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Prevention from COVID-19 in India: Fuzzy Logic Approach

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***Abstract*- In December 2019, a novel coronavirus, called COVID-19 was discovered in the city of Wuhan China, which spread to various cities as well as other countries. At present novel coronavirus has become the most important health hazard, causing severe issues about a concern to the human being and has become a pandemic. Due to the prone of this deadly virus, uncertainty is significantly the facility for a health condition. There are solutions to handle insecurity about health from coronavirus for assessing the condition through FIS (Fuzzy Inference System). Therefore, for this particular reason we study and develop the fuzzy system to help assess the safety of health-related issues of the patient's condition according to the changes of environment. The FIS is permitted to assess the patient's history like temperature of the body, travel history, disinfection frequency, breathing problem, suffering cough and cold and ventilation rate. A fuzzy system consists of several steps like fuzzification, fuzzy database rule and also defuzzification. Furthermore, a study of FIS identifies the risk of health status according to the patient's condition. In this paper, we proposed a fuzzy rule system which is implemented with MATLAB fuzzy tools for simulation to assess the health conditions of the patient and prevention from COVID-19 disease.**

Keywords— COVID-19, Fuzzy Logic, Triangular Membership Function (TMF), Virus, Disease, MATLAB

I. INTRODUCTION

In month December 2019, every people not aware of the deadly coronavirus had been spread in Wuhan (China). This coronavirus is known as Covid-19. It is like a novel coronavirus SARS-COVID-19 million of the people affected in from December 2019 to last week of March 2020 and also affected its neighboring countries [1]-[2]. This virus is transmitted from the wild cat to the human race and also may cause SARS-COV and MERS-COV Now this virus is more spreading from human to human and the rate of spreading the deadly infectious disease to increase exponentially [3].

The SARS and MERS are two factors, it observed by health agencies this type of viruses affecting the aged people and male, which the plays very crucial role changing the symptom to ARDS (Acute Respiratory Syndrome). The MERS has affected the people suffering prolonged illness such as lung disease, diabetes, hypertension cancer, and including the other risk aspects related to more severe sickness presented the details in [4]-[5]. SARS-Cov-2 is a novel deadly coronavirus to causes COVID-19 to have been never encountered before and its origins in China affect more countries and territories. Recently many scientists and researchers are doing hard work to find a suitable vaccine in [6].

This paper is prepared and organized as follows. In Section-1 discussed the brief introduction related to COVID-19, Section-2 discussed the brief literature survey, Section-3 discussed the brief concept of the fuzzy logic approach, Section- 4 explains the experimental results, and Section-5 briefs the conclusions.

II. LITERATURE SURVEY

A common symptom in people who those suffer from Covid-19 basis on the research like headache, fever, tiredness, general chest pains, sneezing, exhaustion, running nose, sore throat, cough, smell difficulties, breathing problem, diarrhea, yellow eye, etc. entire symptom's exposed in those people to stay home quarantine last fourteen (14) days [2].

According to the WHO COVID -19 and other health organizations like Harvard T. H. Chan School of Public Health (CSPH) study has affected more than 62,363,527 people globally with 1,456,687 death cases till now 30 November 2020. According to the report from health, Pharma & Medtech and state of health cumulative COVID-19 statistics for India have 9, 309,871confirmed cases, 8,717,709 recovered cases, and 135,752 deaths cases respectively from 29 January 2020 to 26 November 2020, illustrate fig.-1 detailed in [7].

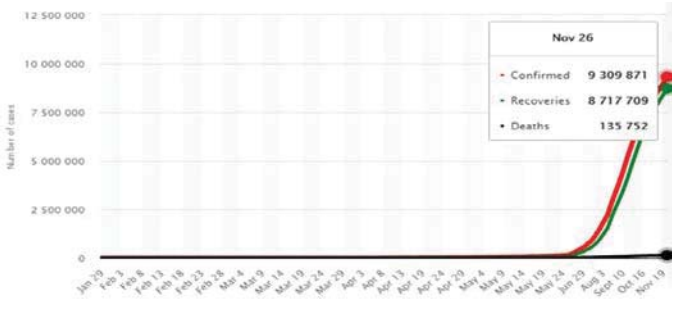

Fig. 1 COVID-19 statistics for India

Analysis of the lung infection identified by applied the fuzzy rule to a determined level of disease presented in[9].

Author Dhiman and Sharma they are discussed in their paper to diagnose the deadly coronavirus on some input like atmospheric temperature, ethanol, body temperature, etc., and the factor of conclusion has broken up three-level for infected people in [10]. The artificial intelligence system applied the more effective play of different conditions of the environment to spread the virus. FIS input has considered like temperature, ultraviolet, humidity, and obtains the output of effect on infected patients briefly discussed in [11].

The study of fuzzification, defuzzification, and how to prepare the inference rules of the given knowledge has been focused on FIS input variable and obtain the conclusion with associated of membership value of membership function detail in [12]. Fuzzy inference system to support maximizes the usability of resources and minimize its cost in real-time. The aim of this system is to explain the risk factors of patients while applied by medical staff [13]. The development framework of the web-based FIS tool used cardiovascular risk assessment and including the input variable like weight, medicine intake, blood pressure, age, and sex. This tool can be used for the prediction of patient risk [15].

III. METHODOLOGY(FUZZY-DIAGNOSTIC DECISION SUPPORT SYSTEM)

A Covid-19 deadly disease is widely spreading the global announcement like a pandemic. The most country is fighting worldwide to prevent it but a limitation of the testing those patients who infected or not. Fuzzy inference systems are used in medical-related research. In this paper, we have to use the same concept applying the symptom of covid-19 and predict to prevent the early stage of spreading it to other people.

A. Proposed Fuzzy COVID-19 Diagnosis

In this section to explain the concept adopted in the proposed overall structure of framework for the detection of infectious disease of COVID-19. This framework consists of the knowledge-based, fuzzy inference system and defuzzification values represent the fig.-2 in [12]. This framework system will help to diagnose the people who are infected with deadly coronavirus and making a quick decision for such contagious infections.

The identification of parameter of all the symptoms going to work more significant in infectious deadly virus, in this paper we predict the novel coronavirus using nine different variables such as fever, diabetes, sore throat, cough, loss of smell and taste, breathing problem, travel history, chest pain, age, illustrate Table-1 in [10]-[11].

The membership functions are picking for every input parameter. The selection of exact membership value for every value of input and output plays the mapping and reveals the system efficiency and its value $\in [0, 1]$.

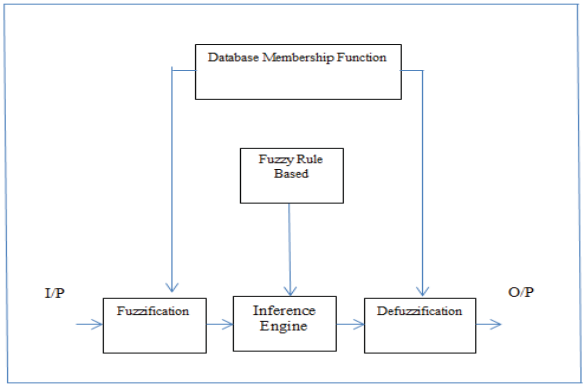

Fig. 2 Framework of fuzzy inference system

Table 1. Parameter of Infectious disease deadly COVID-19

Symptom (Including Factor)	**Linguistic Range**		
Fever	low	moderate	high
Age	<40	40<=and>=50	>=50
Diabetes	normal (140md/dl or7.8mmol/L)	Medium (170md/dl or9.0 mmol/L)	High (199md/dl or11.0 mmol/L)
Travel history	Not infected	Doubt infection	infected
Sore throat	high	low	
Cough	1	0	
Loss of smell and taste	low	medium	high
Breathing problem	1	0	
Chest pain	low	medium	high

The several factors which required type, parameter, operator like (AND, OR), inference operator, fuzzification and defuzzification are also used

Fuzzy set A in X defined as

$$A = \{x, \mu_A(x) | \, x \in X\}$$

Where,

$\mu_A(x)$= membership function of x belongs in a Fuzzy set is a non-empty set without a crisp value and defined the boundary

The conversion of x into $\mu_A(x)$ is called fuzzification. The membership function generally as defined

$\mu_A(x)$: X→ [0, 1], where

$$\mu_A(x) = \begin{cases} 1 \ , if \ x \ is \ entirely \ in \ A \\ 0 \ , if \ x \ is \ not \ belong \ in \ A \end{cases}$$

If x partially belong in A then $0<\mu_A(x)<1$

The function of triangular membership is contained three variable p, q, r lies in x-axis where variable p, r indicate the feet value zero membership but variable q is peak value has the membership degree value one detail explained in [8, 14], defined the TM as equation -1

$$f(x,p,q,r) = \begin{cases} 0 & if\ x \le p \\ (x-p)/(q-p) & if\ p < x \le q \\ (r-p)/(r-q) & if\ q \le x < r \\ 0 & if\ x \ge r \end{cases} \qquad (1)$$

Or

Written as more precise

$$f(x,p,q,r) = \max(\min((x-p)/(q-p), (r-p)/(r-q)), 0)$$

Membership $\mu_A(x)$ is computed for all input value in x

IV. DISCUSS THE EXPERIMENTAL RESULTS

FIS tool used to develop the rule of system find the actual output for every symptom of COVID-19. In this paper predict the symptoms are performed on a fuzzy model using MATLAB Ra12013a. We proposed the inference rule for triangular membership function as follows:

1. If (fever is low) and (age is below 40) then coronavirus is negative
2. If (fever is moderate) and (age is > 50) then take the quarantine precaution
3. If (fever is high) and (age is > 50) and (travel history is not infected) then Quarantine
4. If (fever is high) and (age is > 50) and (travel history is infected)) then strong positive
5. If (sore throat is low) and (age is <40) and (travel history is not infected) then quarantine
6. If (sore throat is high) and (age is>40) and (cough is dry) then take precaution
7. If (breathing problem is no) and (age is>40) and (cough is dry) then negative
8. If (age is 40 and >=50) and (cough is high) and (breathing problem is high) then positive
9. If (age is 40 and >=50) and (breathing problem is low) then negative
10. If (age is <40) and (travel history is infected) and (breathing problem is high) then positive
11. If (age is >50) and (travel history is infected) and (Breathing problem is high) then positive
12. If (age is 40 and >=50) and (travel history is Infected) and (cough is high) and breathing problem is high) then strongly positive
13. If (age is 40 and >=50) or (diabetes is high) or (travel history is not Infected) or (cough is medium) or (breathing problem is high) then positive
14. If (age is 40 and >=50) and (diabetes is high) and (travel is not infected) then quarantine
15. If (Loss of smell and taste is high) and (chest pain is high) and then positive
16. If (travel history is not infected) and (sore throat is high) and (cough is high) and (chest pain is high) and then strongly positive
17. If (age is <40) and (travel is not infected) and (sore throat is low) then negative

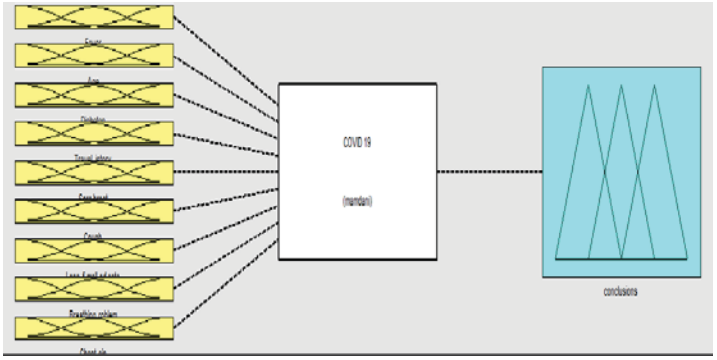

Fig. 3 Structure of a fuzzy inference system with nine I/P and one O/P

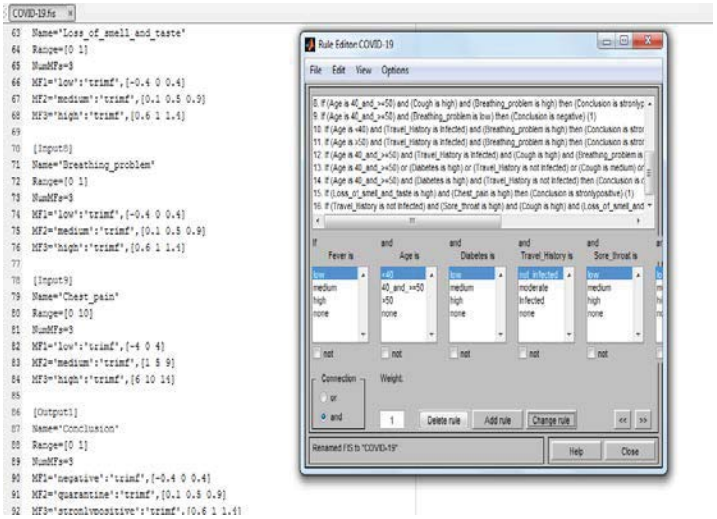

Fig. 4 Illustrate the Fuzzy inference rule

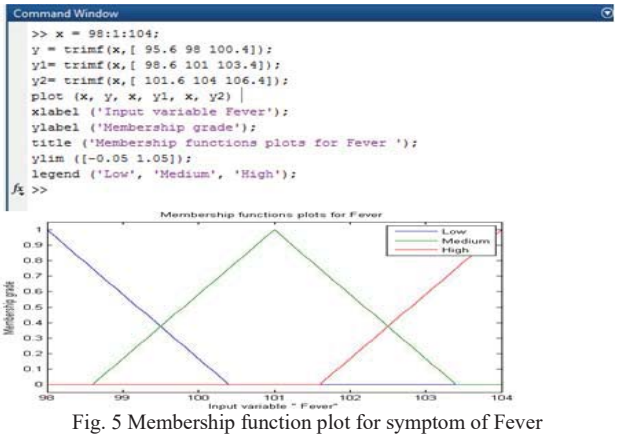

Fig. 5 Membership function plot for symptom of Fever

The input sample choice of membership function and its values as shown in below:

CVID-19 symptom for serial number-1:

[Input1]
Name='Fever'
Range=[98 104]
NumMFs=3
MF1='low':'trimf',[95.6 98 100.4]
MF2='medium':'trimf',[98.6 101 103.4]
MF3='high':'trimf',[101.6 104 106.4]

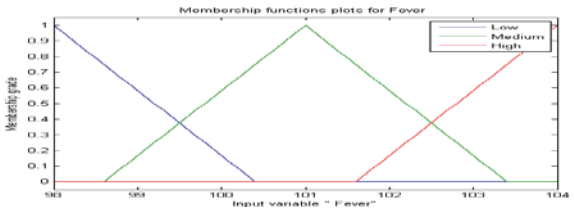

Fig. 6 Triangular Membership function for fever (Temperature^{0}F), and three classifications Low, Medium, and High

CVID-19 symptom for serial number-2:

[Input2]
Name='Age'
Range=[10 70]
NumMFs=3
MF1='<40':'trimf',[-14 10 34]
MF2='40_and_>=50':'trimf',[16 40 64]
MF3='>50':'trimf',[46 70 94]

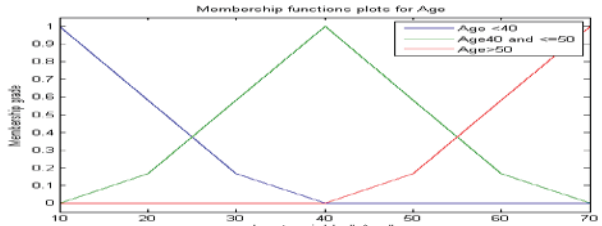

Fig. 7 Triangular Membership function for Age of people (years), and three classification 40, 40 and <=50, and >50

CVID-19 symptom for serial number-3:

[Input3]
Name='Diabetes'
Range=[140 215]
NumMFs=3
MF1='low':'trimf',[110 140 170]
MF2='medium':'trimf',[147.5 177.5 207.5]
MF3='high':'trimf',[185 215 245]

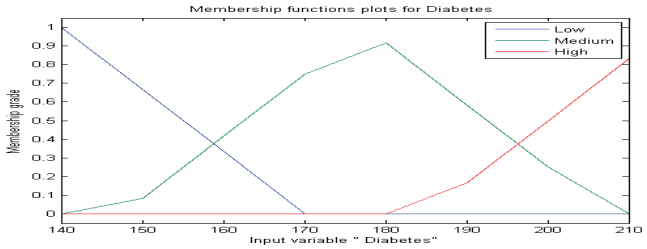

Fig. 8 Triangular Membership function for Diabetes (md/dl), and three classifications Low, Medium and High

CVID-19 symptom for serial number-4:

[Input4]
Name='Travel_history'
Range=[0 1]
NumMFs=3
MF1='not_infected':'trimf',[-0.4 0 0.4]
MF2='moderate':'trimf',[0.1 0.5 0.9]
MF3='Infected':'trimf',[0.6 1 1.4]

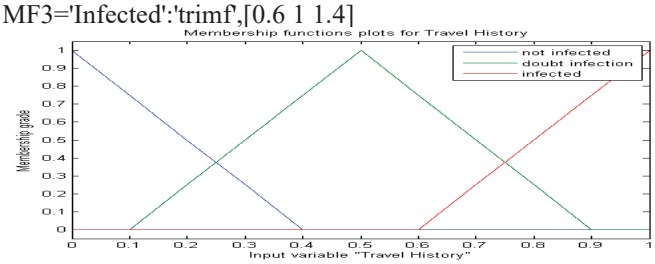

Fig. 9 Triangular Membership function for Travel History, and three classifications not infected, Doubt Infection, Infected

CVID-19 symptom for serial number-5:

[Input5]
Name='Sore_throat'
Range=[0 1]
NumMFs=3
MF1='low':'trimf',[-0.4 0 0.4]
MF2='medium':'trimf',[0.1 0.5 0.9]
MF3='high':'trimf',[0.6 1 1.4]

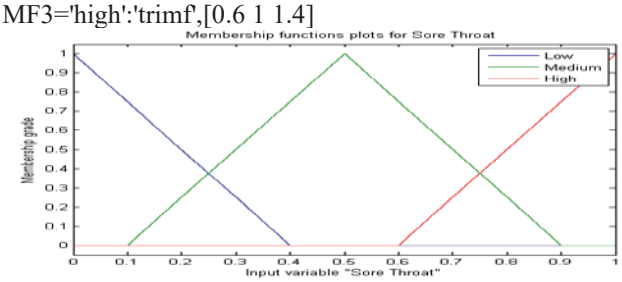

Fig. 10 Triangular Membership function for Sore Throat and three classifications Low, Medium, and High

CVID-19 symptom for serial number-6:

[Input6]
Name='Cough'
Range=[0 1]
NumMFs=3
MF1='low':'trimf',[-0.4 0 0.4]
MF2='medium':'trimf',[0.1 0.5 0.9]
MF3='high':'trimf',[0.6 1 1.4]

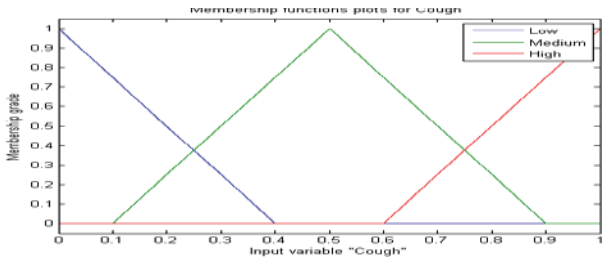

Fig. 11 Triangular Membership function for Cough, and three classifications Low, Medium, and High

CVID-19 symptom for serial number-7:

[Input7]
Name='Loss_of_smell_and_taste'

Range=[0 1]
NumMFs=3
MF1='low':'trimf',[-0.4 0 0.4]
MF2='medium':'trimf',[0.1 0.5 0.9]
MF3='high':'trimf',[0.6 1 1.4]

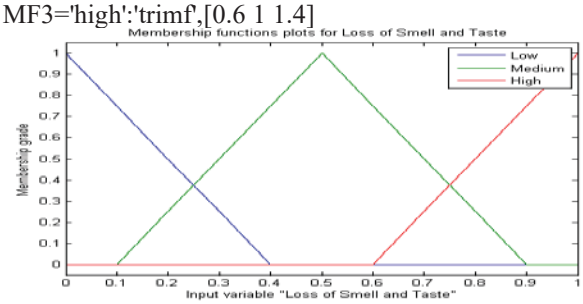

Fig. 12 Triangular Membership function for Loss of Smell and Taste, and three classifications Low, Medium, and High

CVID-19 symptom for serial number-8:

[Input8]
Name='Breathing_problem'
Range=[0 1]
NumMFs=3
MF1='low':'trimf',[-0.4 0 0.4]
MF2='medium':'trimf',[0.1 0.5 0.9]
MF3='high':'trimf',[0.6 1 1.4]

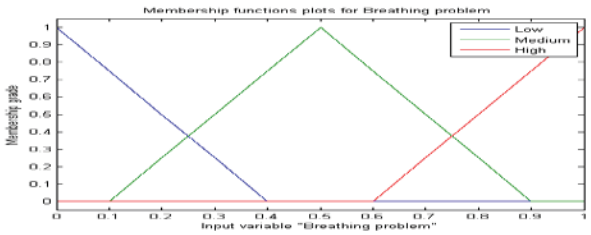

Fig.13 Triangular Membership function for Breathing Problem and three classifications Low, Medium, and High

CVID-19 symptom for serial number-9:

[Input9]
Name='Chest_pain'
Range=[0 10]
NumMFs=3
MF1='low':'trimf',[-4 0 4]
MF2='medium':'trimf',[1 5 9]
MF3='high':'trimf',[6 10 14]

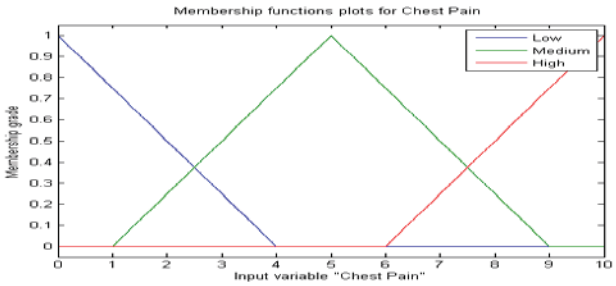

Fig. 14 Triangular Membership function for Chest Pain, and three classifications Low, Medium, and High

For using simulation MATLAB tool, produced the result of nine variables and one output is used. In the fig. 5 result is illustrate, a person has suffers that if fever is low and age is below 40 then the probability of coronavirus seems to be negatives,

Similar if a person's age is greater than 50 and his/her travel history is infected from another country and also has a breathing problem then the probability of coronavirus seems to be positive.

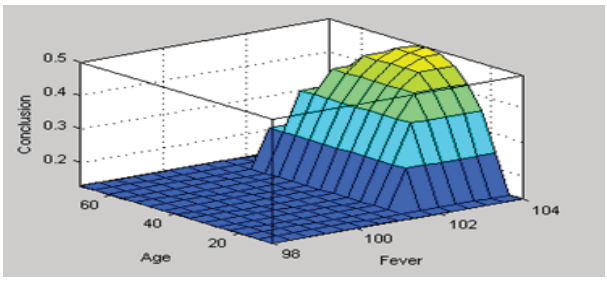

Fig.15 Illustrate the surface viewer conclusion between Age and patients suffer from fever

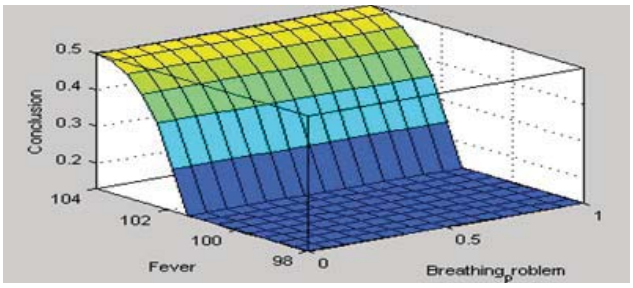

Fig. 16 Illustrate the surface viewer conclusion patients have suffering from both fever and Breathing problem

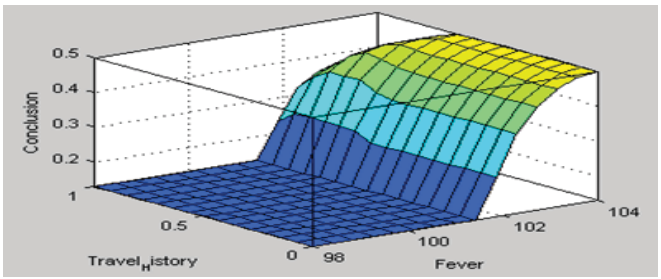

Fig. 17 Illustrate the surface viewer conclusion between travel history and patients have suffer from fever

In surface viewer fig.-15, fig.-16, and fig.-17 shown the blue color is input variables. Further, with help of this simulation viewer can verify the output (yellow color) shown of covid-19, MF (Membership Function) value can be seen in fig.- 6 to fig.-14 respectively, and a surface viewer can be adjust the variables and output can be seen.

V. CONCLUSION

Novel coronavirus COVID-19, the virus remains in the human body for fourteen days during this period infection no symptoms are revealed, but if patient has some travel history or migrate from an infected country, came into contact with the infected patient, he or she has to undergo quarantine for

fourteen days. In this research paper, we proposed a framework that can only assist those people who can be identified by their deadly virus symptoms, and we have examined the possibility of coronavirus infection using randomly selecting the inputs or likely symptom of a novel virus. This framework of fuzzy logic is the automatic system to identify the people infected or not from a deadly virus. In this paper, we have shown how to validate the identification of symptoms by applying the fuzzy rules and an effort to handle this pandemic situation in India.

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