PREDICTION AND MONITORING OF MEDICAL STORAGE SYSTEM USING MACHINE LEARNING AND IOT

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Abstract**—***The objective of this project is to design an IOT device which monitors persistently air quality, temperature, Oxygen Cylinders weight and stores the information in Azure Cloud. Live information can be observed through the Android and Windows Applications which will be interacting with Azure SQL Cloud. At the point when the data of these sensors violates the critical values then the monitoring system sends alert as SMS to the hospital maintainers hand phone through IOT and alert in the Windows Application. Hence it alarms to deal with the harmful gas levels and temperature levels as well as oxygen amount rapidly. Utilizing different ML techniques, the amount of oxygen required for the future operations in hospitals is anticipated and intimated to hospital for maintaining the predicted quantity of oxygen. Right now, the situation used to monitor just temperature in the Hospital. In the proposed framework it screens temperature levels, harmful gases, oxygen cylinder utilization and forecast of the oxygen cylinders.*

Keywords— IOT; Azure Cloud; Oxygen Prediction; ML techniques

I. INTRODUCTION

Internet of Things (IoT) offers the techniques for diminishing errors and hostile occasions. Internet of Things is a term addresses the bury systems administration and organization of the actual gadgets, which can be embedded with programming, sensors, and so on. Distributed computing has been a huge help with exhausting and taking care of the recorded data. Cloud computing is executed an arrangement of far-off servers to store, trade, direct and process information's sake of utilizing a neighborhood server. Poor air quality, change of oxygen gas percentage, change in temperature is incredibly hard to keep up with in emergency clinics. At the point when the information of these was change underneath or over the limit the observing framework naturally sends the data to the maintainers hand telephone on the versatile organization as SMS by means of IOT gadget. Utilization of oxygen by a patient is relies upon the type of operation, age of patient and measure of time taken for the fruition of operation. Using a Machine Learning algorithms cylinders usage was predicted and based on the usage cylinders were maintained. This examination means to build up a custom data framework and UI plan for the Hospital and monitoring system. In this manner, it tends to be overseen on a work area application, web server and can be created on a portable application, for example, Android. There are numerous sorts of Machine Learning Algorithms. Choosing the type of ANN algorithm depends upon the type of the data. We have carried out Linear Regression, Ridge, Lasso and MLP with ReLu Models.

II. LITERATURE SURVEY

2.1 EXISTING SYSTEM

In this article, Paper [1], [7]: this paper incorporates a temperature sensor to detect temperature, a Humidity sensor to sense the mugginess, Smoke sensors are utilized to distinguish for various Toxic gases like nitrogen oxide, methane. Also, a lot more different sensors are utilized to gather information from pollution air.

Paper [2] depended on programmed correspondence between the advanced gadgets and android applications by means of Bluetooth and cloud information. Subsequently, the above framework fills the need for doctors.

Paper [3] explains the gases utilization and causes an impact on clinical gases utilization sustainability. The paper proposed how to calculate the floor area by terms of the number of gases consumed like oxygen, nitrogen, medicinal air, carbon dioxide, and nitrogen protoxide were analyzed by ANOVA and Shaprio-wilk test.

In paper [4], the training in the neural network had determined by using algorithms such as Bayesian network, Decision tree method, conventional classifiers, minimal probability machine, support vector machine is lack of higher prediction accuracy. Live

information from the sensors is gathered by the Arduino UNO R3 and storages in the Google firebase cloud through ESP8266 Wi-Fi module alluded from paper [5].

2.2 Limitations of present system

1) DH11 sensor measures temperature only in positive degrees (range 0-50 degrees), The accuracy defers by +/- 2 degrees. So, we are using LM35 sensor to overcome these limitations.
2) In the current system the data is stored in local database whereas we are using the Azure Cloud for data management and utilized Wi-Fi module for pushing data to Azure.

III. Proposed System

The proposed framework mostly comprises of two modules. First module contains sensors named LM35 sensor, MQ2 sensor, MQ9 sensor, Load Cell Sensor. LM35 sensor is used to screen the temperature. MQ2 and MQ9 sensors are utilized to screen the harmful gases in the clinical stockpiling. Load cell is used to monitor the weight of the oxygen cylinder in the hospitals. On the off chance that these sensors are lower or higher as far as possible IOT gadget send the alarm messages to the clinical stockpiling maintainer.

The oxygen usage of patients is differed from each other based on the operation, age of patient and time taken for the operation. Threshold limit of the oxygen cylinder weight was fixed to a certain limit. As the weight of the oxygen cylinder is below the threshold limit alert message was send to the maintainer to change the load cell. Second Module is ESP8266(Wi-Fi Module). From the above modules the information of these sensors, Wi-Fi module pushes this data to Azure Cloud and gives live checking through the android and windows application with the help of Azure SQL cloud.

Keeping up with of oxygen cylinders is troublesome in the hospitals. Different Machine Learning Techniques used to foresee the oxygen needed for the following registered operations. So that it is not difficult to keep up with the oxygen chambers.

IV. Implementation:

4.1 System Architecture:

The figure shows the framework design, and it involves both hardware and programming parts which are momentarily clarified in Section 4.2,4.3.

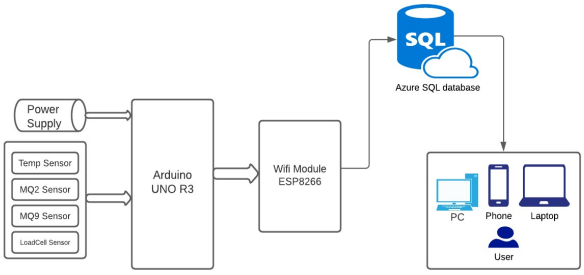

Fig. 1 System Architecture

4.2 Hardware Implementation:

Every Hospital needs to introduce an IoT equipment unit. With the objective that the IoT device records the readings of gases, temperature and Oxygen and pushes to Azure.

Components required are referred to under:

4.2.1 Arduino UNO R3:

Arduino Uno R3 is one sort of ATmega328P based microcontroller board. It incorporates the entire thing needed to hold up the microcontroller. The R3 Arduino Uno is the third just as latest adjustment of the Arduino Uno. To use Arduino, simply append it to a PC with the assistance of a USB link and give the stock utilizing AC-DC connector or a battery.

4.2.2 Wi-Fi Module (ESP8266):

ESP8266-12E Wi-Fi module is utilized to push information to cloud. Arduino IDE is utilized to program the ESP8266 Wi-Fi module. With only a couple of lines of code you can set up a Wi-Fi connection and define input/output pins according to your needs exactly like Arduino, transforming your ESP8266 into a web server and much more.

4.2.3 LM35

LM35(Temperature sensor) has analog pin, voltage pin and ground pin. Analog pin connected to the A0 pin of Arduino where data transmission occurs. VCC (voltage) pin of LM35 connects to the 5v pin in Arduino, and ground pin to ground of Arduino. It can gauge temperature goes from 55-degree Celsius to 150 degrees Celsius

4.2.4 MQ2 & MQ9 Sensors

MQ2 sensor and MQ9 sensor has ground, VCC and analog pins. ground of sensors connects to the ground of the Arduino, VCC of sensors connects to the 5v of the Arduino and analog pins of MQ2 and MQ9 sensors connects to the A2 and A3 pins of Arduino. MQ2 & MQ9 sensors are used to detect the toxic gases in the atmosphere. These gases senses different types of gases like Carbon Monoxide, Town Gas, Liquefied Gas, LPG, Natural Gas, coal Gas etc. MQ2 ranges from 300 to 10000 ppm and MQ9 ranges from 100 to 10000 ppm.

4.2.5 Load Cell Sensor

Load cell is comprised of Anodized aluminum. It is utilized to ascertain the heaviness of the equipment body. The load cell is connected to Arduino using VCC, GND, Pin4, Pin5. This is used to get the oxygen quantity present in the hospital.

4.3 Software Implementation:

In the software implementation, we have designed a Windows Application and essential Mobile application. Utilizing these applications the hospital staff can screen the oxygen, toxic gases and temperature levels and anticipate the oxygen needed for future operations.

These applications are developed by using the following tools:

4.3.1 Arduino IDE:

Arduino ide is utilized to code the Arduino Uno R3 and esp8266 and the bundles imported are '**esp8288wifi.h'**, '**liquidcrystal.h**' and '**sofwareserial.h**'.

4.3.2 Visual Studio:

Visual Studio is utilized to develop PC programs, just as sites, web applications, web administrations and versatile applications. Visual Studio utilizes Microsoft programming advancement stages like Windows API, Windows Forms, Windows Presentation Foundation, Windows Store and Microsoft Silverlight. It can create both native code and managed code. We are developing windows application using Visual Studio and the Windows Application is used in the Hospital Office room for monitoring and predicting the oxygen quantity and other parameters.

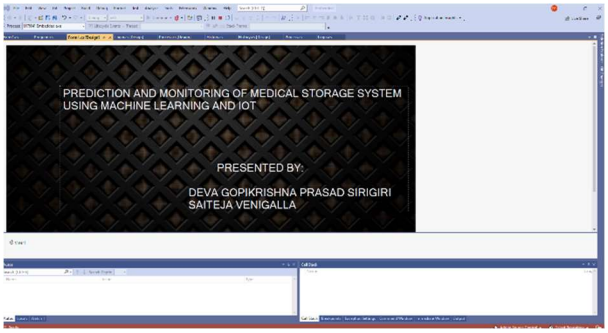

Fig. 2 Windows Application using Visual Studio

4.3.3 Android Studio:

Android Studio is the authority incorporated improvement climate (IDE) for Google's Android working framework, based on JetBrains' IntelliJ IDEA programming and planned explicitly for Android advancement. We are developing essential Android application using Android Studio and this Android Application is used for monitoring and predicting the oxygen quantity and other parameters remotely.

Fig. 3 Android Application using Android Studio

4.3.4 Visual Studio Code

Visual Studio Code is a source-code supervisor made by Microsoft for Windows, Linux and macOS.[9] Features incorporate help for investigating, sentence structure featuring, keen code finish, scraps, code refactoring, and implanted Git. We are implementing machine learning techniques using Visual Studio Code. These techniques used to predict the oxygen quantity required for future operations.

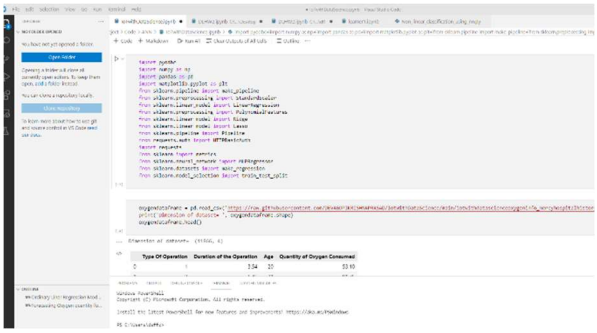

Fig. 4 Machine Learning Algorithms using Visual Studio Code

4.3.5 Azure Cloud:

Azure Cloud is used to store the sensors data. We have created the Azure resource and Azure SQL server then created database with name "MedicalStorage". Then we have created 2 tables "MedStorage" and "Operationsinfo". "MedStorage" table stores the sensors data where as "Operationsinfo" stores the future operations details.

V. Working

The architecture and technical stack associated with the oxygen predicting system were addressed in the previous section. The implementation and working of the system in a real-world scenario are discussed in this section. We ran an experiment to show how our system predicts the oxygen quantity using ML techniques.

Design of the project:

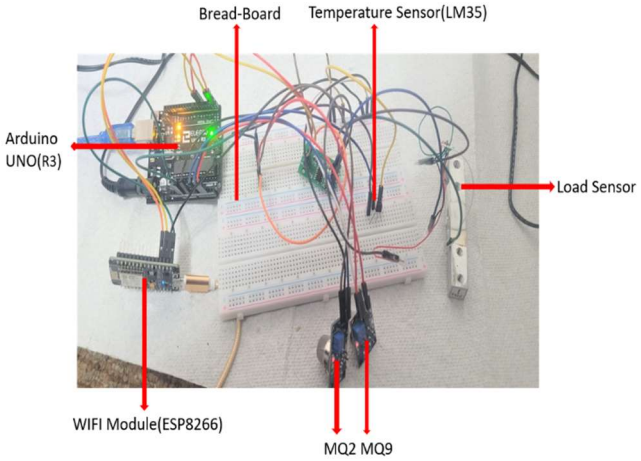

Fig. 5 Hardware Connection Diagram

Components

1. Arduino UNO
2. Wi-fi Module
3. MQ2 &MQ9 Sensors
4. Load Cell & Temperature Sensors

STEP-1: Collect the sensors data using Arduino and Wi-Fi Module and push the data to Azure Cloud.

STEP-2: If any parameter of the sensors data violates the threshold limits, then the alert mechanism will send SMS to end user based on the type of violation and Windows Application will show the alert message in the system.

- Case1: Temperature Violates Critical Values

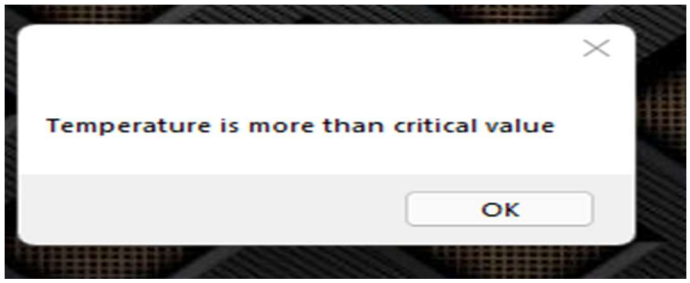

Fig. 6 Windows application Alert for violating temperature threshold value

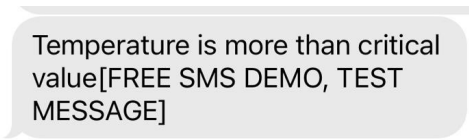

Fig. 7 SMS notification for violating temperature threshold value

- Case2: Toxic Gases Violates Critical Values

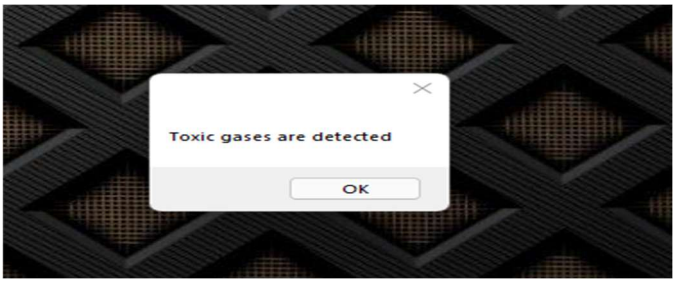

Fig. 8 Windows application Alert for violating toxic gases limits

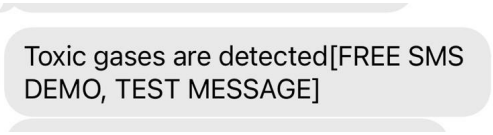

Fig. 9 SMS notification for violating toxic gases limits

- Case3: Oxygen Level below critical value

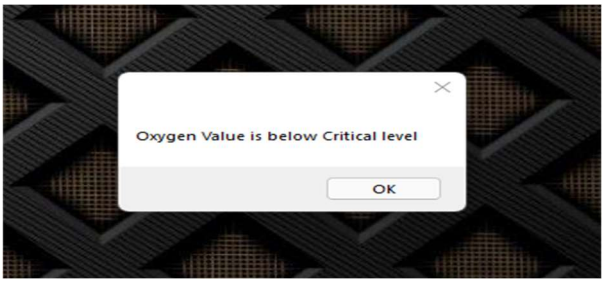

Fig. 10 Windows application Alert for violating oxygen threshold value

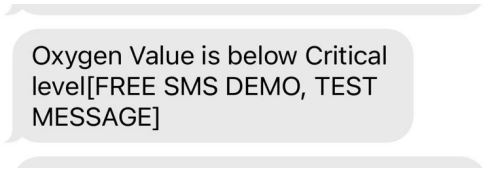

Fig. 11 SMS notification for violating oxygen threshold value

STEP-3: Then we are going to train multiple machine learning models with the data points. In our project we have used Linear Regression, Ridge, Lasso and Multi-Layer Perceptron with ReLu activation function models.

For training we used the dataset which we got from near by hospital and trained each model on this data. In the train data we have 3 features (type of operation, age of patient, duration of the operation) and we used these features for predicting the oxygen quantity required.

- Model 1: Linear Regression Model

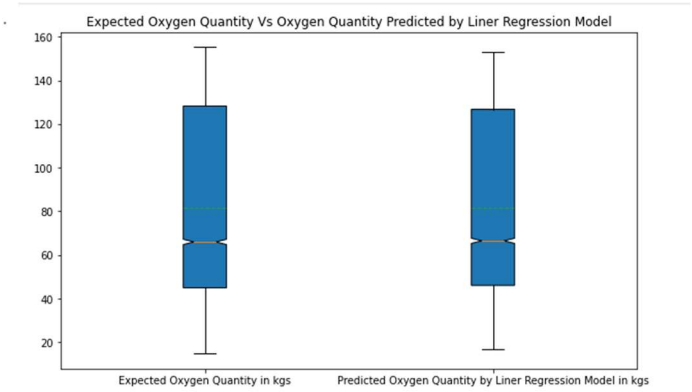

Fig. 12 Prediction using Liner Regression Model

- Model 2: Ridge Model

While training Ridge model we have used polynomial of degree 3, learning rate as 0.01 and maximum iterations as 10000.

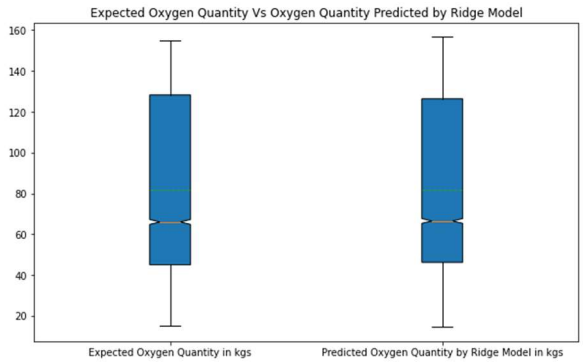

Fig. 13 Prediction using Ridge Model

- Model 3: Lasso Model

While training Lasso model we have used polynomial of degree 3, learning rate as 0.01 and maximum iterations as 10000.

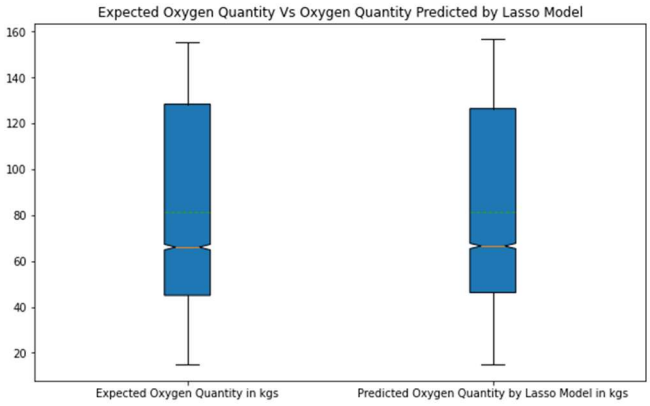

Fig. 13 Prediction using Lasso Model

- Model 4: Multi-Layer Perceptron with ReLu activation function Model

While training MLP with ReLu model we have used random state as 1, learning rate as 0.1, maximum iterations as 100000 and activation as "relu"

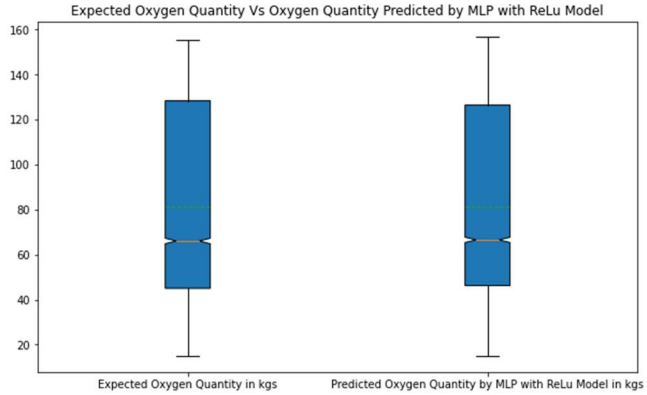

Fig. 14 Prediction using MLP with ReLu Model

Post training all the models, we have compared the prediction score for all 4 models and observed that Ridge model giving higher score among other as shown below:

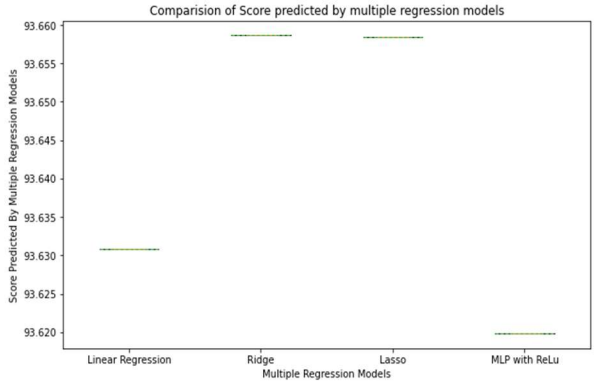

Fig. 15 Predicted Score comparison among the Liner Regression, Ridge, Lasso, MLP Models

STEP-4: Now with the trained model, we are going to predict the quantity of oxygen required for next week.

In our project we have used the opearionsinfo database tables to get the type of operation, age of patient and duration of the operation details and these were used to predict the oxygen for next week. Post that we used the loadcell data to get current capacity of oxygen in the hospital and the difference of current and predicted quantity is the amount of oxygen the hospital should import for next week. This difference quantity sent as SMS notification to end user and also using windows application this info can be retrieved as shown below.

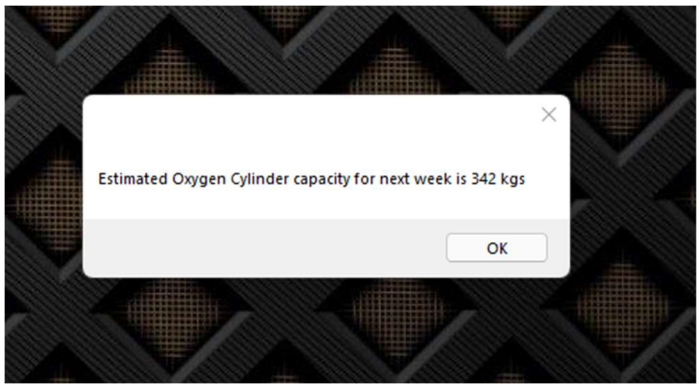

Fig. 16 Estimation of the Oxygen using Ridge Model in Windows Application

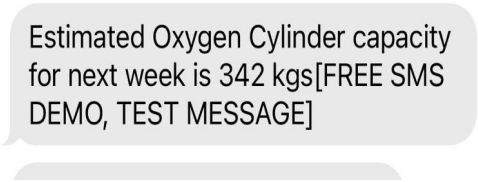

Fig. 17 Estimation of the Oxygen using Ridge Model via SMS

VI. Conclusion and Future Scope

In the current system, keeping up with the oxygen chambers needed for the clinic is truly challenging as it includes regular manual intercession. So, utilizing Iot and Data Science strategies we can conquer this issue by planning a gadget which will screen the oxygen levels present in the medical clinic and AI calculations is utilized to foresee the oxygen which is needed for future tasks. Additionally, some dangerous poisonous gases in the medical clinic can prompt life loss and this Iot gadget will screen the harmful gases also temperature esteems and alarm the emergency clinic staff if these values exceed the threshold limits. Thus, this project proposed and executed savvy strategy to monitor and forecast the medical storage system.

Even though the windows application and the android app is now in working state, we can in any case add some new functionalities in the Windows application like booking medical checkups and producing scanned reports and so forth, later. We can add greater functionality to versatile android application as well.

VII. References

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