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KNOWLEDGE-BASED IN MEDICAL DECISION SUPPORT SYSTEM BASED ON SUBJECTIVE INTELLIGENCE

Emotional Intelligence as cybernetics approach is using cognitive reasoning to collect the subjective attribute of human subject interacted with a system for providing technical advice. This talk contributes in new Cybernetics paradigm on using multidisciplinary in decision making. It is related to the construction of Avatar that can interact with human subject for collecting subjective attributes (emotional and cognitive) and objective attributes (physical), for decision making. paper extends reasoning issues on medical diagnosis related to Virtual Doctor System (VDS). Intuitionistic fuzzy aggregation functions have been used to represent concept reflective to the mental model of the VDS. The VDS project used two physical ontology model and mental ontology model aligned on medical ontology for reasoning. In this paper the mental ontology related to medical diagnosis is the main emphasis. The mental Ontology is represented as two models: Emotion state model, and ego state model. The attributes of mental state are represented as fuzzy intuitionistic criteria. The emotion state related attributes are represented using harmonic hybrid weighted Ordered Intuitionistic fuzzy aggregation function. The ego state related attributes are represented using Bonferroni hybrid weighted average aggregate function. The both aggregate functions as well as the physical ontology aggregate functions are aligned on medical knowledge based for producing aligned inquiry for reasoning in medical knowledge. The model is built for testing.

1. INTRODUCTION

Decision makers rank their criteria in relation to subjective attributes bounded by the situation of that system. These are reflecting the dynamics feature subjectivity of the situation on the system objective feature. Such style of decision making is projected on medical decision making which has a versatile subjective feature related to human patient articulated on systematic objective system of decision making related to the properties of the criteria that some of it have uncertainty values. Uncertainty main aspect comes from when we look to criteria as objective ones. The criteria would provide a sort of uncertain relations to attributes as the methods and algorithms dealing with such approach are based on black box.

This is related to using objective criteria methods (TOPSIS, AHP etc.) to find a decision solution based on data set that are categorized in objective manner. The subjectivity on criteria is for looking to these data, such as to have less uncertainty that would lead to produce white box like solutions. That is to reflect on the criteria in subjective manner. The subjectivity here is looks to see for example how experience can provide a subjective consensus for providing decision to problems using subjective criteria as parametric view to decision making. This is how to represent the data in multi dimensional space (curse of dimensionality) to find subjective relation among criteria based on the subjective input.

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The approach stated here is to provide a solution to decision making based on white box to reduce uncertainty matter. The approach is applied to medical diagnosis decision making.

Decisions making for Medical Diagnosis system have to take diverse type of criteria reflecting the different categorized project on patient. Attributes related to medical decision making is crucial aspect in medical applications. However, these attributes are a mixture of linguistic values and fuzzy intervals.

Also, there are Fuzzy relations that are used in description of Symptoms. Fuzzy set and fuzzy relations are used to represent medical knowledge as network of symptoms and diseases connected with each other by logical relations. Like high temperature is related to fever diagnosis. For example each object in the domain knowledge has n scores reflecting the symptoms, one for each m attribute. For example a symptoms (object) has an attribute from physical set properties, (e.g., high temperature), and other attributes set is from mental set properties (e.g., stress high, or emotional depression). Then for each attribute there is assorted list that list each symptoms with its attribute sorted by scores (fuzzy values). This can be evaluated and reasoned using monotone aggregation function or combining rules. This is because the decision making is aggregated on different ontologies that are using different knowledge layers to select the optimal alternatives due to selected criteria that have aggregation operators. These aggregation operators are used to model medical mental view (subjective) and physical view (Objective) in our model.

The Virtual Doctor System (VDS) is a system assisting human doctor who is practicing medical diagnosis in real situation and environment. The interoperability is represented by utilizing the medical diagnosis cases of medical doctor, represented in machine executable fashion based on human patient interaction with virtual avatar resembling a real doctor. VDS is practiced as a virtual avatar interacting with the human patient based on physical views and mental view analysis. This short paper gives an outline of the VDS system and then discusses related issues in decision making in medical domain. Using fuzzy reasoning techniques in VDS, it becomes possible to provide better precision in circumstances that is related to partial known data and uncertainty on the acquisition of medical symptoms. We have employed combination of Fuzzy geometric aggregation for attributes for representing Physical ontology of VDS (Subjective attributes). We propose harmonic fuzzy reasoning in emotion Ontology in VDS based on cognitive model project on cognitive psychology. The ego state model is represented using Bonferroni fuzzy reasoning model. These all are aligned and aggregated on medical knowledge based using different distance function and entropy functions. The purpose is to derive the weight of related attributes from medical knowledge base and rank the preference order of the set of alternatives based on intuitionistic fuzzy similarity measures related to mental (Subjective) and physical (Objective) symptoms for decision making. A set of ideal solution is provided based on simple cases scenarios. The weight of mental decision making is derived based on hamming distances fuzzy operators. The alignment is to provide an intelligent mapping between the mental view (Subjective) and physical view (Objective) based on fuzzy representation of each through different type of aggregation function. We have in the knowledge based a big weight if the evaluation value is close to the ideal solution, and on the same time has small value if the value is far from the ideal decision. If the weights of some attributes are not known or partially known then we need to predict using patient preferences by looking to the subjective risks they may produce. Here in such short overview I extend the related exploration of building the VDS¹, virtual doctor system [3], [2], [1]. The VDS is a designed medical doctor avatar that is interacted with human patient based on aligned ontology, namely physical ontology, and mental ontology [1].

This paper is discussing reasoning issues using intuitionistic fuzzy reasoning with specific properties on attributes related to mental ontology. This is to establish a diagnosis scenarios based on patient interactive procedural routine. The built system outline is shown on Fig. 1. A version of the system is built and experimented for testing, as shown in Fig. 2. We have created a related technology, reflecting the state of art on creating a program that resembles the user mental psychological behavior through a face, this concept we called it mental cloning [4].

The mental cloning concept is used to mirror a person cognitive behavior into a model that interacts

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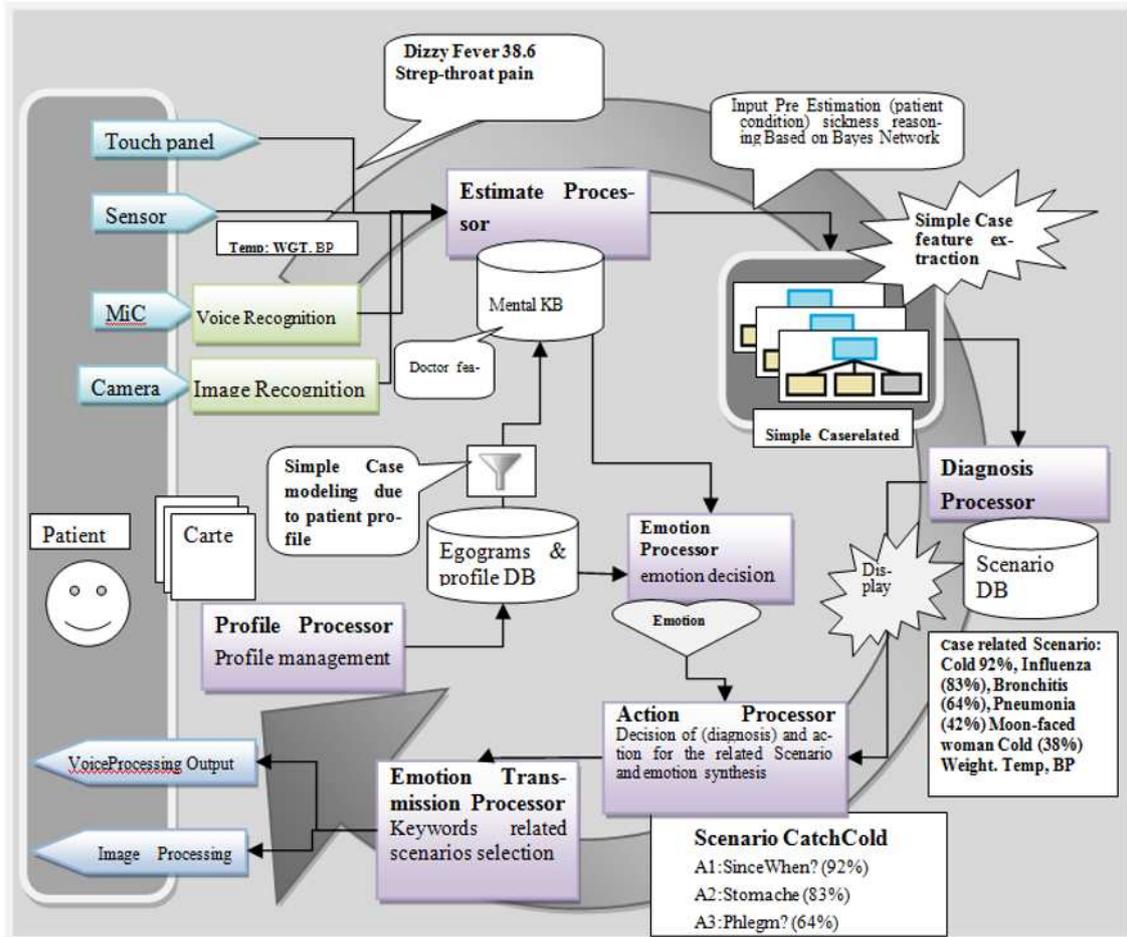


Fig. 1. The VDS system outline.



Fig. 2. Shows an experiment of the system demonstration.

with human user. This is based on facial analysis and voice analysis of Japanese based users, and creating corresponding templates reflecting the related cognitive emotion in the template data base. The voice templates set is a six voice templates that can read annotated narrative text. The annotation is to label the text according to emotional situation of the user reflecting what is called user situation model. This situation indexed linguistic based texting is context subjective oriented reflecting the knowledge expertise of the person resembled in the avatar. Response from medical doctor as decision making is also given as interval due to uncertainty to define the symptoms. Uncertainty computation is part of the decision making in most cases in medical diagnosis due to different attributes involvement in body health. These are contributing in aggregating the decision maker in one possibility among others. These possibilities are ranked according to their computed priority.

We have looked to different knowledge collected from medical doctors in Iwate, Japan to produce an interactive system for diagnosis. The emotional situation variation stored in the data base can be tuned according to the subject user (patient) that the system would articulate based on ego gram and transactional analysis model developed and reported in [13]. These cognitive models reflect the avatar cognitive characteristics and variation with and interact in harmonic accumulated reasoning fashion with the user (i.e., patient). In this system the avatar knowledge is structured medical knowledge, and the cognitive behavior is certain doctor cognitive model studies in practice in this experiment. The user is a real person acts as a patient using this system. The avatar role and the user role are well defined in advance in this system. The avatar animated real-time images created in real-time resemble the emotional behavior of that person in the same manner the real person interacts with certain world in similar invocation. This interaction is taking use of the transactional analysis reported in our project in [6], [14].

Mental ontology related reasoning is based on emotion state model, and ego state model. The attributes aggregated on these two models are related to metrics computed on the face and voice of the patients. Attributes measured on the face images (also collected voice pattern reflected as pitch and power variation) are articulated to compute the emotion state as combination of six emotional states. The ego state is represented by the concept of egogram five states that are used to measure the ego state of a person based on 60 questioners' data base. The ego states is attributed are used to measure the ego state of the patient based on pattern matching. The interoperability for decision making and interaction with patient is represented by utilizing the knowledge based of medical diagnosis related to the medical nominated doctors. This in total run in machine executable fashion based on patient interaction with virtual avatar resembling and mimicking a real doctor. The system is installed in a hospital where that doctor is practicing his medical diagnosis in real situation and environment. The avatar is working as a 1st glance diagnosis to classify patient based on the criticality and emergent examination parameters. These are defined on general guidelines formalization, and customized according to the subject doctor experience by certain specialization. The system is to help the real doctor by filtering the outpatient (when they come to the hospital) who waiting to see the real doctor. The virtual doctor sees patients by interacting with them and issues a decision making for medical cases categorized analysis.

2. REASONING OUTLINE

Here we discuss issues on new aspect of reasoning issues reflected on using fuzzy set to aggregate attributes projected on two different ontologies as shown in Fig. 3 where the two types ontology are used to show the classified criteria. The context of the engagement is defined in advance (In this paper context is medical diagnosis based on Doctor A). So collecting the user mental state is to have the system adapt to changes that would have the user be engaged with the system in a positive manner.

The avatar is a screen mask that is built as a mask of real medical doctor [5]. Such mask interacts with the user in cognitive manner. The face would smile or else and act in emotional manner according to the context and engagement style of the user. The face mental background resembles an ego state reflected through the egogram resembled person (medical doctor) represented in the system as a program. We have studies this and take use of transactional analysis [6]. The face states are the primitive states that

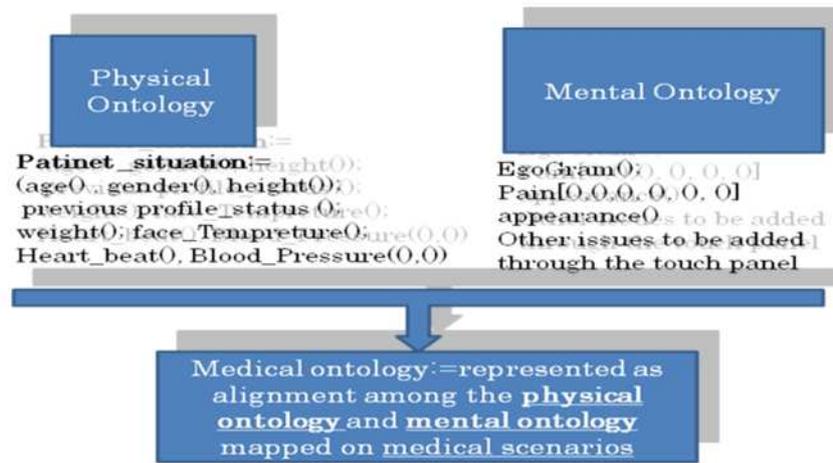


Fig. 3. The two types ontology using in the system.

the system would select interactively according to the user engagement cognitive state. The user ego state related templates are collected as best match from the database based on what we called universal template. A set of egograms is stored in the system and indexed according to universal template. We have evaluated these universal template based on experimenting them with Miyazawa Kenji avatar that experimented in a museum [5], [14]. These stored classified ego gram are to work as a templates to test user ego states. User observed ego state is measured through a set of universal templates. The measurement of face parts movements are referenced (computed) to a indexed templates collected from many Japanese subject contributed in our experiment [6], [9], [11]. On [14] you can view (download to view) the movies showing how the system works and also for public news on the project, (on Japanese media).

Specially, medical diagnosis knowledge and reasoning are based on combination of attributes that values are represented by linguistics adverbs, like, high blood pressure, low temperature linguistics fuzzy values, to interval based fuzzy variables like temperature is represented as interval values as a range of high, and also as a range of low, and so on.

We have experimented that the behavior's effect on mental model has relation to extrinsic attributes affecting the mental state and producing a negative disorder. There are also other values related to the intrinsic attributes that are representing the steady state of the mental behavior of the patient. These are in explicit state and can be represented by the ego state model. The extrinsic attributes are affecting the stability of the ego state.

We represented this using intuitionistic fuzzy set aggregation function based on Bonferroni means that is to aggregate all mental values as these have interrelationship between them. The six Ekman mental model and the ego state as well as the pitch and power of the voice, all these has interrelationship and connected as weighted propertied order attributes. It is a hybrid attributed of weighted average and prioritized weighted order attributes. This internship is to be used for decision making presented in the paper.

The system would test the mental states of the user based on these ego grams, and interact with the user based on instantiation of observed changes on the face parts collected due to emotional experience or back ground.

However, there are metric changes on the cognitive issues collected from human user when they interact with our VDS. These changes are concluded due to brain analysis on interaction when the object of interaction is human or avatar. These data correlation are used in the analysis based on fuzzy component analysis model. The analysis is collected from experiments when people do interaction using iphone or skype to communicate. These experiments are utilized collecting correlation data on differences in human facial and voice analysis to measure the correlation. This is evident from the measurement done on machine can measure deception on human interact with human, but it is not

easy to measure the same when the human interact with machine. This was evident from the MRI data observed on human subject playing poker with human, in comparison to the playing with computers [7]. We also have done related analysis when patients interact with human doctors, and also the same patient interacts with the same doctor generated avatar related to the VDS. We could create a fuzzy correlation based on such study such that we can provide better scoring to the observed fuzzy attributes related to the mental ontology. The attributes weight and related doctor weight are correlative.

These findings are used to provide a mechanism that to be used for reasoning on human patient interacting with computer generated avatar resembling a real doctor. The collected data related to the mental parameters related attributes are reflected from parts of the brain that are in fuzzy correlation to parameters of similar attributes related to actual interaction of patients with real human doctor. These fuzzy correlations analysis are necessary to differentiate the analysis and providing accuracy to decision making related to mental ontology.

In this paper we are discussing two issues:

How to provide a correlation among criteria for decision making on attributes: between

- 1) The observed human subject's mental ontology model related attributes, as interacted by the patient with avatar
- 2) The Knowledge Based collected attributes are related to similar patients' preference interacting with the subject of human doctor. These attributes represent the prototypes data set we have used to compute the correlation between mental attributes representing the criteria for decision making when the two interacted subject are human, in relation to the subject interacted with avatar. This correlation will be utilized to provide better decision making on mental ontology based interaction.

3. CONCLUSION

The outline paper is referencing to research project related to VDS: Virtual Doctor system. The paper is presenting the framework for reasoning based on medical cases for reasoning through physical ontological reasoning and mental ontological reasoning. The integration of such two reasoning is articulated on medical ontology for decision making using intuitionistic fuzzy reasoning. The physical type attributes linguistics values are represented using intuitionistic fuzzy logic attributes aggregated as geometric weighted orders operator. The mental attributes is classified to those related to harmonic ordered weighted attributes (for emotion state) and Bonferroni weighted ordered attributes for ego state. The both are aggregated to do intuitionistic fuzzy reasoning to aggregate on mental reasoning using correlation and hamming distance correlation to stored templates represented as trapezoidal intuitionistic fuzzy values. The both aggregation function are an aggregation on symptoms to reason on medical cases provided by two doctors for decision making for medical diagnosis. We have selected this approach, as we think most of the medical diagnoses for outpatient are uncertainty attributes collected from the patients in different statistical aggregated values. Collectively evaluated these values into collective alignment to reason on medical knowledge would participate to provide suitable reasoning structure mimicking real doctor hierarchical reasoning for better performance.

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