCIATION RULE LEARNING:

Association rule learning is a form of unsupervised learning approach that examines the reliance of one data item on another and maps appropriately to make it more lucrative. It tries to uncover some interesting relationships or links between the dataset's variables. It uses a set of rules to find interesting relationships between variables in a database.

Working:-

Association learning works on the if-else concept.

Fig 4.3

The If element of association is called the Antecedent.

The Then statement is called the Consequent.

This type of relationship is called Single Cardinality.

The metrics to find the association is:

1. **Support**
2. **Confidence**
3. **Lift**

Support

The frequency of X, or how frequently an item appears in the collection, is called support. It's the percentage of the transaction T that has the itemset X in it. If there are X datasets, the following may be written per transaction T:

$$Supp(X) = \frac{Freq(X)}{T}$$

Confidence

The degree of confidence in a rule reflects how often it is correct. Or, since the incidence of X is already known, how frequently the elements X and Y appear together in the dataset. It's the proportion of a transaction including X and Y to the number of records containing X and Y. -

$$Confidence = \frac{Freq(X,Y)}{Freq(X)}$$

Lift

It is the strength of any rule, which can be defined as below formula:

$$Lift = \frac{Supp(X,Y)}{Supp(X) \times Supp(Y)}$$

It is the ratio of the observed support measure and expected support if X and Y are independent of each other. It has three possible values:

- Lift = 1: Antecedent and subsequent occurrence probabilities are independent of one another.
- Lift > 1: Determines the degree to which the two itemets are interdependent.
- Lift 1: It indicates that one object is a replacement for another, implying that one item causes harm to another.

Model specifications:

We utilised the Apriori model in this project to propose the pharmaceutical combination that the consumer is most likely to buy.

R.Agrawal and Srikant presented the Apriori method in 1994, which employs recurrent itemsets to construct association rules. It's primarily intended for use with transactional databases. It is possible to establish how strongly or weakly certain things are related using these principles.

The Apriori approach iteratively finds frequent items from a big dataset using a Hash tree and a breadth-first search to determine the relationships.

What is a Frequent Itemset?

Itemsets that have a higher level of support than the threshold value or the user-specified minimum level of support are called frequent itemsets. If X and Y are

frequent itemsets together, then X and Y should be frequent itemsets alone as well.

Assume there are two sets of items: X1,2,3,4,5 and Y2,4,6,8. The itemsets 2,4 are the most common in these two transactions.

WORKING OF APRIORI MODEL :

The following are the steps of the Apriori algorithm:-

1. Ascertain the support of itemsets in the transactional database and select the minimum confidence and support
2. Gather all the support values from the dataset which are larger than the minimum/selected support value
3. Note all the rules of the subsets that have a higher confidence value than the threshold or minimum confidence
4. Sort the rules in decreasing order of lift.
5. The descending order of the lift will allow us to comprehend the association between the medicines in a more accurate manner.

Dataset:

The dataset used is a sample of medicine combinations that have been commonly bought by customers over the past 2 months. It is a random dataset that we have made to illustrate the idea of medicine prediction and contains 7500 example records.

The dataset has been randomly generated thus ensuring the accuracy of the model in the context of its probability of getting lucky for a particular dataset .

The practical use case of this dataset is that it will be given by the chemist shop based on their previous sales . The apriori algorithm will be executed on this for getting the preferred result .

Screen snippets:

Preprocessing the data

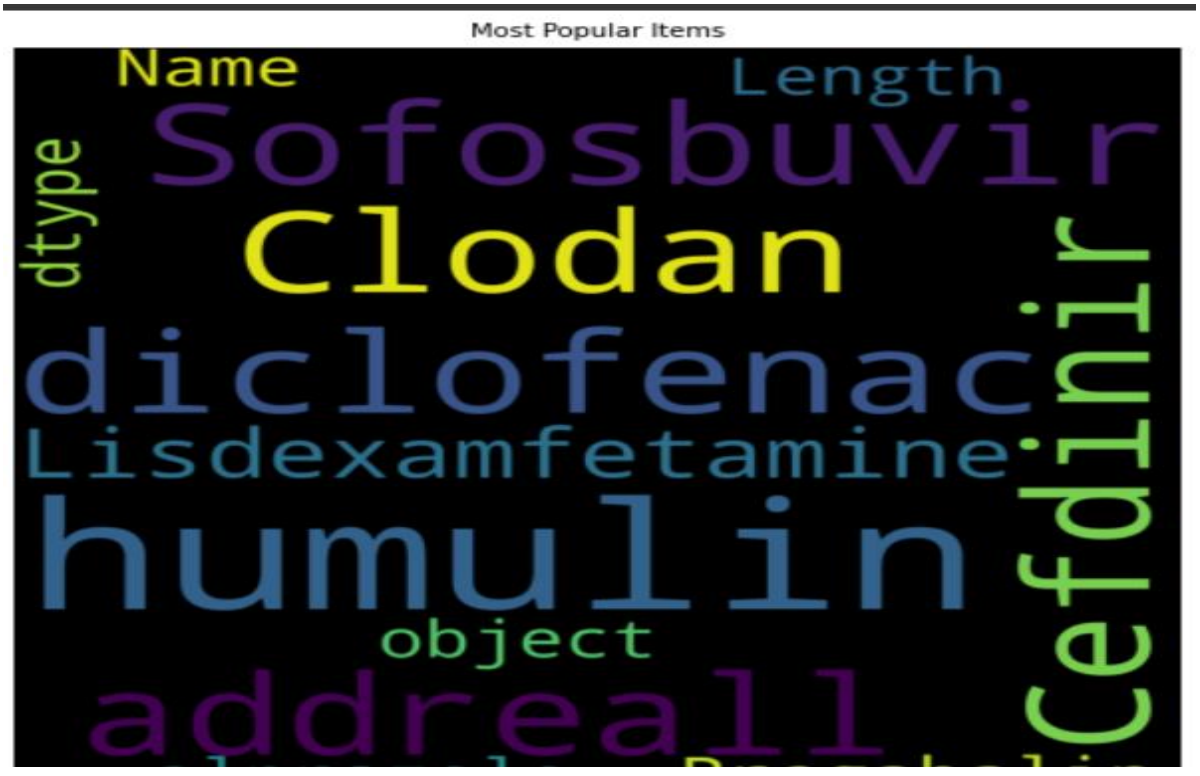
```
[3]  dataset = pd.read_csv('MajorML.csv', header = None)
     transactions = []
     for i in range(0, 7501):
       transactions.append([str(dataset.values[i,j]) for j in range(0, 20)])
```

Viewing the dataset

```
dataset
```

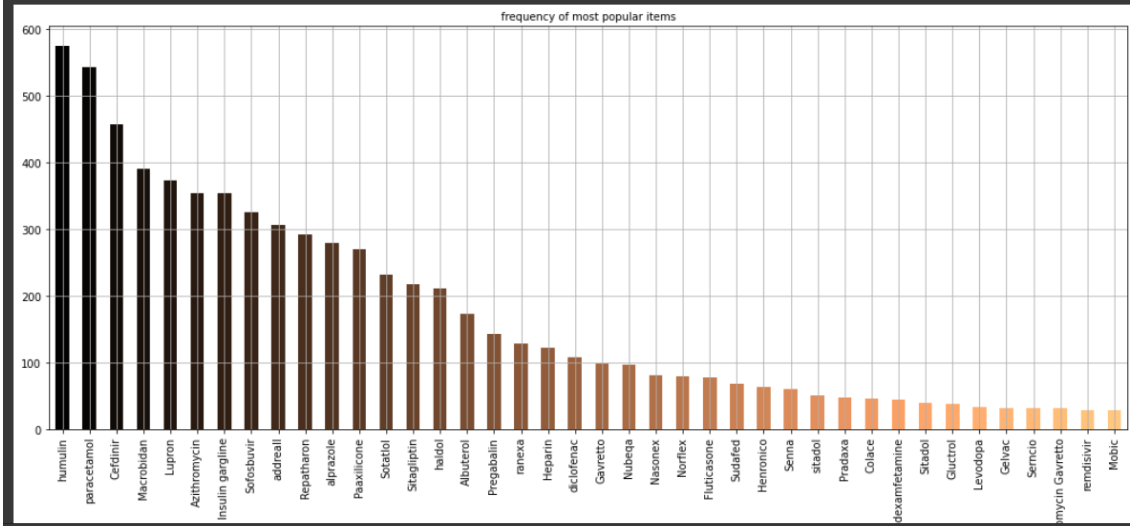
	0	1	2	3	4	
0	Sofosbuvir	Shringix	Nasonex	Sitadol	diclofenac	Ma
1	humulin	Levodopa	alprazole	NaN	NaN	
2	Clodan	NaN	NaN	NaN	NaN	
3	Cefdinir	Nasonex	NaN	NaN	NaN	
4	diclofenac	Azithromycin	Albuterol	Pradaxa	Nubeqa	

Word Cloud showing the most popular items

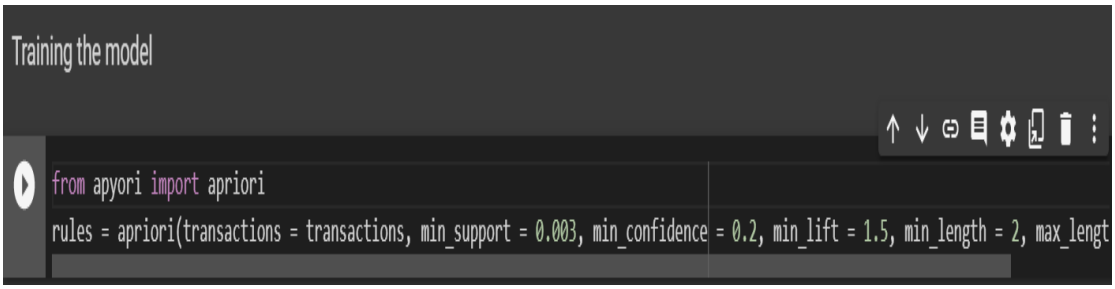


Frequency of the most popular items :

```
plt.rcParams['figure.figsize'] = (18, 7)
color = plt.cm.copper(np.linspace(0, 1, 40))
dataset[0].value_counts().head(40).plot.bar(color = color)
plt.title('frequency of most popular items', fontsize = 10)
plt.xticks(rotation = 90 )
plt.grid()
plt.show()
```



Training the model :



Displaying the results

```
[9] results
```

```
RelationRecord(items=frozenset({'remdisivir', 'Insulin gargline'}), support=0.012798293560858553, ordered_statistics=[Ordere
RelationRecord(items=frozenset({'Insulin gargline', 'remdisivir Macrobidan'}), support=0.003999466737768298, ordered_statist
RelationRecord(items=frozenset({'remeron', 'Insulin gargline'}), support=0.005065991201173177, ordered_statistics=[OrderedSt
RelationRecord(items=frozenset({'sitadol', 'Insulin gargline'}), support=0.006799093454206106, ordered_statistics=[OrderedSt
RelationRecord(items=frozenset({'paracetamol', 'Levodopa'}), support=0.007065724570057326, ordered_statistics=[OrderedStatis
RelationRecord(items=frozenset({'Lisdexamfetamine', 'Levothyroxine'}), support=0.004532728969470737, ordered_statistics=[Ord
RelationRecord(items=frozenset({'Norflex', 'Levothyroxine'}), support=0.0034662045060658577, ordered_statistics=[OrderedStat
RelationRecord(items=frozenset({'Sitagliptin', 'Levothyroxine'}), support=0.003332888948140248, ordered_statistics=[OrderedS
RelationRecord(items=frozenset({'diclofenac', 'Levothyroxine'}), support=0.003332888948140248, ordered_statistics=[OrderedSt
RelationRecord(items=frozenset({'paracetamol', 'Levothyroxine'}), support=0.006932409012131715, ordered_statistics=[OrderedS
RelationRecord(items=frozenset({'paracetamol', 'Lisdexamfetamine'}), support=0.021597120383948808, ordered_statistics=[Order
RelationRecord(items=frozenset({'Lupron', 'Sofosbuvir'}), support=0.01666444474070124, ordered_statistics=[OrderedStatistic(
RelationRecord(items=frozenset({'haldol', 'Lupron'}), support=0.0161311825089988, ordered_statistics=[OrderedStatistic(items
RelationRecord(items=frozenset({'paracetamol', 'Lupron'}), support=0.03319557392347687, ordered_statistics=[OrderedStatistic
RelationRecord(items=frozenset({'Lupron', 'sitadol'}), support=0.005465937874950006, ordered_statistics=[OrderedStatistic(it
RelationRecord(items=frozenset({'Metamucil', 'Macrobidan'}), support=0.0061325156645780565, ordered_statistics=[OrderedStati
RelationRecord(items=frozenset({'Mobic', 'Macrobidan'}), support=0.010665244634048793, ordered_statistics=[OrderedStatistic(
RelationRecord(items=frozenset({'Macrobidan', 'Nasonex'}), support=0.011865084655379284, ordered_statistics=[OrderedStatisti
RelationRecord(items=frozenset({'Macrobidan', 'Neomycin'}), support=0.013598186908412212, ordered_statistics=[OrderedStatist
RelationRecord(items=frozenset({'Macrobidan', 'Shringix'}), support=0.005999200106652446, ordered_statistics=[OrderedStatist
RelationRecord(items=frozenset({'Macrobidan', 'Sofosbuvir'}), support=0.017997600319957337, ordered_statistics=[OrderedStati
RelationRecord(items=frozenset({'Macrobidan', 'remeron'}), support=0.005332622317024397, ordered_statistics=[OrderedStatisti
RelationRecord(items=frozenset({'Mavyret', 'addreall'}), support=0.003066257832289028 2, ordered_statistics=[OrderedStatistic
RelationRecord(items=frozenset({'Mavyret', 'paracetamol'}), support=0.003332888948140248, ordered_statistics=[OrderedStatist
RelationRecord(items=frozenset({'Mobic', 'Sitagliptin'}), support=0.008932142381015865, ordered_statistics=[OrderedStatistic
```

Displaying non - sorted results

```
[11] resultsinDataFrame
```

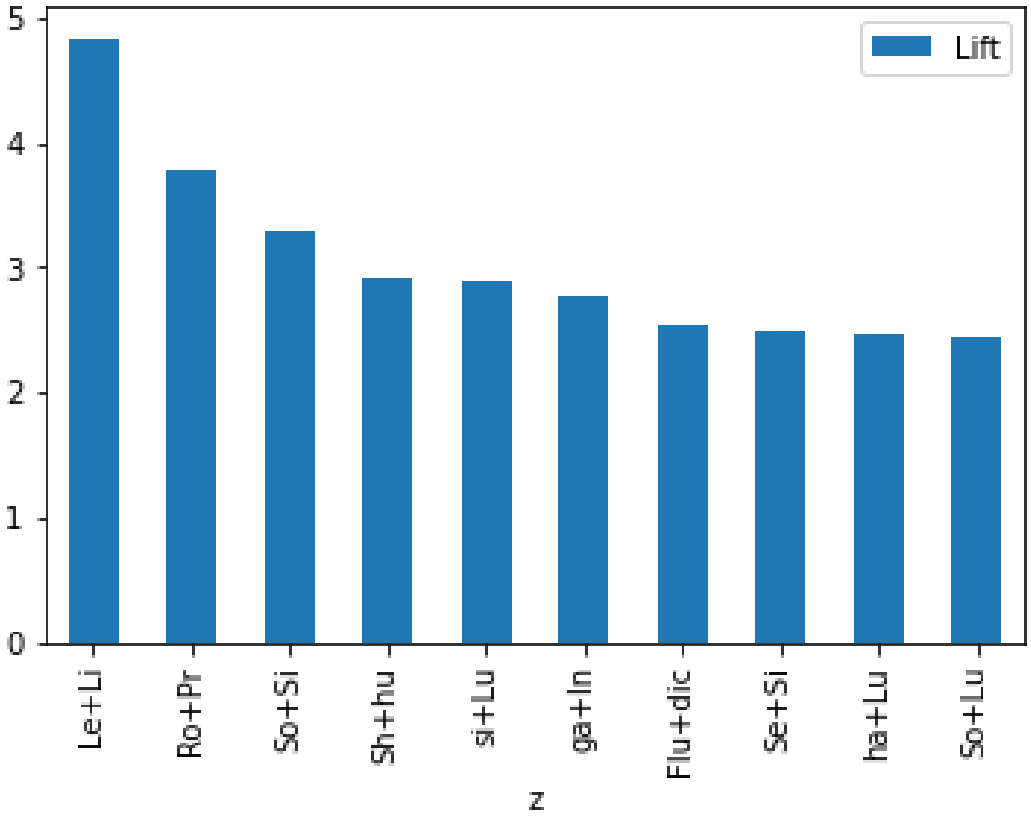
	Left Hand Side	Right Hand Side	Support	Confidence	Lift
0	Albuterol	Azithromycin	0.021197	0.302857	1.522608
1	Alprimine	Insulin gargline	0.003200	0.369231	2.120674
2	Fluticasone	Azithromycin	0.019864	0.393140	1.976503
3	Hofine	Azithromycin	0.009865	0.383420	1.927635
4	Azithromycin	Insulin gargline	0.054793	0.275469	1.582155
...	...	...	...	...	...
116	glucagon	paracetamol	0.004933	0.345794	1.553176
117	ranexa	paracetamol	0.007732	0.347305	1.559963
118	remdisivir	paracetamol	0.014798	0.352381	1.582760
119	remdisivir Macrobidan	paracetamol	0.005333	0.449438	2.018704
120	remeron	paracetamol	0.007199	0.382979	1.720194

Displaying the results ordered by descending lifts

```
[12] x=resultsinDataFrame.nlargest(n = 10, columns = 'Lift')
     x
```

	Left Hand Side	Right Hand Side	Support	Confidence	Lift
68	Levothyroxine	Lisdexamfetamine	0.004533	0.290598	4.843951
99	Rosuvastatin	Pregabalin	0.005733	0.300699	3.790833
105	Sotatlol	Sitagliptin	0.015998	0.323450	3.291994
103	Shringix	humulin	0.005199	0.254902	2.923577
77	sitadol	Lupron	0.005466	0.275168	2.886760
57	gabapentin	Insulin gargline	0.003733	0.482759	2.772720
29	Fluticasone	diclofenac	0.011332	0.224274	2.545056
101	Senna	Sitagliptin	0.006532	0.246231	2.506079
75	haldol	Lupron	0.016131	0.235867	2.474464
74	Sofosbuvir	Lupron	0.016664	0.233209	2.446574

	Left Hand Side	Right Hand Side	Support	Confidence	Lift	var
68	Levothyroxine	Lisdexamfetamine	0.004533	0.290598	4.843951	Le+Li
99	Rosuvastatin	Pregabalin	0.005733	0.300699	3.790833	Ro+Pr
105	Sotatlol	Sitagliptin	0.015998	0.323450	3.291994	So+Si
103	Shringix	humulin	0.005199	0.254902	2.923577	Sh+hu
77	sitadol	Lupron	0.005466	0.275168	2.886760	si+Lu
57	gabapentin	Insulin gargline	0.003733	0.482759	2.772720	ga+In
29	Fluticasone	diclofenac	0.011332	0.224274	2.545056	Flu+dic
101	Senna	Sitagliptin	0.006532	0.246231	2.506079	Se+Si
75	haldol	Lupron	0.016131	0.235867	2.474464	ha+Lu
74	Sofosbuvir	Lupron	0.016664	0.233209	2.446574	So+Lu



Visuals of results

CHAPTER 5

CONCLUSION AND FUTURE SCOPE

5.1 Summary:-

Health care is given extreme importance nowadays by each country with the advent of the novel coronavirus. Thus in this regard, an IoT-controlled healthcare monitoring system is most probably the best solution for such an epidemic. Internet of Things (IoT) is the new revolution of the internet which is a growing research field, especially in health-related services.

We have mainly focused on two objectives. The first one was a smart health monitoring system, to collect the health history of patients with a unique ID and store it in a database so that doctors need not spend much of their time in search of the report and give analysis right from the dashboard. Any health-care that is being done will be updated and reflected in the dashboard itself.

Secondly, the medicine recommendation system will be helpful for the healthcare sector. People won't have to face the problem of unavailable medicines, since the stores will be stocked well in advance since they can know which medicines are most likely to be bought. Moreover, the economy will be helped since the medical black market will be eliminated as medicines are readily available so there is no shortage, thus no scope of dishonest people to dupe others by profiteering from selling medicines at exorbitant rates to needy people.

However, there are a few shortcomings to this too. Basic knowledge of the operation is to be learned by the caregivers. Also, both the caregiver and the wearer should know how to protect the sensors from water damage or any physical damage. Moreover, there might not always be the medicines that have been predicted, people might need some other medicines.

5.2 Future Scope:-

Though the medical sector was unhurried in the first stage to adopt IoT technology compared to other sectors, the new uproar Internet of Medical Things (IoMT) proved revolutionary in today's world. It is set to transform how to keep people healthy and safe while bearing costs in mind.

The that internet of Medical Things (IoMT) combines medical devices and applications that connect healthcare IT systems via different network technologies. The technology can lower needless visits to hospitals along with decreasing the load on the health care sector by interconnecting patients and physicians. Also, it makes secure transmission of medical data possible.

As per experts, the global IoT market was worth $22.5 billion in 2016 and is expected to reach $72.02 billion by 2021. Contributing greatly to the healthcare domain, the IoMT market is filled with smart devices like medical/vital monitors at home, community, clinic along with wearables while connecting real-time location, telehealth, and other services.

Some of the ways in IoT in medical services can help in upcoming time are :

- Reducing waiting time in emergency rooms
- Tracking of patients, inventory, and staff
- Augmenting drug management techniques
- Ensuring the provision of essential hardware
- Converting data into activities

The main motive behind this model is to ensure that the common people get the best possible variant of the medicines available in the market at all points of time.

This model will just recommend the best associated combination of medicines that go along with each other in a certain manner based on the previous sales of those medicines. Thus it thereby allows the optimal transaction to happen between the patient and the chemist shop.

On the flip side , it also allows the chemist to update his/her stocks to its full potential at any given point in time so that the patient can get the best possible variants of the medicines , whenever he/she has a necessity of it .

The future scope of this apriori based machine learning recommendation model is that it will allow low infrastructural casualties in a healthcare center as it will

always ensure that the best possible medicine or other health equipment are available at all times of the year . This will boost the lack of technical and managerial policies that are lacking today in different healthcare centres across India .

This model can be further integrated with UI/UX apps which will allow a patient and his/her family to get a clear visual understanding of the current status of the different healthcare facilities that are available at a healthcare center in some developed areas without even travelling long distances in search of a preferable diagnostic centre for the patient .

This approach will save many lives and thereby contribute to a better policy making attitude for the common people .

(IOMT) benefits include :

REDUCTION IN ERRORS:

The data created by connected devices aids in the making of effective and precise decisions, as well as ensuring smooth operations with reduced costs and waste.

FASTER DIAGNOSIS: Due to continuous monitoring and real-time tracking of patient data, doctors can diagnose/detect disease at an early stage for effective treatment.

COST-EFFICIENT: Doctors may monitor patients in real time by using IoT devices. As a result, this procedure can assist patients in reducing needless doctor visits and hospital stays.

REMOTE MEDICAL ASSISTANCE: It is very hard for lone patients in a medical emergency to call a doctor who is far away. This is made simple by IoT applications in healthcare and other relevant equipment. Furthermore, medical staff can do on-the-spot checks on patients.

ALERTS AND TRACKING: Timely alerts are critical in life-threatening situations. In these instances, IoMT devices and programmes may capture important data and deliver it to medical staff for real-time tracking. These devices can also provide real-time information on a patient's condition, independent of their location or time.

REMOTE REPORTING AND MONITORING: Doctors and physicians can better monitor their patients' health via connected gadgets. In an emergency, such as diabetic episodes, asthma attacks, or heart failure, real-time monitoring can save lives. The collecting of medical and other relevant health data is not difficult with the use of a smart medical gadget connected to a smartphone app. An authorised individual, such as a doctor, insurance company, participating health firm, or external consultant, may readily access and use data collected from these devices, regardless of their location, time, or device.

As per the latest innovations and requirements in medical technologies, we must form an organized network of smart devices that would collect, sync, and manage huge amounts of data effectively and cost-efficiently.

In the IoT future, the scope of automation in health industries is regarded as one of the most revolutionary schemes ever deployed in healthcare. We look forward to this upcoming boost in the infrastructure of the healthcare structure to build a greater nation.

This project has the scope to be expanded in the upcoming semester. Further features and work can be done on this topic.

5.3 Cost Analysis-

Equipment	**Cost**
MLX 90614 Temperature Sensor.	Rs. 1299
MAX 30102 Pulse Rate Sensor.	Rs. 699
Machine learning - software work	Rs. 333
NodeMCU ESP8266 Wi-Fi development board	Rs. 450
Jumper wires	Rs. 199
Total	Rs. 2700

CHAPTER 6

PLANNING & REFERENCES

6.1 Planning and project management

S.No.	Activity	Starting Week	Number of Weeks
1.	Literature Review	3rd-4th week of July	2
2.	Required software setup, hardware gathering, and coding,calibration	1st week of August	1
3.	Code Integration & Debugging	2nd week of August	1
4.	Inclusion of IoT and Blynk	2nd week of Aug	1
5.	Medicine overview along with a basic understanding of python and data manipulation and preprocessing	3rd week of Aug	1
6.	Preparing the model(train)	4th week of Aug	2
7.	Fitting model	1st week of Sept	1
8.	Checking model	2nd week of Sept	1
9.	Analysis after training the model	3rd-4th week of September	2
10.	Metrics evaluation	1st week of October	1

11.	Preparation of project report	2nd week of October	2
12.	Preparation of Project presentation	3rd-4th week of October	1

The Gantt Chart is shown below:-

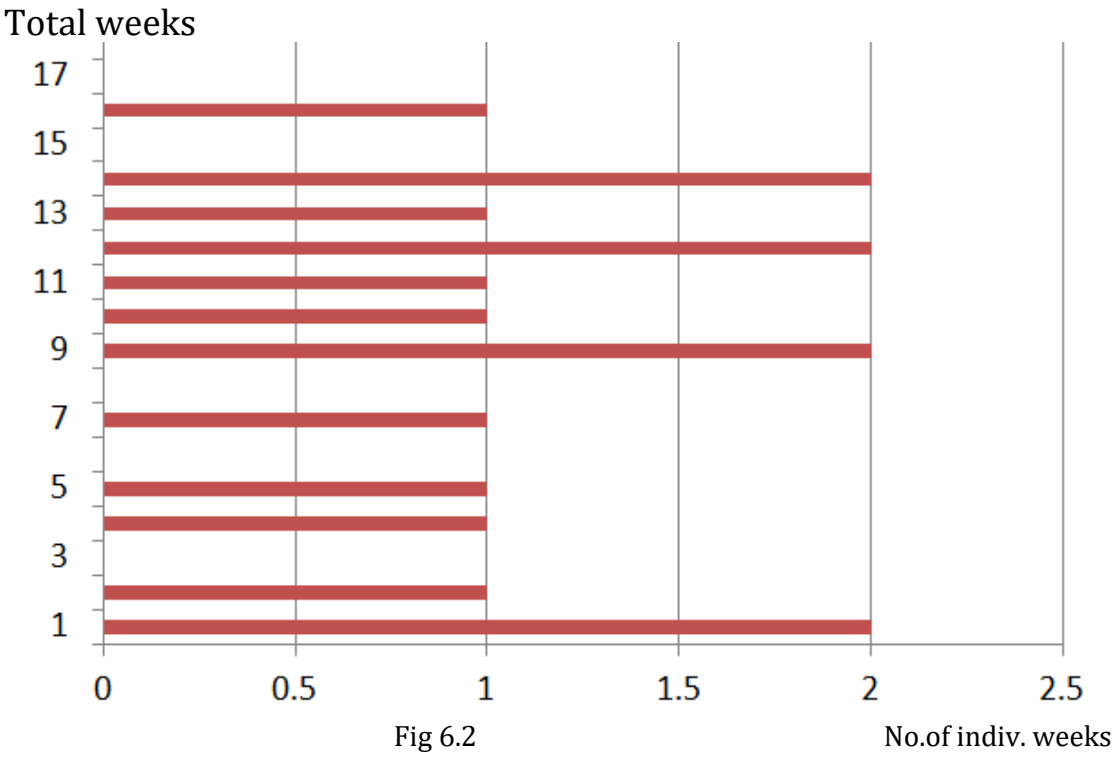


Fig 6.2

6.2 REFERENCES –

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SELF DECLARATION FOR PLAGIARISM CHECK

We, Souvik Karmakar(1807228), Indrashis Mitra(1807274), and Pratyay Basu(1807291) are declaring that our Project report on "ADVANCED **HEALTHCARE MONITORING AND RECOMMENDATION SYSTEM**" has plagiarism well within the limits prescribed to us. We take full responsibility for it.