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Sepsis Detection in newborn infants - Diagnosis using fuzzy inference system- A Review

M.S. Kalas[1*], Nikita D. Deshpande[2]

[1,2]Dept. of Computer Science and Engg, KIT'S College of Engineering (Autonomous), Kolhapur, Maharashtra, India

[*]*Corresponding Author: kalas.mamta@kitcoek.in*

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Abstract—The detection of a health problem, illness, disability, or other condition that an individual may have is known as disease diagnosis. Large data sets are available; however, the tools that can accurately evaluate trends and make predictions arelimited. Traditional methods of diagnosing diseases are considered to be not effective in getting accuracy and prone to error. Artificial Intelligence (AI) is being used to forecast the future. AI with predictive techniques enables to provide auto diagnosis and reduces detection errors compared to exclusive human expertise. In this paper we have taken review of sepsis detection in newborn infants using techniques of AI, like Fuzzy Logic and identified limitations of these studies.
The aim of this research paper is to reveal some key insights into medical techniques. Based on a series of open problems and challenges, the paper also suggests some directions for potential research on AI-based diagnostics systems.

Keywords—Disease, diagnosis, Sepsis Detection, Fuzzy logic.

I. INTRODUCTION

A number of fundamental questions regarding AI-driven health approaches have been raised, including whether the tools, processes, and safeguards traditionally used to make ethical and evidence-based decisions about emerging technologies can be extended to AI. Diagnoses, patient morbidity or mortality risk assessment, disease outbreak detection and monitoring, and health policy and planning are four areas of AI-driven health initiatives that are applicable to global health researchers. In hospitals, sepsis is a leading cause of death. Early detection and diagnosis of sepsis, which is important for reducing mortality, is difficult since many of its signs and symptoms are close to those of other, less serious illnesses [8].

Tool for Fuzzy Systems FST is a powerful method for dealing with imprecision and ambiguity, and it can also be used to deal with the principle of partial true and partial false values, with the goal of tractability, robustness, and low cost solutions for real-world problems. The advantages of using fuzzy set theory include the associated characteristics and the ability to deal with linguistic terminology, which explains its widespread use in medicine and other fields.

FST provides a systematic calculus for dealing with linguistically encoded knowledge, and it performs numeric computations using linguistic labels defined by membership functions it was only recently integrated into the epidemiology and public health section for the purpose of resolving health issues.

In this paper, Section I contains the introduction of Fuzzy System, Need of FST, Section II contain the related work of Sepsis detection using different Fuzzy models like prediction model, expert system and, fuzzy logic control, Section III contain the limitations of these models in neonatal mortality analysis. Section IV explains the methodology with flow chart, Section V describes discussion on future trends/future scope, and Section VI concludes research work.

II. RELATED WORK

In this section we discuss current applied AI techniques which are used for disease diagnostic process, relevant survey on diagnostic process and contribution in regards to the existing work.

SEPSIS is a life-threatening condition that occurs due to your body's response to infection, which causes inflammation that result in multiple organ failures at the same time.

Shelley M. Lawrence performed a systematic review to investigate the current trends in sepsis detection in hospitals. Finally, they discovered that biomarkers and electronic health records can have a significant impact on sepsis prediction.

According to [1],LirLuiz Fernando Costa Nascimento, Paloma Rizol and Luciana Abiuz worked on "**Establishing the risk of neonatal mortality using a fuzzy predictive model**". A fuzzy linguistic model was proposed in this study to assess the risk of neonatal death based on birth weight, gestational age, Apgar score, and previous reports of stillbirth. The computational predictive model by using fuzzy logic that includes 4 main components was developed.

In [2], A.M. Reis, N.R.S. Ortega and P.S.P. Silveira, proposed work on "**Fuzzy expert system in the prediction of neonatal resuscitation**".

The basis of this study is the early identification of risky clinical conditions as a way to anticipate the necessity of skilled personnel for patient care.

The study focused onto the use of an expert system to help decision making in perinatal care in places where highly skilled specialists and sophisticated equipment are not available.

The system can be used even with a cheap outdated 486-processor personal computer or with a portable hand-held notebook.

In contrast to Bayesian systems, the fuzzy expert system described in this can deal with any number of variables without loss of performance.

As stated by Pornchai Chanyagorn and Phattaradanai Kiratiwudhikul, they worked on "**Automatic Control of Fraction of Inspired Oxygen in Neonatal Oxygen Therapy using Fuzzy Logic Control**". According to the authors, study presents a system that can determine an FiO2 value suitable to the current SpO2 and that automatically adjusts FiO2 with an error clearance of +/- 0.25%[3].

III. LIMITATIONS OBSERVED IN THE STUDY

[1], aimed to build a computational predictive model by using fuzzy logic but an epidemiological study about neonatal mortality is still pending.

The number of fuzzy rules grows exponentially and this can impair the model's performance.
The inclusion of new variables does not guarantee the improvement and robustness of the model.

As far Limitations observed in [2], there is no similar previously published study, a fact that prevents comparison of the present findings to those obtained with other approaches. Also there is no the use of weighted risk factors to predict neonatal resuscitation was investigated.

In the analysis of the efficacy of the system in identifying the need for resuscitation in the cases studied, the researchers considered the less than ideal sensitivity of 76.5% to be a possible reflex of the known unpredictability of some cases of perinatal asphyxia and a good challenge for future improvement of our model.

In addition, eighteen of the factors studied were not tested by experimental analysis, for which testing in a multicenter study or over a very long period of time in a prospective study would be probably needed.

Other Similar studies are required to consider this model a prominent/promising one.

Limitations in [3], the fuzzy control algorithm and the rule-based control algorithm appropriately responded to changes in SpO2 but the results from fuzzy control seemed to producea lower FiO2 response time than rule-based control.

Even though a system with fuzzy control might have reduced the risk of ROP, it might introduce the risk of hypoxia instead, because convergence time in some cases of the experiment seemed to be too long.

To speed up convergence time for the FiO2 percentage, a hybrid control of a rule-based algorithm and a fuzzy logic control algorithm had to be studied further.

IV. METHODOLOGY

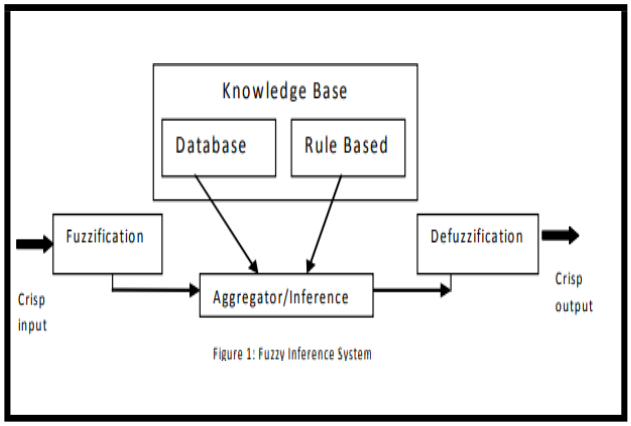

Figure 1: Proposed System of Fuzzy Interference System

Generally, the Fuzzy logic process to disease diagnosis as described in Fig 1 is made by the following steps [8]

Fuzzifier: The Fuzzification process is done by a Fuzzifier. It is a process of changing a crisp input value to the fuzzy set. Hence Fuzzifier is used as a mapping from observing input to
fuzzy value.

Inference engine: After completing the fuzzification process, fuzzy value processed by the inference engineusing a set of rules act as a collection of rules to the knowledge base.

Knowledgebase: This is the main component of the fuzzy logic system. The overall fuzzy system depends on the knowledge base. Basically, it consists of rules, structured andunstructured data also named the database.

Defuzzifier: The process of converting the output from the inference engine into crisp logic. Fuzzy value is an input to the defuzzification that maps fuzzy value to crisp value.

Fuzzy Logic is taken into account among the techniques for AI, where intelligent behavior is achieved by creating fuzzy classes of some parameters. The rules and criteria are understandable by humans. These rules and the fuzzy classes are denied by a domain expert mostly. Therefore, a

great deal of human intervention is required in fuzzy logic. The actual processing of data basically provides a presentation of the information in fuzzy logic. One of such representations can be done using machine learning in the medical _eld even in a much better way than fuzzy logic. The statistical model used for estimation is not capable to produce good performanceresults. Statistical models fail to detect missing values, large data values and hold categorical data [46]. All the above-mentioned reasons can be achieved through machine learning (ML). ML plays an essential role in numerous pplications such as natural language processing, information mining, image detection, and disease detection. In all the above-mentioned domains, ML providesappropriate solutions as per the problem. Thus, ML also facilitates advanced diagnosis systems and treatment options in healthcare[7].

V. CONCLUSION AND FUTURE SCOPE

We have done survey on Sepsis detection and we had reviewed different research papers and identified limitations from the research studies. To overcome the gap we prposed Fuzzy interference System.

There are, however, some noticeable limitations we suspectin the FIS, they include:
a. The use of descriptive knowledge may not be as effective as physical appearance of the patients

b. The output of the FIS is restricted by the number of membership functions and rules of the knowledge base in theInference Engine [7].

c. Worst of all is our inability to include other causative factors of neonatal sepsis.

In our study, we discovered that the specification of an appropriate membership function and the identification of a suitable universe of discourse aid in the construction of Fuzzy Set.

And most cases the specification of an appropriate membership function is more or less subjective. In the nearest future, we intend to apply the combination of neural network and Fuzzy Logic for learning and adaptation.

The sensitivity of the knowledge-based FIS will be looked into by means of adding more rules to the Fuzzy Inference Engine.

Fuzzy algorithms are potential to provide a significant contribution to medical diagnostic systems but they must address some major issues as follows:-

EXPLAINABLE DIAGNOSIS

AI models are often criticized because of its internal unclear decision-making process. In this regard, explainable AI dealswith the implementation of clarity and reasoning of the behaviors of statistical black-box AI learning methods. AI systems should come with causal models of the world supporting explanation and understanding. This is even more important when we seek.

QUALITY OF TRAINING

The performances of machine learning and deep learning algorithms largely depend on the availability of high-quality training models to achieve the required diagnostic capability. Moreover, the problem of data scarcity is very central since data are at the key OF AI-based medical applications.

There exist some efforts to create additional annotated information by utilizing alternative methods, such as information augmentation and picture synthesis. However, it is not fully clear whether they are suitable for AI-based medical diagnostics [7].

CLINICAL TRANSLATION

The development in AI research used in medical diagnostics is indeed rapid, and their possible adoption has been shown by systems including the detection of various brain recognition, and diagnosing diseases in retinal pictures.

As a result, physicians struggle to interpret these models, andfeel it is hard to trust them. Therefore, reliable and trustworthy communications between medical experts and AI model experts is also highly important to transform the AI- based diagnostic potentials into clinical practice [7]

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AUTHORS PROFILE

Dr.Mamata S. Kalas, have been graduate from University Of Mysore, in 1993, From B.I.E.T, Davangere, started her professional career there itself. In 1995, came to kolhapur, after her marriage and since then she has worked as lecturer at D.Y.Patil's college of Engg., Bharati Vidyapeeth's College Of Engg., Kolhapur. She did M.Tech(CST) Graduate and her dissertation work is based on image segmentation using parametric distributional clustering. She has been awarded with M.TECH (CST) from Shivaji University, Kolhapur of Maharashtra in June 2009. She is awarded Ph. D in computer science and Engineering at Walchand College of Engineering, Reseach center, Shivaji University, under the guidance of Dr.B.F.Momin. She is currently working as Professor and Head,Dept of CSE at KIT'S College of Engg, Kolhapur. She is in her credit, 24 Years of teaching experience. Ten Papers presented for international conferences, three papers presented for national conferences, seven papers published in international journals. Her areas of interest are pattern recognition and artificial intelligence, computer architecture, system programming.

Nikita D. Deshpande, have been graduate from D. Y. Patil College of Engineering and Technology,Kolhapur, in 2015. Currently, she is a Research Scholar and pursuing Mtech in Computer Science, with specialization in Data Science at KIT'S College of Engg, Kolhapur. Her areas of interest are Data mining, system programming.

