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APPLICATION OF FUZZY LOGIC TECHNIQUES IN MEDICAL DIAGNOSIS

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Abstract- Recently, Fuzzy logic has been seen as a powerful tool to combat the new coronavirus (COVID-19). In 2019-2022, a new pandemic of coronavirus occurred with hundreds of research activities, mainly based on technology to curb the global Pandemic (COVID-19). Only 20 papers that dedicated on techniques of Fuzzy logic and linked to the human COVID-19 disease were analyzed and evaluated in this Literature Survey. Hence this paper presents the analysis of all the published papers in fuzzy logic of COVID-19. Overall, by highlighting study requirements, this Literature Survey offers an appropriate framework for future research in the area of COVID-19 diagnosis. This work suggested use FCM in order not to neglect any of the features and to deal with ambiguous cases, the FCM algorithm was used to classify cases that owns ambiguous symptoms. Experimental results showed that the accuracy we obtained by applying fuzzy to features ambiguous is (58%) This accuracy, although few, is considered good because it serves as an auxiliary algorithm for the system to deal with cases that the system could not classify.

Keywords: COVID-19, Fuzzy Logic, Fuzzy Methods, COVID-19 Diagnosis.

1. INTRODUCTION

In order to prevent the highly contagious SARS-CoV-2 virus from spreading, billions of people have been quarantined inside their homes. All scientists and researchers are working nonstop to find a treatment for this illness and protect the entire globe from it. However, if the epidemic had been expected explicitly then the epidemic may be confined until a new cure is found [1]. In order to demonstrate the relationship between reason and impact and to test facts of decisiveness with respect to infectious conditions, mathematical models are essential [2]. Precise and prompt diagnosis plays the main role in illness or condition determination. Therefore, treatment plan cannot be developed before a final diagnosis is established [1].

Diagnosis is regarded by health workers as a complicated and dynamic task because doctors have to weigh multiple variables and conditions concurrently as regards medical evidence [3]. Because of complexity of the dynamic diagnostic method, which consider as one of doctors' primary tasks, every health care provider is attempting to minimize diagnostic uncertainty by gathering clinical evidence to solve the concerns of the patient. In reality, diagnosis of diseases is a clinical technique in which useful knowledge is available to enhance the quality of healthcare [2]. The complexity of COVID-19 disease dynamics is investigated with computer-aided methods. Computational resources are important for grasp epidemiological trends in outbreak of disease. Studies have tried to describe the process of decision making in a medical setting by applying the binary or Boolean structure for processing the uncertainty of decision-making. Fuzzy logic is used as a technique of vigorous in medical practice for modeling uncertainty [4].

The field of medicine was one of the first fields of fuzzy theory. Fuzzy groups have an intermediary degree of membership from 1 to 0. Some of the status for use a medical of the fuzzy set theory are the INTERNIST, DOCTORMOON and MYCI applications. Consequently, with these methods of implementation, various kinds of research have been performed in the field of diagnosis of disease [5]. So, the main aim of the existing paper is to test the studies in which the techniques of fuzzy logic have been using in COVID-19 disease so to describe its methods and trends, during processes of the Literature Survey.

2. BACKGROUND

2.1. Process of Diagnosis and Fuzzy Nature for Disease

The word fuzzy refers to confused and ambiguous in this article. Since there is some degree of ambiguity and uncertainty in every aspect of life, with in-complete truth information no one can make decisions with confidence. In medicine, the essence of the illness is complex and is sometimes overlapping [6]. Many diseases are categorized in contemporary medicine as complex diseases due to a gathering of different parameters like as autoimmune and cancers diseases. This viewpoint is comparable to Zadeh's theoretical explanation of the terms "fuzzy health" and "fuzzy diseases." The author described the disease in terms of a person's state of health using a range of linguistic techniques. Zadeh changes the concept of illness even further by referring to it as "disease to a certain degree" in a hazy way. The concept is also seen as a first stage in disease diagnosis by the author [7].

2.2. Methods of Fuzzy for Diagnosis Disease

Techniques of Computational intelligence is vastly applied in many fields of medical. Importantly, in recent years, medical scholars have placed a strong stress on the main role of integrating computational techniques with medical diagnostics methods in order to improve accuracy and reduce diagnostic complexity. Because most diagnoses were usually centered on the potential of clinical outcome, the capacity of fuzzy logic to provide quantitative results and information in the shape of linguistic definition can be essential [8]. In conjunction with literary evidence, a fuzzy approach also provides the benefit of fuzzy theory, simulating human reasoning and judgments, which can apply medical theory based on evidence to enhance diagnosis. Due to the demonstrated efficacy of the application of fuzzy techniques to model ambiguity in medicine, it has been used in diagnosis processes with various uses according to disease type and researchers' goals [9].

2.3. Fuzzy Memberships and Theory of Fuzzy Set

The foundation of all fuzzy logic methods is known as the theory of fuzzy sets. In mathematics, fuzzy sets are applied to predefined sets of crisp values that are specified by the degree of membership. False and true are assigned scores of 0 and 1, respectively, in a collection. Using fuzzy environments, researchers can evaluate any unclear medical condition such as disease probability, disease severity, degree of symptoms and signs, and any incomplete or vague knowledge. Furthermore, decision-making can be simplified during the diagnose process, since this approach is efficient in deciding the existence of diseases with fuzzy sets [10].

We may therefore say that theory of fuzzy set can be a useful method for developing a computer diagnostic framework. Depend on sets of fuzzy, disease and health are not opposite and it have complementary relations, but they. Sanchez introduced one of the earliest methods of fuzzy membership. The author formulated 3 fuzzy sets including diagnosis as D sets, the symptoms as S sets, and patients as P sets to determine the process of diagnosis. Thus, clinicians develop a connection with the patient with the diagnosis of the disease according to symptoms set [9].

2.4. Fuzzy Logic in Decision-Making Processes

Typically, medical therapy and diagnosis are followed by decision-making reasoning. It is challenging to make accurate and timely decisions based on patient information and professional expertise when treating, managing, and identifying diseases. According to recent research, one of the first computerized systems created for medicine was the decision support system (DSS), which provides doctors with the best recommendations [11]. A more thorough mathematical model in the DSS framework can be built by using the use of fuzzy logic for models' diagnosis choice. Information building is an essential component of The Decision Support Systems and fuzzy logic can be a helpful instrument for coping with the issue of expertise illustration with imprecision and uncertainty [12]. In contrast to conventional methods, fuzzy logic may contain ambiguous information in the shape of a collection of ambiguous defined rules. Furthermore, the similarities between fuzzy logic and natural English will inspire how the health specialist makes the best decision. As a result, DSSs are referred to as user-friendly software [13].

3. RELATED WORKS

Anjir Ahmed Chowdhury, et al. (2020): Long-Term Memory (LSTM) and The ANFIS are used to anticipate the recently infected state of COVID-19 in Bangladesh in order to identify the best machine learning model to estimate on tiny data sets with better accuracy. It can be concluded that LSTM produced more satisfactory outcomes than both trials. The findings show that RMSE 6.55, MAPE 4.51 and Correlation Coefficient 0.75 are best used for the Bangladesh scenario model [12].

Boucenna Nassim, et al., (2020): The purpose of this study is to improve our knowledge of how COVID-19 spreads and who is affected. Additionally, all patient's immunological reactions are unique, making classical mathematical techniques very difficult analysis. As long as the various uncertainties remain, they recommend that the related factors be evaluated with the aid of fugitive logic. As this logic takes into account the uncertain and the imprecise, they consider that this application is sufficient in this field, taking 5 variables as inputs (comorbidity, age, confinement, availability and screening of control means) and an output variable representing the disease participation rate. Using MATLAB R2016a, the data processing mode achieves the highest possible accuracy [10].

Deepak Painuli, et al., (2020): A rule-based model has been proposed in this study under FIS, which was used for simulation with MATLAB software to predict whether one suffered from Covid19 or not. Initial predictions can be made using the recommended system, which can help save time and money. The World Health Organization's and other health organizations' guidelines are based on 15 established principles. This method makes use of 11 symptoms, including two that have only recently been noticed by some infected patients, age, gender, dry cough, respiratory problems, cold and flu symptoms, and medical background. Loss of hearing capacity, anosmia. This model's primary goal is to reduce exertion and encourage people to track their symptoms in order to learn more about the possibility of contracting COVID19 [13].

Nitesh Dhiman and M.K. Sharma (2020): They created FIS to analyze the COVID-19 using six input factors such as; Temperature of Atmospheric, Ethanol, Temperature of Body, Cough, Cold and Breath Shortness with one performance factor split into 3 linguistic classes, indicating the patient's severity level. For the factors included, they create membership functions. They suggest a body of FIS, which has been depend on rules of the inference. The findings show a weekly grew rate for COVID-19, a spread rates of COVID-19 in the nation of India, and COVID-19 spreads quickly in Italy in comparison to Iran and India, indicating that the more ethanol employment there is, the greater the spread rates, AT is medium, and a slightly higher BT will bring a normal level of severity, if the BT

is medium , AT is low, patient suffering from cough and the intake ethanol quantity then may observe the level of severity in the patient, if the patient has trouble with breathing, sneezing issues with low ethanol intakes, then the severity level would be marginally higher than other cases [14].

Mohd Salim Qureshi, et al., (2020): This paper preserving social distance from corona outbreak, using robots. The suggested control techniques are built on the basis of sliding mode management and fuzzy logic Control. The efficacy of recommended controllers has been verified in real time. (OP-4500). The results of the program and the OP-4500 (Digital Simulator) in continuous operation were compared to The Suggested Fuzzy Observed Adaptive Sliding It Management (FMASMC) and Fuzzy Basis Sliding Mode of Control (FBSMC) indicate the creation of a control rule for the traditional SMC. implementing a set of findings enhanced by rejecting disturbances and ensuring the device's performance within a specified operating band. The suggested method ensures a robust trajectory tracking and motion control. The technique of developed control has been applied to a humanoid robot during MATLAB and these results had been validated with the assist of Opal-RT simulator in real time (OP-4500), both simulation studies and real-time findings offer that robot enactment has been appropriate [15].

Fadoua Tamtam and Amina Tourabi (2020): In this research, a university medical facility in Morocco was assessed for agility throughout COVID-19, and an evaluating model was provided and assessed using fuzzy logic. The trial's outcomes demonstrated Heather's flexibility. The COVID-19 pandemic has demonstrated the influence of different enablers on hospital mobility. It also showed how some agile tools could be enhanced to increase the agility of healthcare organizations. They have been given access to a top-notch empirical report on the management of the COVID-19 problem by Moroccan healthcare organizations. It describes the adjustments that should be made to speed up the structure. Human resources and technology divisions in institutions have seen development. Despite the benefits of using this approach mentioned above, there are some limitations: the different agile drivers and capability which [16].

Sina F. Ardabili, et al., (2020): This paper compares soft computation and AI methods for forecasting COVID-19 outbreaks. Two machine learning algorithms stand out from the crowd. (ANFIS and Multi-Layered Perceptron (MLP)) showed promising findings and have proven to be useful in predicting the spread of the disease in the five countries. Through this study, they evaluated the possibility of machine learning for future research. The paper goes on to suggest that by combining SEIR models and machine learning, true novelty in outbreak forecast can be attained. Data has been gathered from 5 countries, including Germany, Italy, USA, China, and Iran on total cases over 30 days. The contribution of this paper has been explored the predicting the SARS outbreak using machine learning tools. One of the aims of this study was to model data of time-series depend on the model of logistic microbial growth. It is estimated that the parameters have been tested using evolutionary algorithms such as Grey Wolf Optimizer, Particle Swarm Optimizer, and the Genetic Algorithm (GA). Because of the absence of crucial data and high level of uncertainty, models of epidemiological are highly inaccurate for the long-term prediction. The models designed by ANFIS and MLP had shown to be highly suited to be used in longer-term predictions [17].

You Lei Fuab and Kuei-Chia Lianga (2020): This study introduced an innovative probability evaluation approach of the goods, and a study which provides more comprehensive information on product usage probabilities has been added. Twice the focus group was included: (the first use for developing and discussing a household epidemic questionnaire; researchers, educators and designers with build backgrounds were consisted to produce further definitions; the second use for enhancing the evaluation of Product Function (PF) probability of application in the metric of adaptability; experts from build and backgrounds of health care were consisted to gain broad and precise findings of valued probability. The more valuable PF is, the more likely it is to be prioritized for adoption of build functional cost savings, clustering, or simplification [18].

Velichka Traneva, et al., (2020): They use an intuitive fuzzy two-factor ANOVA and the concepts of index matrices and intuitionistic fuzzy sets. To determine the amount of COVID-19 status, data were gathered over a specific period of regular COVID-19 status up until 24 June. based on the criteria for the European continent's "climate zone" and "density." Certain details in the data source cannot be obvious, inaccurate, or absent. To cope with the input uncertainty, they employ fuzzy logic. They also provide a brand-new software tool that implements IMs to conduct 2-D IFANOVA. In the end, a comparison of the results from IFANOVA and ANOVA was discovered [19].

Mohammad Mahmoud, et al., (2020): In this study, fuzzy clustering was used to organize and evaluate Covid-19 distributions in the US, Italy, Germany, Iran, and France. The Covid-19-time series datasets from a few chosen countries were originally considered. Following that, the link between population increases and the spread of COVID-19 was examined using Pearson correlation. The findings of the Pearson correlation revealed a strong and favorable correlation amidst the overall number of confirmed cases, deaths, and population of the various nations. The clustering findings revealed that the spreading distribution in Italy and Spain was approximately distinct and similar to other countries. Each data point in soft clustering corresponds to every cluster, despite the fact that membership values vary [20].

Mohammad Asaduzzaman Chowdhury, et al. (2020): In this research, a ML was employed to assess COVID-19's ambient impacts. In order to predict how the COVID-19 epidemic will propagate, the connection between relative humidity, temperatures, and UV index has been examined. An adaptable reasoning model has been developed and is currently in use.

Temperature and relative humidity (RH) are found to have a greater impact on COVID-19 dissemination than UVI. The COVID-19 spread is reduced by a low RH and greater temperature. On the other hand, the ideal environment for the COVID-19 to propagate is one with a high RH and a lower temperature. This means that the distribution of COVID-19 due to weather conditions does not appear to be as predominated in those regions with a high temperature [21].

Patricia Melin, et al. (2020): In this paper, fuzzy response aggregation with a several ensemble models of neural network for the COVID-19-time series has been offered. NN provide information in a summary way for generate of several predictions under various conditions. Aggregating the responses of several predictors has been done through fuzzy logic. Intelligent system handles the uncertainty in making an ultimate prediction about the outcomes. The model had been validated for the Mexican COVID19 data set in the states as well as the entire nation. In the validation information collection, the projected values from all of the ensemble models of neural networks appear to be correct [22].

Andrio Adwibowo (2020): The goal of this research is to develop a fuzzy approach to evaluate the safety of dentistry therapy in a variety of circumstances and subject profiles. The fuzzy method allows for evaluation based on variables such as the patient's trip history, body temperature, cleansing frequency, and the rate of oral ventilation. Fuzzy control, fuzzification, and the defuzzification are merely a few of the phases involved in the development of a fuzzy system. The fuzzy algorithm can determine and evaluate the dental care risk based on the patient's dental health as well as the state of the hygiene conditions [23].

Mohammed Al Qaness, et al. (2020): offered the application of 2 optimization met heuristic methods to improve the accuracy of predictive for the suggested ANFIS that has been applied for forecasting and estimating the amount of confirmed COVID-19 statuses in the next ten days is determined by earlier confirmed statuses reported in China. The improved system comprised of ANFIS and two Meta heuristic algorithms, namely, algorithms of swarm and flower pollination. The improved algorithm of flower pollination had been utilized to train the ANFIS by improving its factors, in terms of the success measures listed below: The model's forecasts outperform other techniques when it comes to of accuracy [24].

Shahzaib Ashraf, et al. (2020): they trained fuzzy system to monitor COVID19 transmission and to prevent the spread of COVID19 has been very effective. Under spherical fuzzy data, a theory regarding smart decision-making algorithms' imprecise mathematical model was put forth. The generalized and newly developed methods for COVID19 that rely on complex proportional assessment (COPRAS) techniques and the method for choice ranking based on similarity to ideal answer (TOPSIS) under spherical fuzzy environments have both been improved in the proposed framework. The emergency scenario of COVID-19 has been used as an example to describe the validation of the suggested technique. This example also includes analysis, comparative analysis, and sensitivity, and it offers the validity and applicability of its results [25].

Warda M. Shaban, et al. (2020): A novel Hybrid Diagnose Strategy, was used in this research. HDS depend on a novel method for projecting specific traits into a recommended patient area. A properly constructed feature connectedness graph shows the significance of each character as well as its level of connection to other features. The ordered traits were used to create a classification system that could categorize new individuals and determine if they were infected. The classification system, which is a hybrid model, combines a fuzzy logic engine and a network of deep neural networks. According to the results, the proposed HDS beats its competitors in terms of accuracy (97.658%), precision (96.756%), recall (96.55%), and dependability (96.55%) [26].

Mesut Togacar, et al. (2020): In this research, COVID-19 is located using a deep learning approach, a form of machine learning. They classified their data into three groups: normal X-ray pictures, pneumonia, and coronavirus. Structured images were layered with the original images in this research after The Fuzzy Color processing method was used to arrange the data groups. In this manner, social mimic optimization with feature sets had been used to train stacked deep models and handle their feature data. Then, Support Vector Machines were used to classify and merge effective features. The suggested method yielded an overall classification rate of 99.27%, indicating that this model can accurately identify COVID-19 disease [27].

Ana Paula Silva Artur, et al. (2020): For this project, the modeling was carried out with 2 input variables, each of which offered 3 pertinence functions, and 1 output variable, which also offered 3 pertinence functions and 9 regulations. What would happen if a vulnerable group was exposed without any means of defense or isolation was described and graphically portrayed. The simulation is a very helpful technique because it is possible to generate global information during the simulation, providing a critical viewpoint on different circumstances without requiring a significant quantity of effort to obtain responses [28].

4. BIOMEDICAL ENGINEERING APPLICATIONS FOR COVID-19 DIAGNOSTIC

Artificial intelligence, a branch of computer science. the application of AI in the medical engineering area enhances processes and boosts productivity for better patient care and improved healthcare. The use of artificial intelligence in the medical field enhances the efficacy of diagnosis and treatment. The healthcare environment is significantly impacted by bioengineering (BE) technologies. This has continually increased; especially as medical practice has incorporated more technology. he battles against COVID-19 has made a number of bioengineering experts' contributions and persistent efforts to support our healthcare systems more visible. Their creativity and intelligence are laying the groundwork for eradicating this infection [29].

4.1. Comparison between Application of Fuzzy Logic for COVID-19

The major aim related works was to choose, examine and diagnosis the distribution of the different studies, which linked to the employment of the fuzzy logic methods for COVID-19 disease to enhance diagnosis. This improvement may be attributable to fuzzy logic's ability to distinguish between partial truths between true and untrue, which is crucial in the diagnosis process. This section discusses the key results of related works. In this paper, we were capable of identifying and reviewing 20 articles that using various techniques of fuzzy logic in diagnosing COVID-19 disease in 2020. Table 1 shows the comparison between the 20 articles. The selected survey discussions offered in this section that covering those studies that have been published in different type of journals and conferences.

4.2. Techniques of Fuzzy that were more Dominant in Data Analysis of COVID-19

The selected articles there are different fuzzy techniques. On the basis of this studied field, the fuzzy techniques are typically classified in three main classes; the rule based fuzzy logic, FIS and ANFIS. The FIS used in 25% and the ANFIS technique used as shown in 15% of candidate papers while the fuzzy logic used in 30% of candidate papers. While the other techniques used in 5% as shown. As shown in the percentage of the studied papers, fuzzy approaches can be said to be an effective way for ambiguous disease modeling conditions such as the diagnosis of COVID-19.

4.3. Programming Language that was more Dominant

In this review, we analyzed some fuzzy logical techniques depend on the COVID-19-diagnostic. According to studies on the implementation and creation of fuzzy logic systems, researchers appear to require tools or software that can employ fuzzy set theory in order to implement and create such systems. As a consequence of the widespread use of fuzzy systems in recent decades, a wide range of software is now accessible to apply various fuzzy logic implementation techniques. Our primary emphasis in this query is on applied tools in order to identify the most common tools used by fuzzy researchers for study in connection with COVID-19 diagnostics. The frequency with which tools used to model fuzzy logic in earlier works. The findings show that software of MATLAB is the most beneficial method used in the re-viewed papers. However, the methods used were not listed in 45 percent of studies. In contrast, 40% of the papers in their research used MATLAB. One of the most popular software programs for computer engineering is MATLAB, and 5% of projects also used C++ which is given with frequency 7.14%, and Python, which is offered with frequency 5%, are other programming languages that have been employed in fuzzy logic-related papers for identifying COVID-19.

Table 1. Comparison of works Fuzzy Logic for COVID-19

References	Method	Application	Data Sources of COVID-19
Anjir Ahmed, et al. (2020) [12]	ANFIS and LSTM	Predicting the COVID-19 cases	Statistical report of Bangladesh
Boucenna Nassim, et al. (2020) [10]	Fuzzy inference algorithm	Predict the degree of certainty of the COVID-19 infringement	World Health Organization
Deepak Painuli, et al. (2020) [13]	Fuzzy inference algorithm	Predictions of suffering from Covid-19 or not	World Health Organization
Nitesh Dhiman, M.K. Sharma (2020) [14]	Fuzzy inference algorithm	Diagnose the COVID-19 disease	Patients from many countries
MohdSalim Qureshi, et al. (2020) [15]	FLC with SMC	Control methods for specific hospital robots were developed and applied to fight the COVID-19 pandemic	People suffering from COVID-19
Fadoua Tamtam, Amina Tourabi (2020) [16]	Fuzzy logic approach	In the aftermath of COVID-19, I assessed the organizational agility of a state hospital in Morocco	Moroccan healthcare organization
Sina F. Ardabili, et al. (2020) [17]	GA, PSO, GWO, MLP and ANFIS	Estimate the COVID-19 spread	Many countries over 30 days.
You-Lei Fua'b, et al. (2020) [18]	Fuzzy logic programming	COVID-19 anti-epidemic normalization	Not Mentioned
Velichka Traneva, et al. (2020) [19]	ANOVA with intuitionistic hazy two factors (2-D IFANOVA)	Investigate COVID-19 instances in Europe based on density and climate zone	Daily COVID-19 instances until June 24, 2020
Mohammad RezaMahmoudi, et al. (2020) [20]	Fuzzy clustering technique and Pearson correlation	Compare the Covid-19 diffusion rate in high-risk nations.	Patients from many countries
Mohammad Asaduzzaman, et al. (2020) [21]	Fuzzy logic model	Examine the effectiveness of different environmental factors in the spread of COVID	World Health Organization
Patricia Melin, et al (2020) [22]	Model of a neural network with fuzzy logic	Predicting COVID-19 Time Series	Mexico and the total data of the country
Andrio, (2020) [23]	Fuzzy logic rules	Assess the safety of dental care	Patients in dental care
Mohammed Al Qaness, et al. (2020) [24]	ANFIS using FPA by using SSA	Forecast confirmed instances for the next ten days	World Health Organization
Shahzaib Ashraf, et al. (2020) [25]	Intelligent logical ambiguous	Control and diagnosis of COVID-19	World Health Organization
Warda M. Shaban, et al. (2020) [26]	HDS consist of fuzzy inference engine and DNN	Diagnose COVID-19 cases	Scientific Institute for Research, Hospitalization and Healthcare
M. Togacar et al. (2020) [27]	DNN, Fuzzy technique and SVM	COVID-19 identification, Social Mimic Optimization,	GitHub and Kaggle websites
A. Paula Silva Artur, et al. (2020) [28]	Fuzzy logic modeling	Analysis of the pandemic COVID-19	Brazilian Ministry of Health

5. SUGGESTED ALGORITHM TO COVID-19 DIAGNOSIS

The aim of this work is to Suggested a predictive technique for rapid COVID-19 detection using Fuzzy C-Means algorithm to deal with ambiguous symptoms is employed. applied to the on a large dataset Containing more than 5 thousand statuses for training and testing purpose. finally, the real cases and prediction cases are compared based on some predefined metric. The proposed technique consists of 9 steps as shown in the Algorithm 1.

Algorithm 1. Suggested algorithm to COVID-19 diagnosis

Inputs: Patient's symptoms
Outputs: Diagnosis
Step 1: Data Collection and Understanding
Step 2: Data Preparation and Pre-processing using outlier detection algorithm
Step 4: Diagnose the patient using Fuzzy C- Means to deal with ambiguous symptoms
Step 8: technique evaluation using Performance Metrics such as confusion matrix (Accuracy, precision, recall)

Figure 1 shows in the flow diagram of the fuzzy C-Means algorithm. The original centroid selection procedure included clustering, which helped reduce the distance between the different clusters in the dataset. The representations were improved through the computation of the dataset in respect to the object and the cluster. The systems utilized to measure the distance between items in the method include the city block distance, the cosine distance, and the correlation distance. By choosing a primary centroid at a grouping of datasets on distinct datasets that are to be enumerated, expected distances functions are calculated.

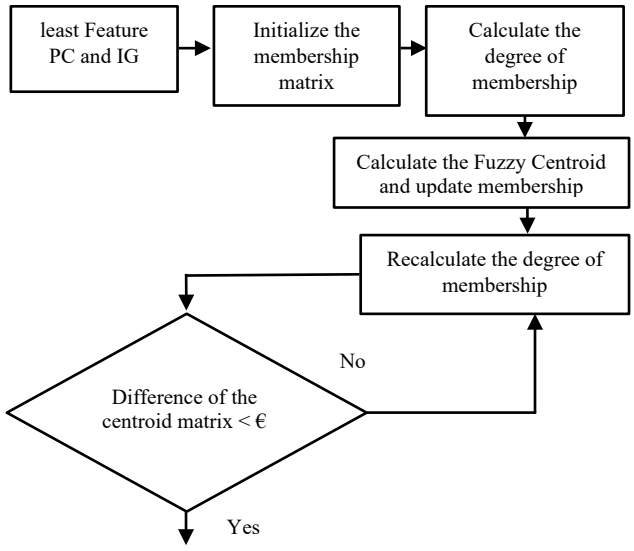

Figure 1. Fuzzy C-Means for prediction COVID-19

5.1. Data Collection and Understanding

In order to construct the proposed system, the database that was collected through the questionnaire is called, which contains more than 3000 cases of corona disease, and each case consists of 22 features. They are the main symptoms for this disease as it was described by the doctors of the specialty such as governorate, age, sex, and other individual traits temperature, cough, headache, smell sense, taste sense, etc. In order to forecast whether the patient status (the target (class) would be favorable or unfavorable, these features are used.

5.2. Data Preparation and Pre-processing.

The first phase of the proposed ALGORITHM is the processing, which is an important phase to prepare data and the Discovery abnormal data which can affect negatively to the accuracy of the system. This is done Through the process of data mining and the detection of anomalies, using algorithm of the (Outlier), which divides each class (column) into four layers, where the second and third layers are taken as good cases. The first and last layers are considered abnormal cases and are neglect it.

5.3. Diagnose the Patient is Case Studies Using Fuzzy C-Means

The FCM, shown in algorithm 2, is employed in the suggested system to cope with ambiguous symptoms by calculating the distance between the original centroid selection process. The parameter utilized in the centroid computation between the clusters will depend on the number of groups (K) and centroids used to compute the distance in this situation. Given that the intensities of the cluster dataset, which are used in the fuzzy c-means algorithm's clustering, are highly sensitive to the start centroid's closet, and that the creation of relationships between the clusters has generated the distance through the initialization and the redefined dataset between the surface distances.

Algorithms 2. Fuzzy C-Means Clustering Multivariate Gaussian

```
Input: dataset, MAX_ITER
Output: best feature selects
Step 1: initial parameters
      K= Count of Clusters
      MAX_ITER = 100
      N= Count of data points [number row in dataset]
      Get Class labels from dataset
Step 2: Membership Matrix
        Membership Mat = []
        For each i in Number of data points do
        Random list for each Clusters
        Summation of Random list
        Temp list=[]
         For each x in Random list do
            Temp list=x/ Summation
         End for
         Find index max in Temp list call flag
         For each j in length (Temp list) do
            If j = flag, then
               Temp list[j]=1            Else
               Temp list[j]=0
            Endif
         End do
       Append [Temp list] to Membership of the Mat.
      End for
Step 3: curr =0
       do while curr <= MAX_ITER
 Cluster Centers = Calculate Cluster Center (Membership of the Mat)
          The membership =update Membership Value
  Cluster of the Labels = get Clusters (Membership of the Mat)
          Curr = Curr+1      end while
Step 4: Find Accuracy (Cluster Labels, Class labels)
Step 5: End
```

6. IMPLEMENTATION CASE STUDIES USING FUZZY C-MEANS

In the Figure 1, ambiguous cases are dealt with, where we enter the features that contain the least Information Gain and Pearson Correlation, and then the membership matrix is initialized by calculating the values (x, y) for each attribute, and then we select one of these features as the centroid of the cluster Then we repeat the calculation of the value of (x, y) based on the value of the centroid. When we reach a difference between the centroid of the new matrix and the centroid of the previous matrix that is smaller than the Euclidean distance, we will have reached the final cluster. These steps are illustrated in the algorithm 2. In most cases, we make use of the fuzzy-means algorithm, which enables and selects the initial centroids in a random fashion. Therefore, it created the problem of improper centroid selection, which can lead to improper efficacy. When we are building a cluster because the accuracy and quality of the cluster are heavily dependent on the initial centroid, and choosing those centroid results in an increase in the amount of computational time that is required as shows in table 3. Each data point was placed in the group that was the most appropriate. As a result, we implement the fuzzy c-means algorithm in order to perform an improved calculation of distance in the shortest amount of time.

Table 3. Cluster to Selected Feature Using FCM

Name Feature to fuzzy-means	No. Feature to fuzzy-means
19,20,21,22,23,24	6
0,2,4,6,7,8,10,11,12,14,15,16,18,19,20,21,22,23,24	19
1,3,5,9,13,17,19,20,21,22	12
0,8,12,19,20,21,22,23,24	9
1,2,3,5,9,12,14,17,18,19,20	15

In order to test the effectiveness of the proposed system on ambiguous features, we apply Fuzzy C-Means algorithm. Figure 2 shows the obtained clusters by applying Fuzzy C-Means algorithm, which is multivariate Gaussian and regression vectors. The values shown on the left of the screen are just the location of each feature in its cluster. Which was calculated according to the algorithm 2.

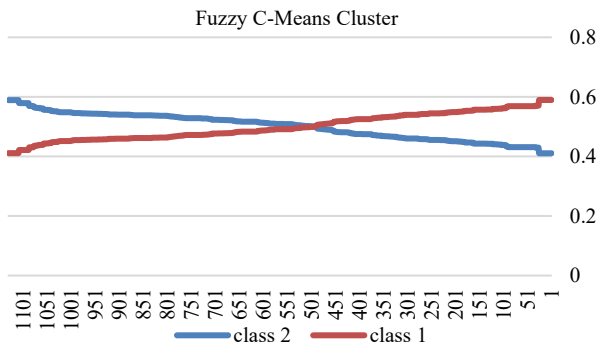

Figure 2. Fuzzy C-Means Cluster

7. ANALYSIS AND RESULT

The experimental results showed for both accuracy, error and chi-Square are (58%), (42%) and (11%) that we obtained from the applying of Fuzzy C-Means, and although the accuracy is not high, but it remains the best result that we obtained instead of neglecting these features. as shows in table 2. One of the key considerations we made when developing the suggested system was not to overlook any features, even after choosing the best features and separating the ambiguous features from them. These cases weren't addressed in earlier works, so we used the fuzzy c-mains algorithm to handle them. The ambiguous cases were taken into account when calculating the final results, which accounts for the slight difference in the results obtained compared to earlier works.

Table 2. Accuracy of Fuzzy C-Means

Performance Manse Measure	Value
Accuracy	0.58
Error	0.41
Pearson	0.10
Ch-Square	11.64
Kappa Stderr	0.00

8. SURVEY THIS WORK WITH OTHER PREVIOUS RESEARCH

One of the key considerations we made when developing the suggested system was not to overlook any features, even after choosing the best features and separating the ambiguous features from them. These cases weren't addressed in earlier works, so we used the fuzzy c-mains algorithm to handle them. The ambiguous cases were taken into account when calculating the final results, which accounts for the slight difference in the results obtained compared to earlier works. table 4 shows Survey of this work with other previous researches.

Table 4. Shows Survey of this work with other previous researches

References	Method	Accuracy
Deepak PainuliRule, et al.	Rule based Fuzzy inference System	*ACC*=83.7%
Nitesh Dhiman, et al.	Fuzzy Interface System based on Gaussian Membership Function	*ACC*=62%
Velichka Traneva, et al.	intuitionistic fuzzy sets (IFSs) and index matrices (IMs),	No accuracy
Mohammad Reza, et al.	Fuzzy Clustering to compare the spread rate of Covid-19 in the high risks countries	No accuracy
This study	Fuzzy C- Means	*ACC*=58.7%

9. CONCLUSIONS

Previous research on the implementation of fuzzy methods in the COVID-19 illness categorization was the topic of this effort. This study's main objective was to conduct a thorough meta-analysis to evaluate the prevalence and impact of fuzzy techniques on enhanced detection and reduced misdiagnosis errors. From 2019 and 2022, only 20 works were published, and they are being examined. Several systems make extensive use of fuzzy logic techniques such as fuzzy logic-based rules, fuzzy FIS, and ANFIS. Another important result of this research is that academics use MATLAB to apply fuzzy techniques

in this situation, making it a helpful instrument for building fuzzy systems. There is additional need to suggest more frameworks on the fuzzy logic techniques for COVID -19 disease prediction and detection. Finally, it occurs that the difficulty of having the research data, which are suitable for implementing of fuzzy logic is one of the explanations for the limited number of important publications on COVID-19 diseases.

This work suggested use FCM in order not to neglect any of the features and to deal with ambiguous cases, the FCM algorithm was used to classify cases that owns ambiguous symptoms. Experimental results showed that the accuracy we obtained by applying fuzzy to features ambiguous is (58%) This accuracy, although few, is considered good because it serves as an auxiliary algorithm for the system to deal with cases that the system could not classify.

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