IOT Based Fire Fighting Robot

Megha Kanwar[1], Agilandeeswari L.[2]

[1]School of Information and Technology, Vellore Institute of Technology
Vellore, Tamil Nadu, India
[2]Associate professor and Head of Department
School of Information and Technology, Vellore Institute of Technology
Vellore, Tamil Nadu, India
[1]iammegha90@gmail.com, [2]agila.l@vit.ac.in

Abstract: **With the advancement in the field of mechanical technology, human interruption has become less and robots are being utilized for various works and for welfare of beings. Nowdays, fire mischances keep happenings frequently, cause danger to human life and property, also cause difficulties to fire fighters to save lives. In such cases, a firefighting robot is utilized to protect human lives, wealth, and surroundings from the fire mishappenings. This model is an IOT based firefighting robot that detects fire. After being informed the authorities can start visualizing the fire location and can communicate with people stuck with a help of an automatic receiver installed. Instructions can be given to the robot regarding its movement, turning on its water pump or carbon-dioxide pump depending on fire type through long distances. The fire type and carbon-monoxide level is known using the sensors installed that provide a graph to make the analysis. The analysis is also useful to further give information to safety authorities regarding amount of poisonous gases inhaled over a time period by the occupants of the affected area so they can take appropriate actions to undo the harm.**

Keywords: **Firefighting, IOT, Node MCU, graph analysis, robot design**

I. INTRODUCTION

There have been much technological advancements since few decades. Sometimes situations arise when humans have to lose their lives while working for these developments. One such very common situation arises due to fires in industries, work places involving hazardous substances. Controlling these fires by experts also leads to loss of life (every year there is a significant mortality rate of firemen on duty). Robotics department has been coming up with new models that can substitute human requirement to personally go inside a building to extinguish fire. Flying drone is one of the recent most innovative ways that is under study to extinguishing fire. In real life, destruction through fire often happens without our realization. Therefore, this type of robot will be in high demands in the market because of its usefulness.

II. RELATED WORK

In the present time putting out fires is a risky issue. Numerous researchers are working on various methods for putting out fires systems. Author Ratnesh Malik et al. has built up an approach towards a kind of fire robot. The robot is planned and developed in a way which can extinguish fire. The robot is completely self-ruling. It actualizes the idea likes ecological detecting and mindfulness, relative engine control. The robot gets data from its sensors and equipment components. UV, and Infrared light are utilized to distinguish environmental surroundings. The robot is fit for battling burrow fire, industry fire and military applications are planned and fabricated. Photosensitive sensors are utilized to distinguish fire. When fire is recognized, robot sounds a caution. At that point it initiates water to be sprinkled on the fire. Utilization of sensors and microcontroller allows it to recognize fire naturally in a little span of time. This robot is utilized as a part of areas which are in high risk of danger. [1]

Kristi Kokasih et al. has created fighting tank robot. It is produced using iron, acrylic and plastic. Robot segments are servo engines, DC engines, compass sensors, ultrasonic sensor, fire locator, thermal sensor, switch sensor and white identifier. The goal is to look through a territory, find, stifle the fire for various fire locations. Robot is initiated through DTMF transmitter and receiver.[2]

An Autonomous Industrial Fire Fighting Mobile Robot is developed by H.P. Singh et al. The paper describes the construction and design of mobile fire fighting robot. The system contains two optically isolated D.C. motors. Robot performs analog to digital conversion of the data provided by infrared sensors. Five infrared sensor are used. Two sensors control the motion of the robots and three are for flame detection. The extinguisher comprises of D.C water pump and a water container. The basic theme of the paper is to sense the flames of fire and extinguish it. For this infrared sensor is used as input sensor which senses the infrared rays coming out of the fire. The microcontroller controls the extinguishing system. [3]

Swati Deshmukh et al has created a wireless fire fighting robot. It involves a system which has capacity to recognize fire and blow it off. It can move in forward and backward direction and turn left or right. In this manner fire warrior can work with it over long distances. Light reliant resistors are utilized for identification of flame. These resistors are quite sensative and are equipped for recognizing little fire. It is a smart multisensory based security framework. [4]

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Phone controlled robot with flame identification sensors was created by Lakshay Arora that comprises of cell phone which controls a robot by making a call to the cell phone which is appended to the robot. Amid the call actuation period, if any key is pushed on the telephone, the tone comparing to the key pushed is heard at the opposite end of the call that is set on the robot. The robot sees Dual-Tone Multiple-Frequency (DTMF) tone with the assistance of telephone mounted on the robot. The got code is prepared by the microcontroller and after that the robot performs activities as needs be. In the proposed framework DTMF innovation is utilized to position the pole of engine at a required point with various sensors, each playing out its own undertaking. Tough, Simple and savvy framework is proposed here. [5]

Android Phone controlled Robot Using Bluetooth is created by Arpit Sharma et al. Different methods of Human Machine connection utilizing signals are introduced. Signals are caught by utilizing an accelerometer. The paper examines the movement innovation to catch motions utilizing an android advanced mobile which has an inbuilt bluetooth module and an accelerometer to control the energy of robot. Microcontroller controls signs of Bluetooth module. Highlights like easy to understand interface, compactness and lightweight can it a good option as compared to old models .[6]

Creator SaravananP has composed and built up an Integrated Semi-Autonomous Fire Fighting Mobile robot. The System controls four D.C. engines fueled by Atmega2560 and controlled self-governingly by route framework. Route framework contains incorporated ultrasonic sensors and infrared sensors. The robot is fitted with remote camera which captures video and transmits it. The fire location contains LDR and temperature sensor. In the event when there is a fire the sensor distinguishes it and the robot will reach to the source of origin of fire and douses it. The quenching framework consists of BLDC engine with water holder. The SABOT is used for extraordinary conditions. It contains a GUI bolster through which robot can be commanded. [7]

Another type of Fire Extinguisher System is produced by Poonam Sonsale et al. The paper proposes of a versatile combination calculation for flame location. It utilizes a smoke sensor, fire sensor, temperature sensor for flame identification. It contains keen multisensory based security framework that contains a putting out fires framework in everyday life. The security framework can identify unusual and perilous circumstance and tell. Clever structures are required to be more secure helpful and effective living conditions for society. The motivation behind Intelligent Fire Extinguisher System is to douse fire in a specific measure of time. The framework recognizes the area of the fire and smothers it by utilizing sprinklers. As being Intelligent System, it removes the power of zone where fire has been gotten and begins the sprinklers just of that area.[8]

Remote Controlled Fire Fighting Robot developed by Phyo Wai Aung describes the functions of remote control fire fighting robot. It contains two main parts that is transmitter and receiver in which two sets of RF modules are used. One RF module is used to transmit the data to the motor driver and another RF module is used to know the condition on fire. Microcontroller PIC16F887 is used operate the whole system of the fire fighting robot. The motors are driven by the L298 and ULN2003 drivers in this system. The operator controls the robot by using wireless camera mounted on the robot. If the temperature of fire sight is above 40 degree Celsius, the alarm will be ringing so that operator can control the fire fighting robot and avoid the damage of heat. [9]

III. PROPOSED WORK

The objective of the proposed model is to design an IOT based Fire Fighting Robot which can replace the traditional Fire Protection Robot. This robot will send a fire alert to the cloud which can be easily viewed through an android application. Once the alert is sent the user can call the automatic receiver attached to the robot which will provide live streaming video of the fire location, this is possible by installation of an android application at user's end as well as for the robot. This receiver will also serve the purpose of communication of the user with the people stuck in the location where fire has occurred, thus instructions on exit routes can be given which is a good real time application of the model. In addition to the alert, the values of carbon dioxide sensor can be used to get an idea of the fire type and then the viewer can manually signal the water pump or CO2 pump to extinguish fire accordingly. The concept used to classify fire types is that cleaner fuels give out lesser amount of CO2 than the poor fuels as they have significantly more moisture content than clean fuels. Table 1 tells about the ideal fire extinguishing method for different types of fires. This directs us to the biggest disadvantage of traditional fire fighting robots that automatically start the water pump without having knowledge of fire type. In case of fire type B, water will not only defend the fire extinguishing process but also will increase the fire as oils are less dense than water so ends up floating on them. Therefore, where ever the water flows, the fire keeps expanding with it.

TABLE 1: TYPES OF FIRE AND WAYS TO EXTINGUISH THEM SAFELY

Fire Type	Description	examples	Safe way of extinguishing
A	Combustible material	Paper, wood	wet chemical, dry powder, water
B	Flammable liquids	Paint, petrol	foam, , co2, dry powder
C	Flammable gasses	methane butane,	dry powder
D	Flammable metals	Lithium, potassium	dry powder
E	Electrical equipments	Computers, generators	co2, dry powder

F	Deep fatfryers	Chip pans	wet chemical

The level of carbon dioxide can be measured through MHZ-14 sensor and a corresponding graph of ppm verses time can be plotted through it. The analysis of graph for the initial minutes of fire occurrence can be done and accordingly robot can be instructed to use water pump or CO2 pump depending on fire type.

TABLE II: CARBON MONOXIDE LEVELS AND POSSIBLE HEALTH EFFECTS ON HUMANS

Level of CO	Possible health Effects
0 PPM	Normal, fresh air.
400 PPM	Headache and nausea after 1-2 hours of exposure. Life threatening in 3 hours.
1000 PPM	Loss of consciousness after 1 hour of exposure.
6400 PPM	Death within 30 minutes.
12, 800 PPM	Immediate physiological effects, unconsciousness. Death within 1-3 minutes of exposure.

Figure 1 shows the process flow of the proposed system.

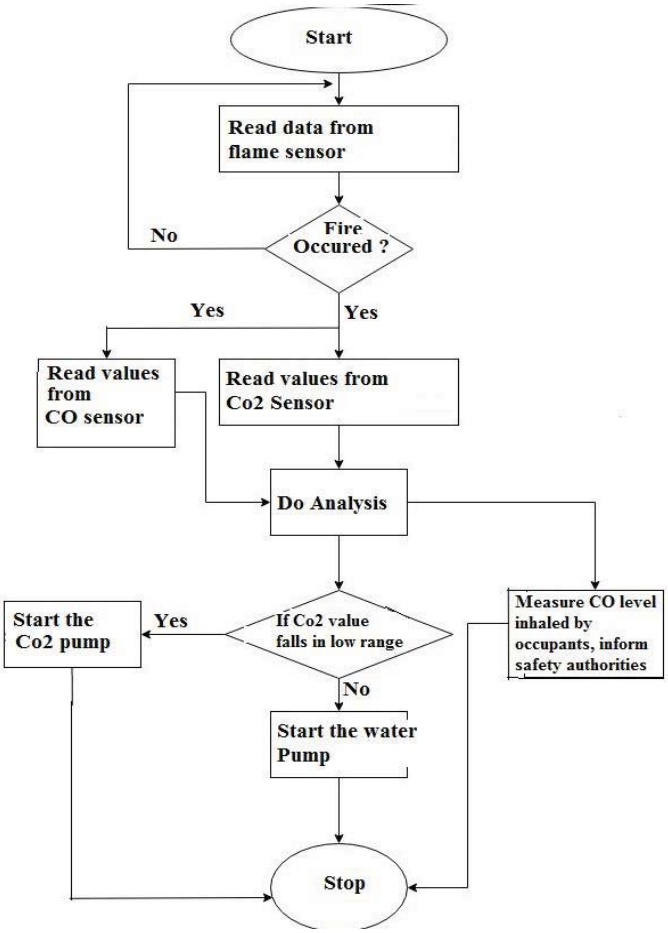

Fig. 1. The flow of processes after the fire is detected

Higher values of CO2 indicate fire type A hence water pump is appropriate while for the lower range of values CO2 pump can be used.

Another advantage of this model when compared to the traditional models is that it aims to do graph analysis for calculating the amount of carbon monoxide exposure inside the fire area for a period of time. Possible health effects and fatality condition can be roughly estimated and accordingly safety authorities can be informed regarding the deadline of number of hours the inhabitants can be risked to stay inside the fire affected area till rescue team reaches out to them. Table 2 shows the levels of CO and effects it has on humans depending on how long they constantly inhale this gas.

All the modules of the system are integrated; figure 2 shows the final design of the proposed model.

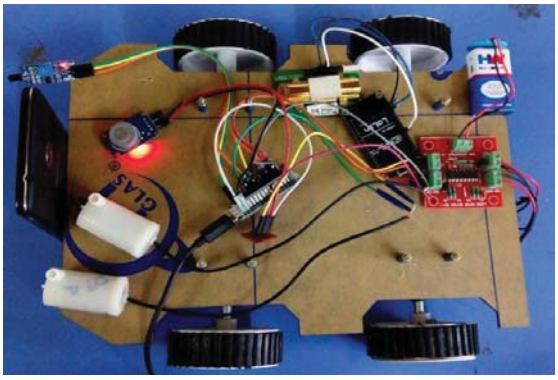

Fig. 2. Proposed Fire fighting robot

IV. METHODOLOGY

Figure 3 shows the data flow diagram of the proposed system. Structuring it is important for organization of the work and how the desired purpose has to be accomplished. Bird's eye view can be attained through the flow diagram, many changes or alterations can be made possible if needed in upcoming models.

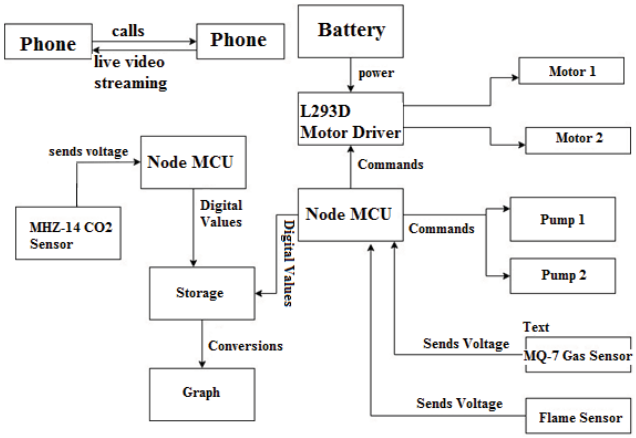

Fig. 3. Data Flow Diagram of the proposed system

Figure 4 and 5 show the pin diagram of the proposed model.

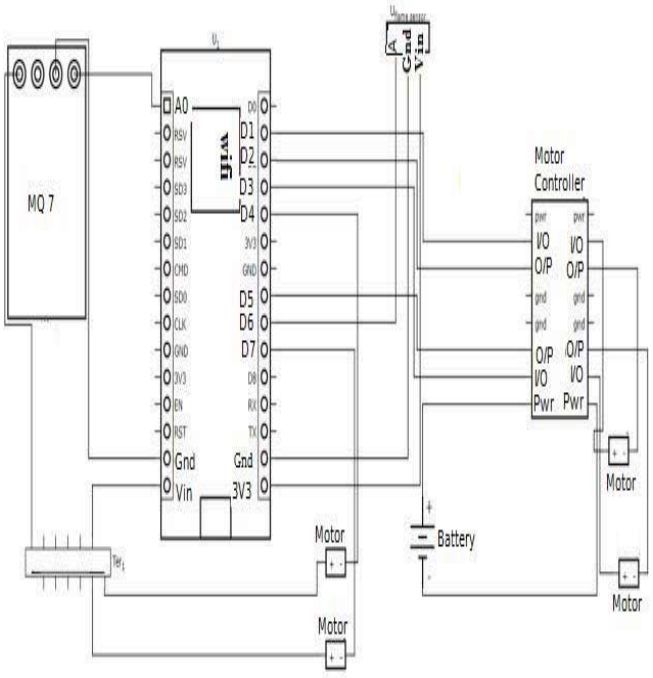

Fig. 4. Connections of the MQ7 gas sensor, Fire sensor, L293D Motor Driver, water pump and Co2 pump with Node MCU

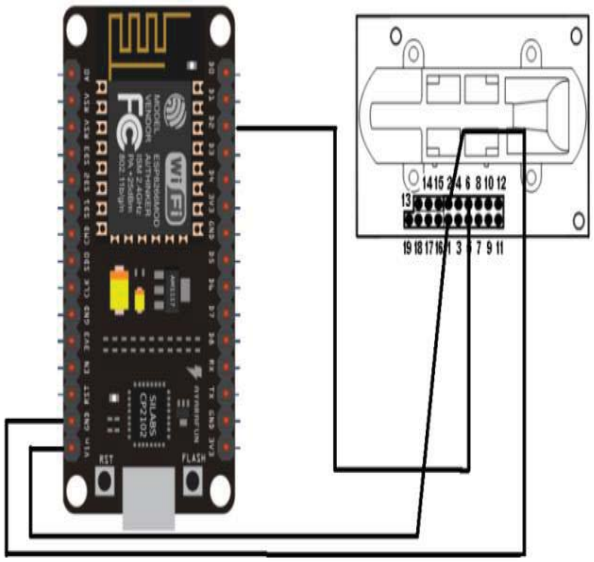

Fig. 5. Connection of MHZ-14 gas sensor with another Node MCU

V. RESULTS AND DISCUSSION

MQTT Box (application of Chrome) and MQTT Dashboard (android application) are used to control the movement of the robot and to start or stop the two pumps. The values of CO2, CO can also be viewed along with fire alert messages.

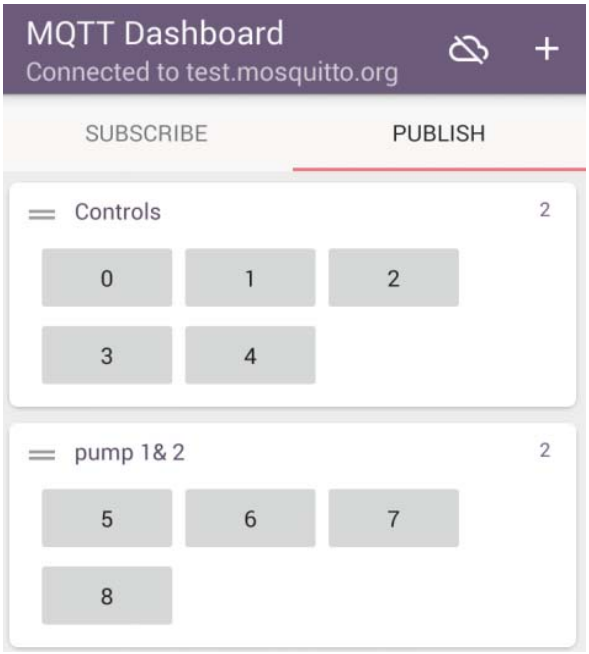

Fig. 6. MQTT Dashboard showing topic to publish window for controls of robot movement and the pumps

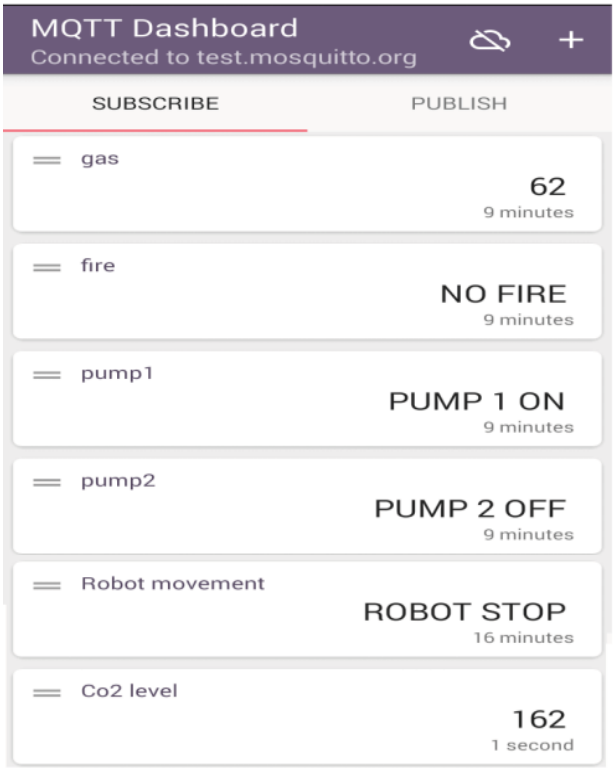

Fig. 7. MQTT Dashboard showing the subscriptions where values from sensors can be viewed

After the sensor values of MQ7 sensor and MHZ-14 sensor are retrieved, the data is converted to graphs for quick analysis. Figure8 shows the trend of increase in CO2 level.

a) Normal air conditions: Values range below 500ppm

b) Fire type B occurs: Values range between 500 ppm and 1000 ppm which implies that use of CO2 pump is more appropriate

c) Fire type A occurs: Values exceed 2000ppm which implies that use of water pump is more appropriate

These values are subject to the ventilation of the room and other factors like temperature of the room etc. But the trend which is constant is that the values of CO2 level for fire type A will always have a significant difference from fire type B.

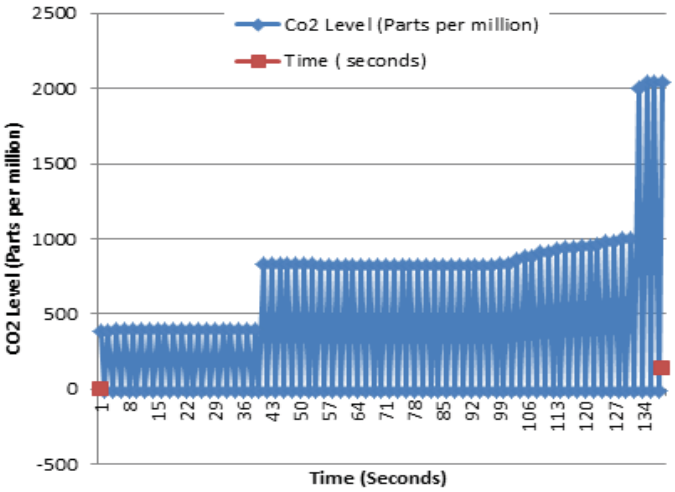

Fig. 8. CO2 level for a given period of time

Figure 8 shows Co2 level over a given period of time in ppm vs sec. The figure 9 shows CO level for a period of 5 minutes. These values range between 3 to 5 ppm which is slightly higher than 0 ppm (values of normal air conditions) hence indicates that at present poisonous gas amount is too low to cause much damage.

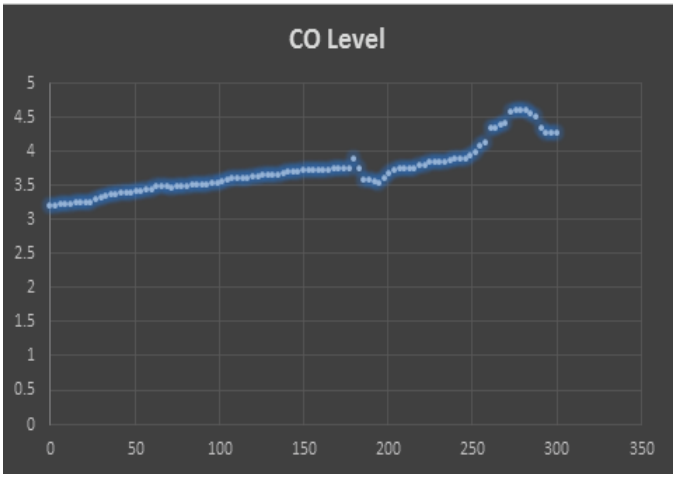

Fig. 9. CO level recorded over period of 300 seconds (x-axis: CO level(ppm), y axis: time(seconds))

VI. CHALLENGES IN EXISTING SYSTEMS

Finding fire type so that it can be extinguished with help of appropriate means. Existing models using Bluetooth modules have a very less range. Scenarios like fire scenes need robots that can be controlled from anywhere in the world. There is trouble using wire connected robot.

Real time monitoring is needed for better view. Less time consumption in executing commands for robot control. Accuracy of the sensor values to a point where meaningful analysis can be drawn.

This model aims to overcome all the challenges mentioned above.

VII. FUTURE WORK

Presently the robot design has manual controls to switch on the two types of pumps installed to be used depending on the fire type which can be made automatic by having knowledge of environment where the robot has to be kept. Knowledge of factors such as building type, its ventilation etc. a definite value can be specified for carbon dioxide level to reach for which Co2 pump needs to start automatically as possibilities of fire type B are reflected.A way to find electrical fires can make the project more feasible for real time use where water can be avoided for extinguishing purpose as can cause electric shocks to humans around hence alternate methods can be used instead to extinguish fire.The same robot design can be done on a drone which can make the process of extinguishing fire quick as doesn't need to deal with

VIII. CONCLUSION

The paper not only presents a successful implementation of a fire fighting robot but also presents addition of better features that makes it a more practically usable robot in real time scenarios where acknowledging fire type is important in order

to further avoid increasing fire with spilling of wrong fire extinguishing agent in the process of extinguishing fire. Carbon monoxide exposure measure alongside gives another novel feature to the designed model.

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