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Adaptive Neurofuzzy System for Brain Tumor

Shashank Bhardwaj
Dept. of Computer Science and Information Technology
Shobhit University, Meerut, India
shashank12swe@gmail.com

Niraj Singhal
Dept. of Computer Science and Information Technology
Shobhit University, Meerut, India
sonia_niraj@yahoo.com

Neeraj Gupta
Electrical & Electronics Engineering
Krishna Institute of Engineering and Technology, Ghaziabad, India
neeraj_gupta2000@yahoo.com

***Abstract*— This paper emphasizes on brain tumor detection and hereby minimizing the deviation of target value and actual value using back-propagation algorithm. In this paper, a structure of adaptive system is proposed with the help of Adaptive neurofuzzy inference system (ANFIS) for diagnosis of brain tumor. Investigation of brain tumor is performed based on predefined rules. Investigation of brain tumor by the proposed system is illustrated and good performance is achieved. In this paper, the prototype consisting of six symptoms of brain tumor and using different rules have been explained. The behavioral pattern of EEG with normal and abnormal activities has also been shown.**

Keywords—Brain Tumor, fuzzy, electroencephalography, ANFIS, Simulation

I. Introduction

Fuzzy Logic(FL) has emerged as one of the active area of research activity particularly in control system application. It is a very powerful method of reasoning which is utilized when there is no mathematical model and input data are not precise. Its applications, mainly to control are being studied throughout the world by control engineers. Wherever logic can be introduced in the spirit of human thinking, fuzzy logic finds extreme application there. Sacrificing some amount of information we get a more robust summary of the information What this really mean? Though we are conditioned to think in precise quantities, at a subconscious level, we think and take actions that are fuzzy in nature. And that is the way we perceive the nature and react to it.

Before going to into the details, let's look how fuzzy logic has become a household jargon. Though fuzzy logic originated in USA some 30 years back, the researchers there were skeptic about its applicability in real world applications and some even scoffed it off as nothing but probability.

On the other hand, the Japanese was closely the pioneering work done by Mamdani and his associates in steam engine control and started applying fuzzy control even too consumer goods like cameras, air conditioners, vacuum cleaners etc. Thus fuzzy based products became highly competitive due to better performance, high reliability, robustness, low power consumption, cheapness etc. One of landmark success of fuzzy control was complete automation of subway train's drive control system in Japan. With fuzzy logic getting a wider acceptance in recent years, it is predicted that by the end of decade fuzzy logic will replace most of convention logic.

In classical control paradigm, a lot of stress is placed on the precision of input, the intermediate steps which process them, and modeling of the system in question. In spite of this we observed that many a time such sophisticated classical controllers developed often find it difficult to perform in real world control problems.

Because the real world is so complex that regardless of the complexity of our model of the problem and the care taken to design such models, there exist so many parameters that not been properly accounted for and many more of which are totally ignorant of. Whereas a FL solution is possible to the imprecision in the inputs and the model of system and still produce an output which is desired out of the system. It was put in a effective way by Lofti A. Zadeh(the father of fuzzy set theory), when he said "Most application of fuzzy logic exploit its tolerance for imprecision. Because precision is costly, it makes sense to minimize the precision needed to perform a task." Thus the applicability of fuzzy logic is indeed promising.

The thinking process involved in fuzzy realm is not complex. It is simple, elegant and easily applicable. The simplicity arises because it eludes mathematics to a great extent and elegance lies in its expressiveness.

Even a person who does not know anything about camera operation can design fuzzy based controller for it with the help of expert camera operator.

A technique has been proposed in this paper which allows the user to diagnose the disease himself/herself by defining seen symptoms observed by him/her through the web interface .All data entered on web interface are recorded into the related database and are analyzed by the knowledge based system in client server. The proposed solution/result is stored in the database. This solution/result is then sent to user by email.

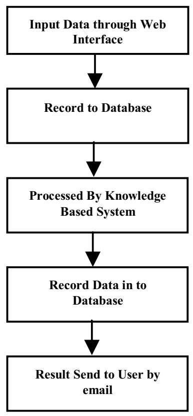


Fig 1: Basic block diagram of email Advisory System

This paper proposed an adept system for early diagnosis of brain tumor. Section II(A) discussed Methodology for development of brain tumor using neuro-fuzzy logic. Section II(B) described System Block Diagram For neuro-fuzzy Logic. Section II(C) discussed FIS Rule Editor Showing Prototype of Brain Tumor Symptoms. Section II(D) described Rules Viewer Showing Different Percentages of Symptoms And Corresponding Severity of Disease. Section III sum up all the ideas discussed in this paper.

II. SIMULATION RESULTS

This section proposes the neuro-fuzzy architecture of a Brain tumor. A flowchart and working methodology is proposed which is based on the data gathered on the disease brain tumor .There are following parameters which are connected to brain tumor:

Symptoms:

1. Nausea and vomiting.
2. Muscle jerking or twitching (seizures or convulsions)
3. Problems balancing or walking
4. Headaches (usually worse in the morning)
5. Problems with memory
6. Changes in speech, hearing, or vision
7. Numbness or tingling in the arms or legs.
8. Change in smell, sensation, vision, or/and hearing without losing consciousness.
9. Changes in personality, mood, or ability to concentrate

The block diagram for the methodology explaining the disease is shown. First of all a set of symptoms is prepared for the model. All these symptoms are combined to a system and are called as inputs. Different conditions like low, medium and high are assigned to each and every input and correspondingly output is generated.

A. Methodology for development of brain tumour using neuro fuzzy logic

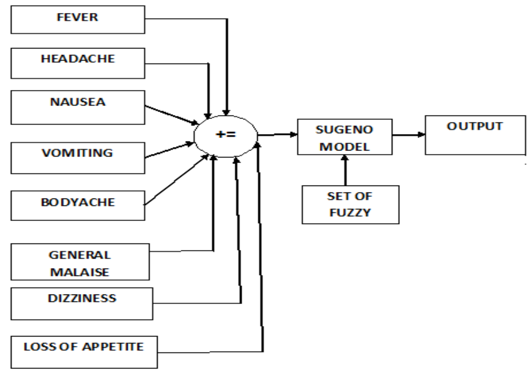


Fig 2: Flowchart of brain tumor model in fuzzy systems

B. SYSTEM BLOCK DIAGARAM FOR NEURO FUZZY LOGIC

1. In this paper, six inputs parameters have been used.
2. The output refers to the disease we want to diagnose which is brain tumor.
3. The third step refers to assigning values to the inputs subjected to the degree of percentage of the symptoms described by the customer.
4. The rules are defined for each step. In this paper, a set of 18 rules have been incorporated.

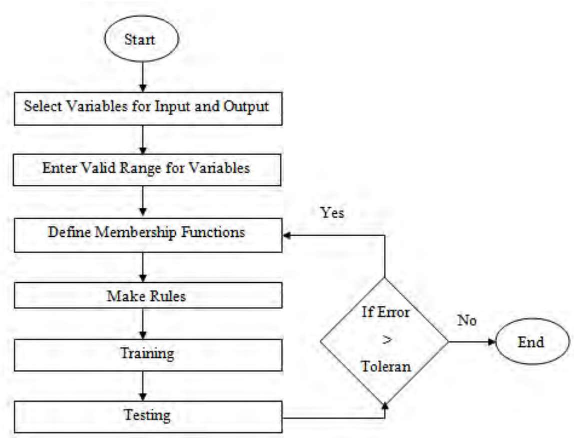


Fig 3 Algorithm of ANFIS Implementation

The process of converting the scalar value into fuzzy value is known as Fuzzification. Triangular fuzzifiers, Gaussian fuzzifiers, Trapezoidal fuzzifiers and singleton fuzzifier are four type of fuzzifiers used for the process of fuzzification. In this research, Triangular fuzzifier is widely used.

The degree of membership of membership functions is determined by the process of fuzzification [15] of data, in which input parameters are selected on horizontal axis and projected vertically to upper boundary of member function . The transformation of raw data to fuzzy value using functions marked the beginning of fuzzification.

C. FIS RULE EDITOR SHOWING PROTOTYPE OF BRAIN TUMOUR SYMPTOMS

Fig 4 includes the analysis done on six symptoms of brain tumor and further combined in rule editor with further rules based upon the magnitude of symptoms occurring in the disease.

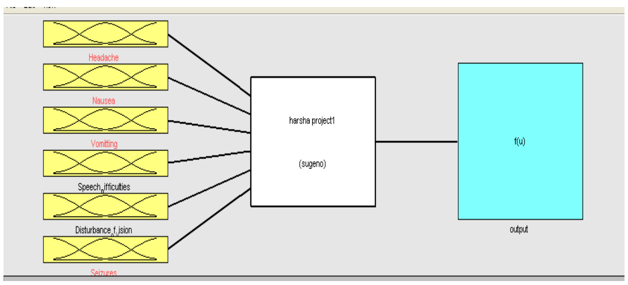


Fig 4: Prototype of the Brain Tumor Symptoms

D. RULES VIEWER SHOWING DIFFERENT PERCENTAGES OF SYMPTOMS AND CORRESPONDING SEVERITY OF DISEASE

The rule editor shows the different values corresponding to the four symptoms discussed.

One result is shown below:

If headache = 7.27 and vomiting = 97 and nausea = 97 and disturbance of vision = 97 and seizures = 97 and speech difficulties= 97 then brain tumor = 0.0796

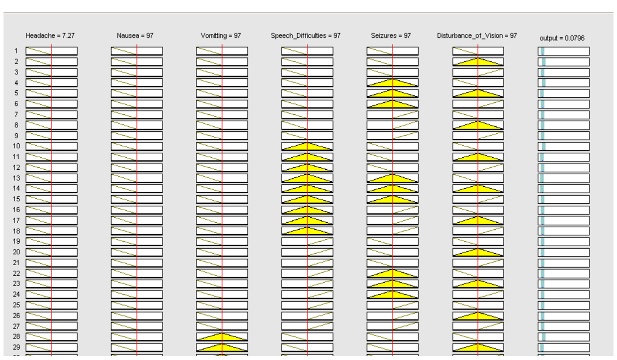
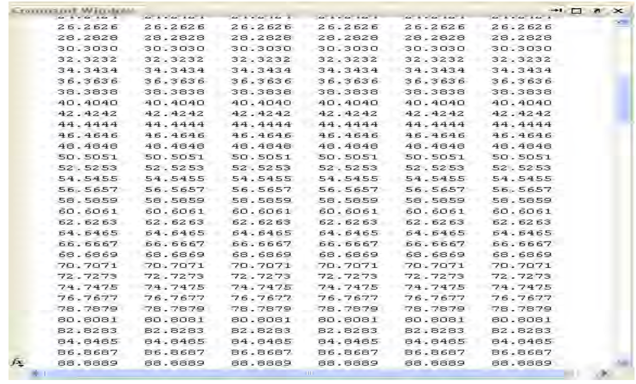


Fig 5: Rule Viewer

1) Program simulation on matlab .

In this stage generated MATLAB program is run for the simulation of brain tumor fuzzy system, this will result in a set of input-output related values.



26.2626	26.2626	26.2626	26.2626	26.2626	26.2626
28.2828	28.2828	28.2828	28.2828	28.2828	28.2828
30.3030	30.3030	30.3030	30.3030	30.3030	30.3030
32.3232	32.3232	32.3232	32.3232	32.3232	32.3232
34.3434	34.3434	34.3434	34.3434	34.3434	34.3434
36.3636	36.3636	36.3636	36.3636	36.3636	36.3636
38.3838	38.3838	38.3838	38.3838	38.3838	38.3838
40.4040	40.4040	40.4040	40.4040	40.4040	40.4040
42.4242	42.4242	42.4242	42.4242	42.4242	42.4242
44.4444	44.4444	44.4444	44.4444	44.4444	44.4444
46.4646	46.4646	46.4646	46.4646	46.4646	46.4646
48.4848	48.4848	48.4848	48.4848	48.4848	48.4848
50.5051	50.5051	50.5051	50.5051	50.5051	50.5051
52.5253	52.5253	52.5253	52.5253	52.5253	52.5253
54.5455	54.5455	54.5455	54.5455	54.5455	54.5455
56.5657	56.5657	56.5657	56.5657	56.5657	56.5657
58.5859	58.5859	58.5859	58.5859	58.5859	58.5859
60.6061	60.6061	60.6061	60.6061	60.6061	60.6061
62.6263	62.6263	62.6263	62.6263	62.6263	62.6263
64.6465	64.6465	64.6465	64.6465	64.6465	64.6465
66.6667	66.6667	66.6667	66.6667	66.6667	66.6667
68.6869	68.6869	68.6869	68.6869	68.6869	68.6869
70.7071	70.7071	70.7071	70.7071	70.7071	70.7071
72.7273	72.7273	72.7273	72.7273	72.7273	72.7273
74.7475	74.7475	74.7475	74.7475	74.7475	74.7475
76.7677	76.7677	76.7677	76.7677	76.7677	76.7677
78.7879	78.7879	78.7879	78.7879	78.7879	78.7879
80.8081	80.8081	80.8081	80.8081	80.8081	80.8081
82.8283	82.8283	82.8283	82.8283	82.8283	82.8283
84.8485	84.8485	84.8485	84.8485	84.8485	84.8485
86.8687	86.8687	86.8687	86.8687	86.8687	86.8687
88.8889	88.8889	88.8889	88.8889	88.8889	88.8889

Fig 6: Training and Testing Data

2) Final training & error reduction.

In this stage the training and testing of the system is done by utilizing ANFIS. The training and testing is done by the sets of input-output related values generated in third stage. The Figure 7 shows the loaded training and testing data.

Dots show the testing data & circles show the training data

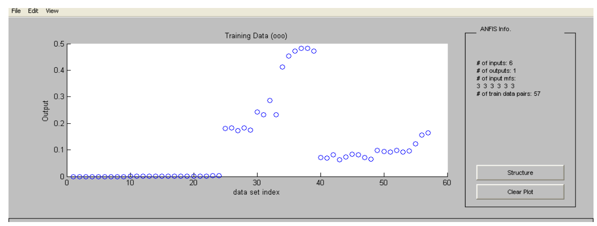


Fig 7: Training Data

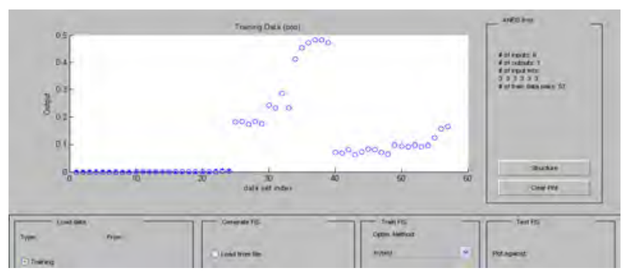


Fig 8: Testing Data trained with Trained Data

The autonomous navigation could provide solution for people who have high degree of disability i.e., people who cannot predict their brain behavior. But, in this system as there is no involvement from the user therefore the reliability is little less and it also requires the prior information about the location of the goal and the environment around the system, which results in increased cost.

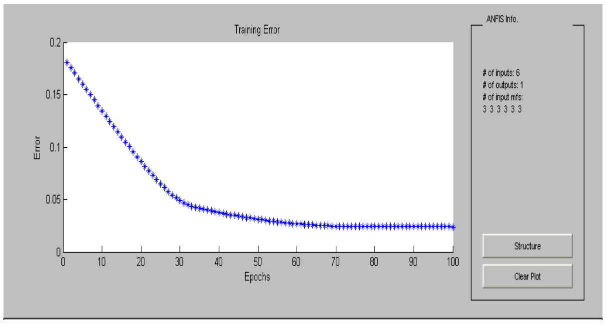


Fig 9: Error Minimization Curve

Epoch required=100

Error Tolerance=0.01

Error Minimization achieved=0.02678

ANFIS info:

Number of nodes: 1503

Number of linear parameters: 729

Number of nonlinear parameters: 54

Total number of parameters: 783

Number of training data pairs: 57

Number of checking data pairs: 0

Number of fuzzy rules: 729

III. CONCLUSION AND FUTURE SCOPE

In this paper, a structure of adaptive system has been proposed with the help of fuzzy system (FS) for diagnosis of brain tumor. Investigation of brain tumor using fuzzy system has been used decision making ability based on predefined rules. Investigation of brain tumor by the proposed system has been illustrated and good performance has been achieved. This paper explains the prototype consisting of six symptoms of brain tumor and using different rules.

The rule editor shows the different values corresponding to the six symptoms discussed.

One result is shown below:

If headache = 0.691 and vomiting = 0.647 and nausea = 0.27 and seizures = 0.241 and disturbance of vision = 0.345 and speech difficulties = 0.234 then

Brain tumor = 0.351

The urgency to improve systems of care is especially keen in the case of cancer. Estimates suggest that applying what is known in prevention and early detection alone can reduce overall mortality from cancer by as much as 50% over time. By applying what is known in personalized surveillance and by enhancing the effectiveness of coordinated care, we can improve outcomes for cancer patients through diagnosis, treatment, and survivorship. Moreover, by linking our medical data systems, we can create a translational environment in which discovery is pushed from bench to bedside and then back to the bench through informatics systems that serve to connect cancer research to care settings.

Such a step, we believe, will require a user-centered orientation to apply data to the problem of reducing error and improving outcomes across the interfaces of care. By making these systems truly supportive of user goals, it should be possible to capture the same return on investment for fuzzy logic realized in other economic sectors. In cancer care, that return is measured not just in terms of returns in economic investments but in an opportunity to accelerate success against cancer now.

In rural and tribal areas, where the economy crises and illiteracy forces people to take wrong decisions and advice regarding healthcare, this research work can prove very useful.

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