Original Article

Internet of Medical Thing and FIS Evaluation for Selecting and Delivering the best Health Insurance Coverage

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Doi: 10.47750/pnr.2022.13.S08.422

Abstract

Smart city living and luxury lifestyles will undoubtedly look better in the future. However, there is a significant need to provide appropriate fitness-care services because the world's population is becoming more and more urban-centric. With the help of modern technologies, the need-gap could potentially be widened. According to the current study, providing medical care remotely could be a positive development. Continuous monitoring of numerous health markers is required for no-hit identification of health concerns. Devices that monitor your health are power-constrained and have limited communication capabilities. This study uses the Internet of Mechanical Things (IoMT) and the Fuzzy Inference System (FIS) to determine the optimum human insurance plan. The IoMT devices are outfitted with regulating microchips that have the ability to demand thoughtful decisions by processing the supplied data. As a result of the transmission of unnecessary information being omitted, the present study projects the employment of assisted data collection and observant themes in health insurance services. In the current study, FIS with IoMT offers low risk and high benefit health plans to humans. It may also be utilised in the future to predict other health risks, such as actual and intellectual illness situations.

Keywords: Fuzzy Inference System, MATMAB2014a, Smart health plan, Fitness-care, IoMT

1. INTRODUCTION

Nowadays, the best health insurance plan plays an important role in developing a good health care system. The E-Health system is based on android-based applications in which patients can check and find their blood pressure, sugar level, and pulse rate by themselves and save their data on a cell phone for use in comparison in the future [1]. Europe is far ahead of the rest of the world in terms of policy development and execution [2]. It is set to make our surroundings smarter through the use of cutting-edge technology that is environmentally friendly. The Internet of Things is the most likely to seek intelligent systems in the Smart Metro area. Smart cities must have a policy for ensuring smart and efficient healthcare services to their residents, given the growing population [3-6], using a variety of mobile devices to help health professionals' transition from a PC at their desk to a mobile device at their bedside. These systems (CodeBlue, MobiHealth) have developed intelligent healthcare systems [7-8]. Sensor data of various forms is needed by health-care applications. The authors suggested that data must be collected carefully and in a reasonable timeframe [9, 10]. Developed and investigated the technique that transmits the sensor's electronic signal to the cloud service [11].

Intelligent systems based on fuzzy logic may be used to make fast and effective diagnoses of hazardous diseases, which provide value to the health sector that supports medical practitioners in diagnosing and determining the severity of illnesses [12].

Fuzzy logic is essential in several scientific disciplines that utilise it to reflect human reasoning capabilities, particularly in medical science [13–15]. Because of the unclear and imprecise nature of the problem, many aspects are involved in the decision-making process of a medical diagnosis, making the expert's task tough. The illness diagnostic procedure is difficult and ambiguous since one symptom can lead to a variety of diseases, and one disease might have several symptoms [16]. Fuzzy logic assists in the determination of a definitive answer to complex clinical emergencies [17].

Fuzzy logic facilitates the assessment of a valid explanation for challenging medical cases [18]. Intelligent systems based on fuzzy logic may be used to make fast and effective detection of severe illness, which provides value to the healthcare industry and assists medical professionals in diagnosing and preventing illness by reducing the severity of illnesses [19]. For unskilled doctors, fuzzy logic methods employed in the medical field provide a proficient way to diagnose illness more expeditiously, which facilitates the quick, inexpensive, and hazard-free detection of infectious

ailments [20]. This is a commendable technology that utilises imprecise reasoning to provide a consistent, precise, and accurate outcome, which aids clinicians in illness diagnosis mechanisms [21]. The increasing complexity of surgical treatments has boosted demand for fuzzy logic technologies, which provide the ability to approximate reasoning. A fuzzy assessment may emulate human decision-making [22]. By minimising imprecision, ambiguity, and missing input information, fuzzy rule-based systems using a typical mathematical technique give a definitive result [23]. Many authors have also used the different type of mathematical modelling to solve real life problems [24-40]. FIS has been used to diagnose different types of critical medical dieses [41-43].

Artificial intelligence can be used to develop and implement technologies that mimic not just rational thinking and activity but also general intelligence [44]. The concept that the human mind can be monitored by reverse engineering was created. Several concerns related to evolutionary theory surfaced, which developed according to evolutionary theory [45].

This article examined the different implications of fuzzy network topologies for identifying and providing the best health insurance plan in the field of medicine, with an emphasis on the many strategies with fuzzy logic techniques to improve pattern recognition efficiency, also applied to the IoT (Internet of Things) [46]. The establishment of a high-performance fuzzy system in which a number of issues occur, including the search for membership functions and relevant rules, is a challenging task.

2. DATA AND METHODOLOGY

The current part addresses the procedure to identify the best health insurance plan by the Internet of Medical Thinks (IoMT) and providing the input parameters such as age, pulse rate, oxygen, respiration rate, and blood pressure to FES. The framework of the FES (Fig.1) has been described in this section.

2.1 Fuzzy Expert System

When a framework's complexity exceeds a certain threshold, it becomes irrational or computationally impractical to make precise judgments about it. This FIS then comes into play. [47] The fundamental building block of Fuzzy Set (FS) theory and fuzzy logic was created by Zadeh in 1965 and is called a FES. FES is a method that assigns measured values as the output factors after interpreting crisp values as the input factor and adopting a few FS rules. This technique, which is based on the mapping process, uses fuzzy logic to map an input to an output. A fuzzy rule is defined to establish the rule outcomes from the information provided as rule input. Fuzzy rules convey human expert knowledge in linguistic terms, whereas membership functions reflect expert assessment of those factors. The suggested method made use of the IF-THEN association FS rule while considering variables including age, blood pressure, pulse rate, oxygen saturation, and respiration rate. The working process of the FES has been shown in Fig.1

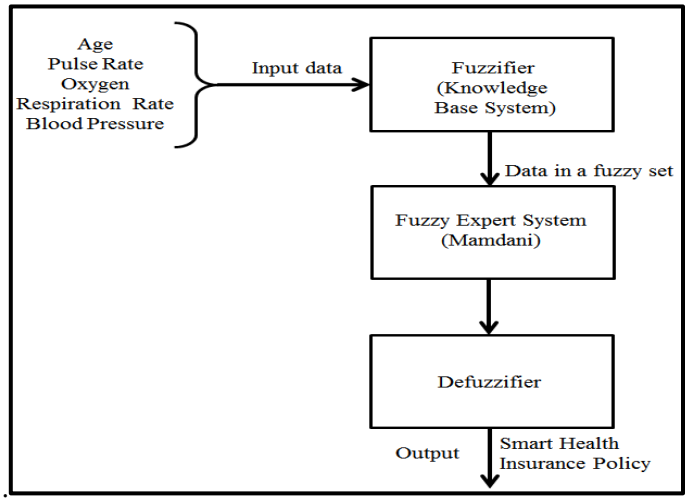

Fig.1: Framework of FES

This system is based on three steps. First, the input (age, pulse, blood oxygen, blood pressure and respiration rate) is given in the crisp form in the knowledge base system, i.e., the Fuzzifier. The second one is the fuzzy expert system. The Mamdani technique has been used in this study. The last one is the Defuzzification. Here the output is generated in the form of the crisp value.

Step-I: A scope of genuine qualities that we get from sensors frames the fresh arrangement of crisp qualities. That means x belongs to X (where X is the universal set, i.e., the set of all the values of the sensor). Presently utilizing an information base given by a specific work force, the creation of the membership function has been done in this process. The Fuzzifier changes crude, fresh information over to fuzzy semantic factors. The characterised semantic factors as factors whose qualities are not numbers, yet the written statements here are artificial or natural [48].

Step-II: FIS is designed in a system that can deduce these fuzzy inputs from previous advances using the IF premise, THEN ensuing rule base counselling, and producing fuzzy parameters. The reason is made up of fuzzy input parameters that are linked by consistent capacities (such as OR and AND), and the result is made up of fuzzy result variables.

STEP-III: The Defuzzifire transformed the fuzzy results into crisp qualities. These fresh qualities can be utilised to produce wanted occasions and activities. In this study, the Defuzzification was done by using the centroid method.

$x^* = \frac{\int \mu_A(x) * x dx}{\int \mu_A(x) dx}$, where the membership function is defined by μ_A.

2.2. Internet of Medical Things (IoMT)

IoMT is defined as having characters and virtual characters working in clever spaces, utilising astute interfaces to associate and communicate in social, natural, and client settings [49] (Gubbi et al. 2013). At present work, the main aim of IoMT is to speak with one another, enter data over the Internet, and communicate with clients, making shrewd, inescapable, and consistently associated conditions. The sensors can be continuously monitored by machines around the world to create an immense amount of significant data that would require years to accomplish. In the healthcare framework, use of IoMT is featured in this section.

2.2.1 IoMT for health care

It has been empowered by IoMT, far off wellbeing observing framework enjoys tremendous upper hands over customary health checking system. Patients can now wear health condition detecting devices continuously for checking because they have gotten so much smaller and more adaptable. A patient's IoMT-enabled health monitoring device could be thought of as a virtual patient in the digital realm. The virtual patient shares the same physiological conditions as the actual patient. Only a few times per day can a patient be examined by a certain dieses specialist, but critical health condition patient can happen all of a sudden. So, every minute in a day checking of health condition is essential. The medical issue of a patient can be observed uninterruptedly by IoMT, because Patients can now be reached via the Internet and by various machines thanks to IoT. It has made it possible to identify a basic ailment at the ideal time so that the proper adjustments can be done.

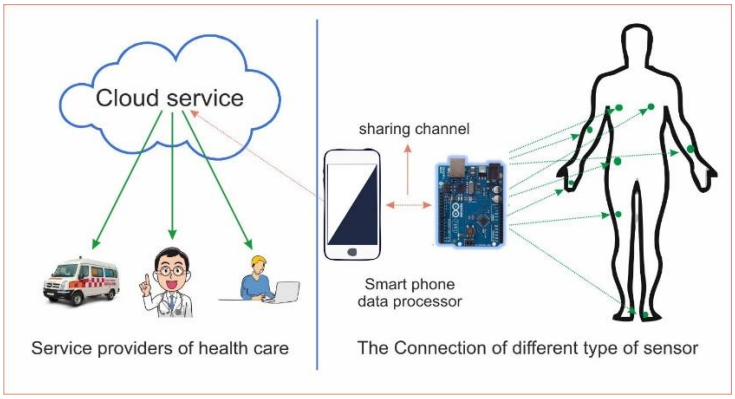

Fig. 2: The Framework of the System

Likewise, IoMT can assist with gathering wellbeing records and creating factual data connected with an ailment. When IoMT is used, a faster, more comprehensive, and error-free collection of information is possible, something that human techniques can never accomplish.

Here, a fitness-checking framework dependent on IoMT is depicted. In the present study, a sensor-cloud classification [50] is also used and a portion of the difficulties are talked about with a specific spotlight on a medical services application. This structure establishes the framework of the IoMT-empowered medical care checking framework. The working system framework has been shown in Fig. 2. The framework comprises of two sections: nearby and distant. The isolated portion enables putting away and dispersing the information to remote assistance searchers similar to crisis specialist organizations, specialists, and protection suppliers.

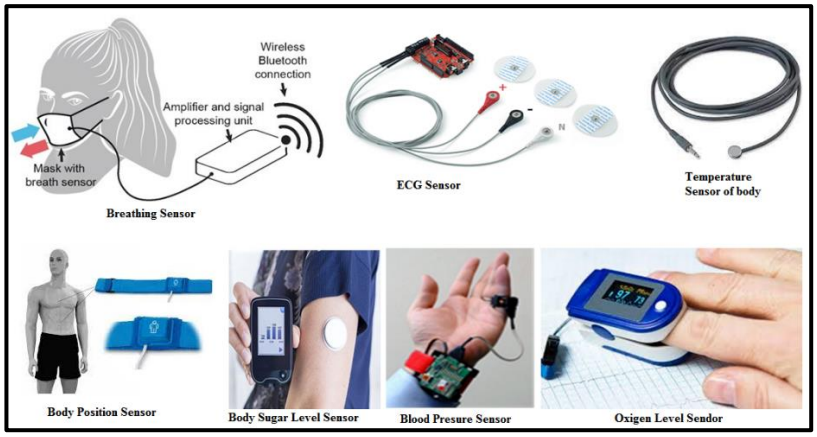

Fig. 3: Sensors for health monitoring

The nearby part manages an assortment of data after the devices associated with a sufferer. The Arduino-based information gatherer (Arduino is an open-source gadget prototyping stage) [51] remains utilized to gather the receiver prior toward shipping off the information handling component. It also processes the gathered crude information toward creating significant data that can be perceived by subject matter experts and specialists. Then, at that point, it shows the handled data then conducts the situation near the far-off servers. The above medical maintenance examination framework contains a few sensors associated with an individual. The sensors that have been utilized vogueish the medical maintenance frameworks are: breathing device, ECG device, body temperature sensor, body position sensor, blood sugar level sensor, Oxygen level sensor, and blood pressure sensor (Fig.3). All things considered, a lot of sensors may incorporate this distant checking framework, whenever suggested through specific specialists. These large numbers of sensors are associated with an information aggregator gadget. Then, at that point, the information is transferred to the cloud through multi-bounce remote correspondence from the information aggregator. This information might be gotten to and imagined via parental figures. In addition, the information might be utilized to distinguish abnormalities and create alarms.

2.3 Medical Sensors: Data Collection

Medical service applications need to get various sorts of sensor information. The information should be gathered in an exact and convenient manner [52]. When wellbeing sensor-information is sent to the information complex hub, it is sent over a joint correspondence network. In addition, once the information from different devices is sent in the direction of the aggregator hub, additional detecting information might be collected along the course. Hence, an immense amount of traffic might be produced during information assortment. Dealing with this type of lot of information while guaranteeing zero resistance to information misfortune has testing. Inadequate care may result in unequal and wasteful energy distribution, a clogged network, and thus a degraded organization's performance.

By and large, the information is sent or gathered through different jumps, either in a solicitation-answers way or in ceaseless streams. Besides, it has likewise been seen in [50] that parcel discontinuities play a significant part in the by and large execution of a directing plan. The gigantic measure of sensor information might prompt troubled payload, which brings about bundle fractures and, because of parcel discontinuity, the inactivity for information assortment turns out to be lengthier.

To handle the above issues, an occasion-driven information assortment conspiracy is proposed and talked about in the accompanying area.

Approach of occasion-driven

In our methodology, consistent information assortments from all the sensors are not needed. All things considered; information is accumulated in the event of specific occasions. The information aggregator gadget chooses which sensor information is needed to be sent in the event of the occasion. Typically, in an event recognition system, sensor hubs gather nearby information and send it to the combination community. Then, at that point, the combination focuses and settles on the choice. In our methodology, all things being equal, of conveying combination focuses, the occasion identification and choice components are completed by the sensor hubs. Occasions are characterised as some of the boundary limit upsides. Assume that three sensor boundaries A, B, and C are defined for a medical care framework HC, which is defined as H_C = A, B, and C.

Assuming that the upsides of the boundaries rely upon one another and A1, B1, and C1 are the edge upsides of A; B, and C separately, then, the information gathering capacity can be characterized as:

$$f(H_C) = \begin{cases} f(A_1)\ if\ A < A_1 \\ f(A_1, B_1)\ if\ A \geq A_1\ and\ B < B_1 \\ f(A_1, B_1, C_1)\ in\ other\ condition \end{cases}$$

This occasion-driven information social event will without a doubt limit the utilization of correspondence assets and lessen overhead to an enormous degree. Yet, wellbeing information should not be put on the edge due to their temperament. It will figure out the wellbeing information in the event that we notice the condition of the specific boundaries. The Fuzzy expert system has been used for participation classifications of various boundaries to follow and choose the idea of the occasions as depicted in section 2.1.

Our proposed wellbeing observing framework contains numerous sensors, which measure a few actual features of the human body. The identification is made by concentrating on a few boundaries of a body of a human recognized equally manifestations besides a few indications are checked in a steady progression prior to acquiring an end with regards to a specific infection. This fuzzy helped conspire employments these standards of determination and adheres to the means of analysis to make a choice in regards to which sensor is needed to be initiated furthermore when it is needed to be enacted.
The framework actuates a couple of sensors that record some essential boundaries within the human body. The fresh qualities got based on the sensors changed to fuzzy sets like 'normal', 'above normal, 'low', and so on, utilizing a predefined information base (rules characterized by particular specialists). These fuzzy factors developed the contribution towards the dynamic platform which distinguishes the genuine state such as a weakened heart, shockwave, respiratory difficulty, and indicated by these results, activities furthermore occasions like cautioning specialists and additionally actuating more sensors for additional observing the patient are begun.

3. RESULTS AND DISCUSSION:

In the present study, the e-Health sensor kit [51] has been used for collecting the IoET data. There are a few sensors associated with the body of the patients utilizing remote associations or wired. Health observing gadget which is available together with the medical records a few considerations of health monitoring through the situation devices besides cycles them. The gadget relates the information vile besides the standard base current inside it near recognize the strange states of the patient. Assuming a few strange conditions are distinguished than the gadget alarms specialists who are somewhat found and crisis benefits with the goal that legitimate moves can be made and the patient can be treated on schedule.

At first, information from every one of the sensors is recovered and the information aggregator concludes which specific information ought to be sent relying on the state of the patient. All information is taken care of the Fuzzifier. Fuzzifier is utilized to recognize whether the boundaries are typical, small, or extraordinary (fuzzy sets) based on approximately predefined enrollment capacities. A short time later, the fuzzy induction framework processes these fuzzy sets dependent on the contribution from the standard motor. The checking the condition of the patient used GSR (sensor which measures perspiring) and temperature are assisting in deciding the initially condition of the patient such as whether the patient is experiencing a shockwave. Assuming shock remains distinguished, information since respiration sensor and heart rate monitor are examined to recognize the particular reason for the amazement. This device information is utilized towards analyze extra with regards to the reason for the emergency. The result since the fuzzy framework stays utilized towards distinguish in the event that the heart condition is awful, basic, or ordinary. Contingent upon these fuzzy results, the activities and alarms like beginning the ECG, cautioning heart experts and so on are produced.

The fuzzy helped method might be utilized in a comprehensive zone of wellbeing presentations. By way of an experiment, we must attempted towards carry out fuzzy helped recognition of a heart condition in a step wise way, similarly as it is analyzed in reality. The input parameters of the fuzzy expert system have been shown in Fig. 4. In the present study five input parameters have been used. Serious heart conditions like myocardial localized necrosis, ischemic illness of heart (the heartrate range of diagnosis are 80-125 and more than 125, 60-79 and 21-59 for Tachycardia, Normal and Bradycardia respectively, according to the medical survey) and so on have the side effects like perspiring, low fringe internal heat level, tachycardia (high pulse), and ordinary breath rate, and so on. The range of the patient age, blood oxygen, respiration rate and blood pressure for setting up the rules of the knowledge base have shown in the Fig. 4. For the identifying the real time status of a patient may be investigated.

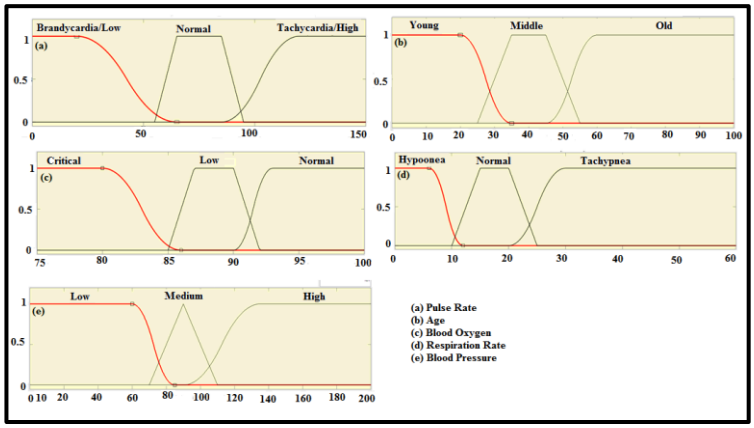

Fig.4: Input parameters in FES (a) Pulse rate, (b) Age, (c) Blood Oxygen (d) Respiration Rate and (e) Blood Pressure

In this study the young has been considered till 25 years, and middle age of the patients have been considered 35-45 and more than 60 years patents have considered old as shown in Fig. 4b. The oxygen level considered as normal if it is more than 92%, blood oxygen level assumed low if lies between 85% to 91%, if the blood oxygen level less than 84% than in the present study assumed as in critical condition (Fig. 4c), as observed by blood oxygen sensor. The respiration rate range has shown in the Fig. 4d, if the breath is 15 to 22 unit in a minute than it is consider as normal, low (hypopnea in medical term) is consider when breath rate is less than 15 per minute and tachypnea consider if breath is more than 22 in a minute. The range of the blood pressure have shown in the Fig. 4e used as input in current FES.

The output for the smart health insurance policy based on the above input parameter collet form the e-heath smart medical device shown in the Fig. 5, after generating the fuzzy rules by using fuzzy rule viewer (Fig. 6). The output is shown that ordinary health monitoring is appropriate or its requirement of the alert generation.

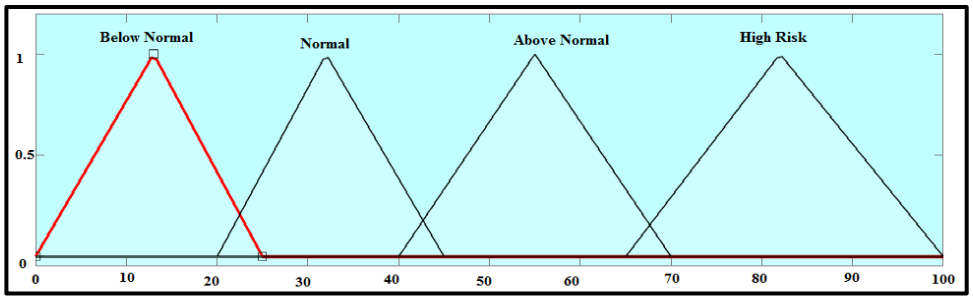

Fig.5: The smart health insurance policy provider by applying IoMT in FES

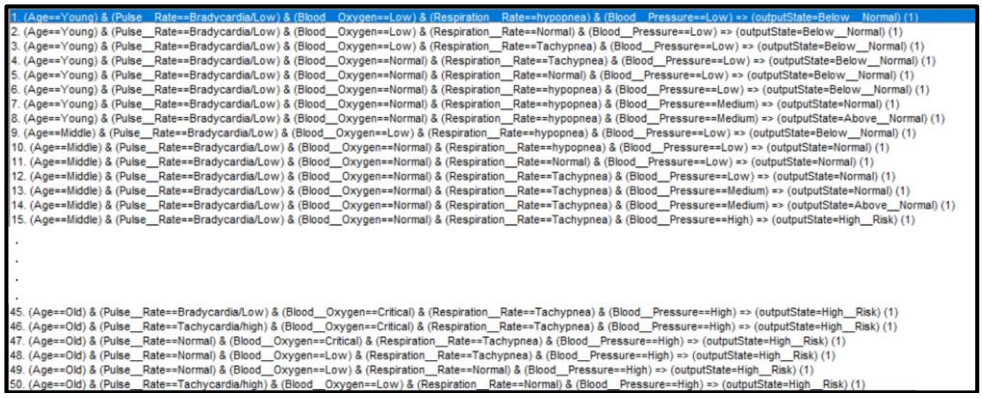

Fig.6: Fuzzy Rule Viewer

In the present study total 50 rules have been generated by using the five input parameters created from IoMT. This capacity decides if an alarm will be created or typical checking is adequate. Suman et al. 2014 [38] have studied the fuzzy modeling with the artificial neural networking with other parameters as compared to present study. This study has compared the results with previous work [38].

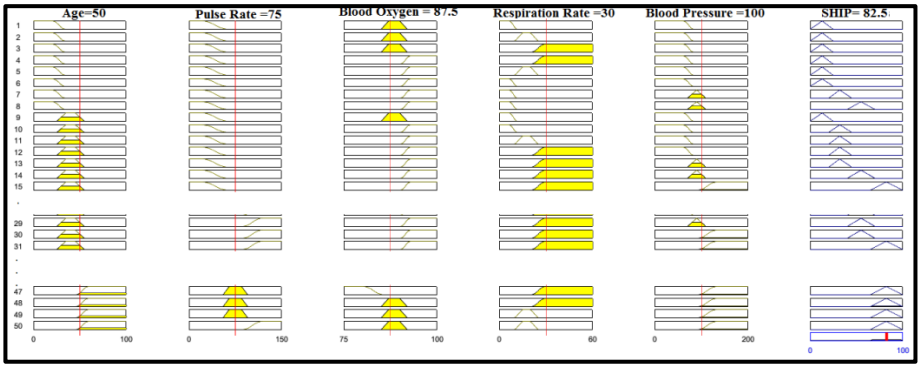

Fig: 7 FIS Rule viewer at the age of 50 years.

A bunch of test rules is introduced in Fig. 7. At the age 50, the principles have been comprised, At the point when pulse rate sensor peruses a moderate (75), and blood oxygen sensor understands low (patient is perspiring), respiration rate is 30 and blood pressure sensor showing the low blood pressure (100), it is shown that the patient is in shock. As one of the side effects of coronary episode may seriously shock of the patient, our framework enacts the pulse screen when the over two circumstances are valid. When astonishment is followed by tachycardia (excessive pulse), the ECG remains started, and specialists are alerted by the framework that envisages a crisis situation and the patient needs to go to hospital. If patient do not have the health insurance, then patient may also suffer with economic problem as well as illness. It has also seen in Fig. 7 that if any patient may suffer form same condition by using IoMT, then Smart Health Insurance Purchase (SHIP) chance is 82.5 %.

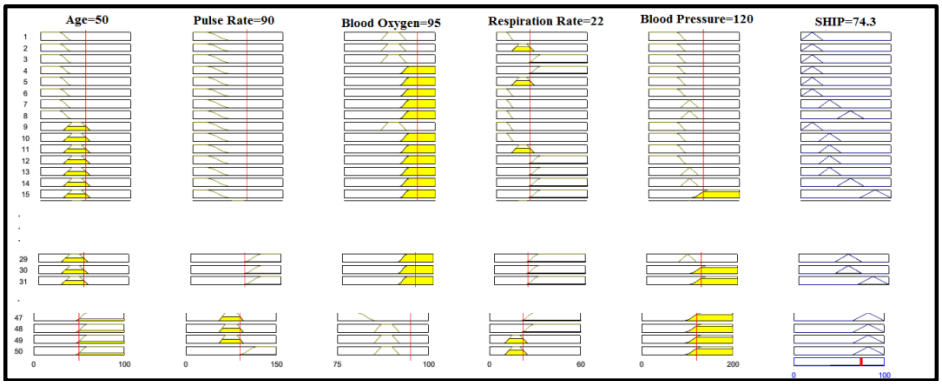

Fig: 8 FIS Rule viewer at the age of 50 years with different condition.

The other rule has a distinct at the same age of 50 as shown in Fig. 8. When the pulse rate is high, blood oxygen is 95, respiration rate is 22, and blood pressure is 120, the output shows a 74.30% chance of SHIP. Once temperature is recognized, the framework actuates the blood oxygen device and the respiratory device. Extraordinary breath rate and low blood oxygen might remain the justification behind the pneumonia observed by IoMT. Consequently, specialists besides crisis administrations exist cautioned and legitimate moves remain initiated via our methodology.

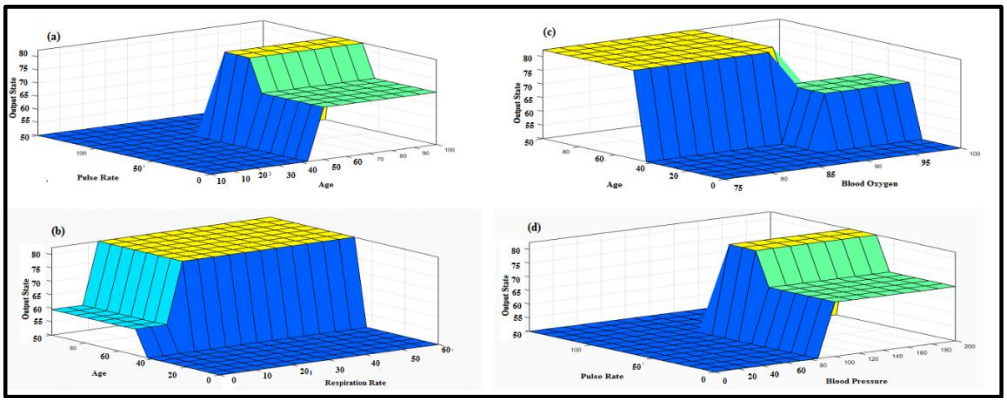

Fig. 9: 3D representation of risk factor (a) Age vs Pulse rate, (b) Age vs Blood Oxygen (c) Age vs respiration rate and (d) Pulse rate vs blood pressure

It is also observed that if age is more than 40 years old, the chance to purchase health insurance is more than 75% (Fig. 9a). The risk factor for health is always high if the blood oxygen level may be normal at age more than 50 years (Fig. 9b) and SHIP is near 80%. If the respiration rate is normal at the age of 60 (Fig. 9c), SHIP will range from 60% to 80%

depending on the illness. If the BP is more than 100 and the pulse rate more than 80, at that condition, SHIP is approximately 75% (Fig. 9d).

The present paper introduced the plan of remote health observing framework that spotlights on utilizing fuzzy principles to recognize strange states the patient and makes accurate action of cautioning specialists besides fitness specialist if there should be an occurrence of emergency.

4. CONCLUSION

Utilizing FIS, discovery of simple physical stages of a human frame can be identified without any problem. Performing this recognition in a bit of a way as analyzed by specialists appears to be encouraging, as superfluous information assortment might be stayed away from, saving important energy in the versatile checking gadget. However, planning any fuzzy put together rationale depends generally with respect to the information base, and the presentation of the accuracy of the information base is necessary for the overall structure. Along these lines, planning a fuzzy-based wellbeing checking framework requires the weighty contribution of particular specialists and clinical scientists who can give an exact and consummate information base. This framework has been exposed. How beginning with a few devices and by the utilization of an information base, the basic functional state of a human figure could be identified. Now, the investigation is focused on the methods that are expected to be used to recognize the state of the heart. This study advocates that more examination work, testing, and checking should be done in this field, so more physiological circumstances can be identified and the framework can be embraced in a genuine circumstance.

REFERENCES

1. Iuliana Chiuchisan, Hariton-Nicolae Costin2 and Oana Geman, "Adopting the Internet of Things Technologies in Health Care Systems", 2014 International Conference and Exposition on Electrical and Power Engineering (EPE 2014).
2. A. Caragliu, D. B. Chiara, P. Nijkamp, "Smart cities in Europe", Journal of urban technology Vol. 18, no. 2, 2011, pp.: 65-82.
3. TU Report on Internet of Things Executive Summary: www.itu.int/internetof things/
4. R. G. Hollands, "Will the real smart city please stand up? Intelligent, progressive or entrepreneurial?", City, Vol. 12, no. 3, 2008, pp: 303-320.
5. Pollard, J.K., S. Rohman, S., Fry, M., 2001. A web-based mobile medical monitoring system. International Workshop on Intelligent Data Acquisition on Advanced Computing Systems. Technology and Applications, IEEE Press
6. Kjeldskov, J., Skov, M.B., 2001. Supporting work activities in healthcare by mobile electronic patient records. Lectue Notes in Computer Science, 191-200.
7. Almudevar, A., Leibovici, A. & Horwitz, C. 2005. Electronic motion monitoring in the assesment of non-cognitive symptoms of dementia. International Psychogeriatrics. Cambridge University press. 40 West 20th st, New York, NY 10011-4211 USA, 190-191.
8. Jones, V., Gay, V. & Leijdekkers, P. 2010. Fourth International Conference on Body sensor networks for mobile health monitoring: Experience in europe and australia. Digital Society, . ICDS'10.,. IEEE, 204-209.
9. Tonny Heng Yew Ling, Lim Jin Wong, Jocelyn Ee Hung Tan, and Chong Kee Lee, "XBee Wireless Blood Pressure Monitoring System with Microsoft Visual Studio Computer Interfacing", 2015 IEEE 6th International Conference on Intelligent Systems, Modelling and Simulation.
10. J. Yick, B. Mukherjee, and D. Ghosal. "Wireless Sensor Networksurvey", Computer networks Vol. 52, No. 12, 2008, pp: 2292-2330.
11. Junaid Mohammed, Abhinav Thakral, Adrian Filip Ocneanu, Colin Jones, Chung-Horng Lung and Andy Adler, "Internet of Things: Remote Patient Monitoring Using Web Services and Cloud Computing", 2014 IEEE International Conference on Internet of Things (iThings 2014), Green Computing and Communications (GreenCom 2014), and Cyber-Physical-Social Computing (CPSCom 2014)
12. Djam, X. Y., Wajiga, G. M., Kimbi, Y. H., Blamah, N. V., "A fuzzy expert system for the management of Malaria," Int. J. Pure Appl. Sci. Technol, vol. 5(2), pp. 84-108, 2011.
13. Elhefny, M. A., Elmogy. M., Elfetouh, A. A., Badria, F. A., "A fuzzy ontology-based representation for obesity related cancer knowledge," International Journal of Intelligent Computing and Information Science, vol. 16(3), pp. 15-36, 2016.
14. Jankowska, D., Milewska A. J., Gorska U., "Applications of logic in medicine, Studies in Logic," Grammer and Rhetoric, vol. 21(34), pp. 7-24, 2010.
15. Ahmadi, H., Gholamzadeh, M., Shahmoradi, L., Nilashi, M., Rashvand, P., "Diseases diagnosis using fuzzy logic methods: A systematic and meta-analysis review," Computer Methods and Programs in Biomedicine, vol. 161, pp. 145-172, 2018.
16. Sattar, R. R. M.,, Chellappan, K., Omar, N., Megat, N., Amilia, A., "Finger photoplethysmograph as a monitoring device for LIPID profile in men with cardiovascular risk," Journal of Theoretical and Applied Information Technology, vol. 95(6), pp. 1225-1235, 2017.
17. Ahmed M. Nassef, Hegazy Rezk, Mohammad Ali Abdelkareem, A. Alaswad, A. Olabi, "Application of fuzzy modelling and particle swarm optimization to enhance lipid extraction from microalgae," Sustainable Energy Technologies and Assessments, vol. 35, pp. 73-79, 2019.
18. Ahmed M. Nassef, Hegazy Rezk, Mohammad Ali Abdelkareem, A. Alaswad, A. Olabi, "Application of fuzzy modelling and particle swarm optimization to enhance lipid extraction from microalgae," Sustainable Energy Technologies and Assessments, vol. 35, pp. 73-79, 2019.
19. Djam, X. Y., Wajiga, G. M., Kimbi, Y. H., Blamah, N. V., "A fuzzy expert system for the management of Malaria," Int. J. Pure Appl. Sci. Technol, vol. 5(2), pp. 84-108, 2011.
20. Jimmy Singla, "Comparative Study of Mamdani-Type and SugenoType Fuzzy Inference Systems for Diagnosis of Diabetes," 215 Authorized licensed use limited to: CALIFORNIA INSTITUTE OF TECHNOLOGY. Downloaded on November 02, 2020 at 12:42:53 UTC from IEEE Xplore. Restrictions apply. International Conference on Advances in Computer Engineering and Applications (ICACEA), Ghaziabad, India, 517-522, 2015
21. Ambilwade, R. P., Manza, R. R., Ravinder Kaur, "Prediction of diabetes mellitus and its complications using fuzzy inference system," International Journal of Emerging Technology and Advanced Engineering, vol. 6(7), pp. 80-86, 2016
22. Abdullah, A. A., Fadil, N. S., Khairunizam, W., "Development of fuzzy expert system for diagnosis of diabetes", International Conference on Computational Approach in Smart Systems Design and Applications (ICASSDA), Kuching, Malaysia, October 2018.
23. Hasan, M. A., Sher-e-Alam K. H., Chowdhury, A. R., "Human disease diagnosis using a fuzzy expert system." Journal of Computing, vol. 2(6), pp. 66-70, 2010.
24. Kalra, G., Kishor, K., Kumar, A., Rajoria, Y. K., Yadav, A., and Boadh, R. (2022a). FIS-Based Prediction and Estimation of Health Insurance for Workers in the Manufacturing Sector, Journal of Pharmaceutical Negative Results. Vol. 13 (S8), pp. 2236-2245. DOI: 10.47750/pnr.2022.13.S08.331
25. Bhagat, R. K., Yadav, A., Rajoria, Y. K., Raj, S. and Boadh, (2022). Study of Fuzzy and Artificial Neural Network (ANN) Based Techniques to Diagnose Heart Disease, Journal of Pharmaceutical Negative Results. Vol. 13 (S5), pp. 1023-1029. Doi: 10.47750/pnr.2022.13. S05.161.
26. Poswal, P., Chauhan, A., Aarya, D. D., Boadh, R., Rajoria, Y. K. and Gaiola, S. U. (2022a). Optimal Strategy for Remanufacturing System of Sustainable Products with Trade credit under Uncertain Scenario, Materials Today: Proceedings. https://doi.org/10.1016/j.matpr.2022.08.303.
27. Boadh, R., Yadav, S. N., Tiwari, A., Rajoria, Y. K. and Singh, J. (2022a). Application of fuzzy inference system (FIS) for assessment and predication of compressive asset of concrete containing fly ash, Materials Today: Proceedings. https://doi.org/10.1016/j.matpr.2022.08.160.

28. Poswal P, Chauhan A, Boadh R and Rajoria Y.K (2022b). A review on fuzzy economic order quantity model under shortage, AIP Proceeding, 2481, 040023(1-13) 10.1063/5.0103757.
29. Karla, G., Boadh, R., Rajoria, Y. K. and Rajendra, P. (2022b). Prediction and Analysis of Health Risk by using Fuzzy Control System, International Journal of Health Sciences (IJHS). Vol. 6(S2), pp. 7511–7524. https://doi.org/10.53730/ijhs.v6nS2.6808.
30. Poswal, P., Chauhan, A., Rajoria, Y. K., Boadh, R. and Singh, A. P. (2022c). An economic ordering policy to control deteriorating medicinal products of uncertain demand with trade credit for healthcare industries, International Journal of Health Sciences (IJHS). Vol. 6(S2), pp. 9392–9414. https://doi.org/10.53730/ijhs.v6nS2.7460.
31. Poswal, P., Chauhan, A., Rajoria, Y. K., Boadh, R. and Goel, A. (2022d). Fuzzy optimization model of two parameter weibull deteriorating rate with quadratic demand and variable holding cost under allowable shortages, Yugoslav Journal of Operations Research, Vol.32 (4).
32. Boadh, R. Aarya, D. D., Dahiya, M., Rathee, S., Kumar, A., Jain, S., Rajoria, Y. R., and Rani, S. (2022b). Study and prediction of prostate cancer using fuzzy inference system, Materials Today: Proceedings, vol. 56 (1), pp 157-164. doi:https://doi.org/10.1016/j.matpr.2022.01.040.
33. Boadh, R. Grover, R., Dahiya, M., Kumar, A., Rathee, R., Rajoria, Y. R., Rawat, M., and Rani, S. (2022c) Study of fuzzy expert system for the diagnosis of various types of cancer, Materials Today: Proceedings, vol. 56 (1), pp 298-307. doi: https://doi.org/10.1016/j.matpr.2022.01.161
34. Boadh, R., Chaudhary, K., Dahiya, M., Dogra, N., Rathee, S., Kumar, A., Rajoria, Y. K. (2022d). Analysis and investigation of fuzzy expert system for predicting the child anaemia, Materials Today: Proceedings, vol. 56 (1), pp 231-236. doi:https://doi.org/10.1016/j.matpr.2022.01.094.
35. Karla, G., Rajoria, Y. K.. Boadh, R., Rajendra, P., Khatak, N., and Kumar, A. (2022c). Study of fuzzy expert systems towards prediction and detection of fraud case in health care insurance, Materials Today: Proceedings, vol. 56 (1), pp 477-480. doi: https://doi.org/10.1016/j.matpr.2022.02.157.
36. Poswal, P., Chouhan, A., Boadh, R., Rajoria, Y. K., Kumar, A. and Khatak, N. (2022e). Investigation and analysis of fuzzy EOQ model for price sensitive and stock dependent demand under shortages, Materials Today: Proceedings, vol. 56 (1), pp 542-548 doi:https://doi.org/10.1016/j.matpr.2022.02.273.
37. Neelofar, Rajoria, Y. K., Alsaraireh, I. and Boadh, R. (2022). The Initial Investigation of Mathematical Anxiety & Phobia: It's Solution in Middle School Students, Journal of Positive School Psychology. 2022, Vol. 6(6), pp. 8323-8328.
38. Aarya, D. D., Prakash, S., Boadh, R., Chauhan, A., and Rajoria, Y. K. (2022). The Implementation of the Pentagonal Fuzzy Number toward the Solution of the Fuzzy Inventory Model with Ramp Demand Function and Three Parameters Weibull Deterioration, Neuroquantology, Vol. 20 (17), pp. 117-126. Doi: 10.14704/Nq.2022.20.17.Nq88017.
39. Mangla S., Sharma, S., Boadh, R. and Rajoria, Y. K. (2022). A Mathematical Model of the Impact of Deforestation on the Growth of Forest Resources, Neuroquantology, Vol. 20 (17), pp. 223-226. Doi: 10.14704/Nq.2022.20.17.Nq88030.
40. Rajoria, Y. K., Saini, S., & Singh, S. R. (2015). EOQ Model For Decaying Items With Power Demand, Partial Backlogging and Inflation. International Journal of Applied Engineering Research, 10(9), 22861-22873.
41. O'Regan JK, Noë A. A sensorimotor account of vision and visual consciousness. Behav Brain Sci. 2001;24:939–973. [PubMed] [Google Scholar]
42. Matthen M, Stephens C. Philosophy of biology. Amsterdam: Elsevier; 2007. [Google Scholar].
43. Mardiana M. N., Wan, H. H., "Current research on Internet of Things (IoT) security: A survey" Computer Networks, Vol. 148, pp. 283-294, 2019
44. Zadeh, LA., Fuzzy sets. Information and control, 8, (1965), 338–353. https://doi.org/10.1016/S0019-9958(65)90241-X.
45. Zadeh, L.A.'Outline of a new approach to the analysis of complex systems and decision processes," IEEE Transactions on Systems, Man, and Cybernetics, 1973, pp. 28-44.
46. J. Yick, B. Mukherjee, and D. Ghosal. "Wireless Sensor Network survey", Computer networks Vol. 52, No. 12, 2008, pp: 2292-2330.
47. N. Mukherjee, S. S. Bhunia, P. S. Sen, "A Sensor-Cloud Framework for Provisioning Remote Health-Care Services", Computing & Networking for Internet of Things (ComNet-IoT) workshop co-located with 15th International Conference on Distributed Computing and Networking (ICDCN), January 2014.
48. Arduino website : http://arduino.cc/en/
49. J. Gubbi et al, "Internet of Things (IoT): A vision, architectural elements, and future directions", Future Generation Computer Systems Vol. 29, No.7, 2013, pp. 1645-1660.
50. S. S. Bhunia, D. Sikder, S. Roy, N. Mukherjee. 'A Comparative Study on Routing schemes of IP based Wireless Sensor Network', 9th IEEE International Conference on Wireless and Optical Communications Networks (WOCN), 2012.
51. E-health sensor kit: https://www.libelium.com/libeliumworld/success-stories/e-health-low-cost-sensors-for-early-detection-of-childhood-disease-inspire-project-hope/#
52. S.B. Suman, D. K. Sourav, M. Nandini, 2014, iHealth: A Fuzzy approach for provisioning Intelligent Health-care system in Smart City, e-Health Pervasive Wireless Applications and Services (eHPWAS'14), IEEE.