AN INTELLIGENT CONVERSATION AGENT FOR HEALTH CARE DOMAIN

K. Karpagam[1] and A. Saradha[2]

[1]*Department of Computer Applications, Dr. Mahalingam College of Engineering and Technology, India*
E-mail: karpagam80@gmail.com
[2]*Department of Computer Science and Engineering, Institute of Road and Transport Technology, India*
E-mail: saradha.irtt@gmail.com

Abstract
Human Computer Interaction is one of the pervasive application areas of computer science to develop with multimodal interaction for information sharings. The conversation agent acts as the major core area for developing interfaces between a system and user with applied AI for proper responses. In this paper, the interactive system plays a vital role in improving knowledge in the domain of health through the intelligent interface between machine and human with text and speech. The primary aim is to enrich the knowledge and help the user in the domain of health using conversation agent to offer immediate response with human companion feel.

Keywords:
Artificial Intelligence, Question Answering, Conversational Agent, HCI, Pattern Matching, Speech Synthesis

1. INTRODUCTION

For the past few decades, interface technology has attained a greater height for interaction between machine and human for various purpose and situations. The concept of intelligent machines was first conceived by the British Mathematician, Alan Turing to develop a computer program to help humans for information sharing through human dialogue.

The communication between a system and user is through user interface, the growing interest in user interface generation leads to the development of conversation agents. The conversation agent is a computer program used as an interface between the system and user for information transformation through natural language. The user is allowed to communicate with the agent by the natural language, gestures, speech with free of cost, access at anytime, anywhere.

The agents are multi-disciplinary in nature with enhancing features as animated characters, gestures, multilingual, multi-modal interaction. The conversation agent is to engage users in text- based information search dialogs for a range of applications [1]. The application areas of conversation agents are education, marketing, selling, doubt clearing, website navigation, technical support customer service, health care, language learning, cultural interface, natural interface, behavioral user interface, etc.

There are two main streams of CA's: Linguistic conversation agent and Embodied conversation agent. In those streams, the conversation agents are of different categories such as Spoken dialogue system, Chatter bots,

NLP based dialogue management system, Goal-oriented conversation agents and Embodied conversation agents [9].

Along with this, the agents are of relational and pedagogical agents that were developed for particular need of effort enhancement. Likely relational agent used to support social-emotional relationship of the user to analysis and predict the behavior to provide better output. The pedagogical agents used to ease the learners in the computer arbitrate environment for knowledge sharing. An example of pedagogical agent is "Baldi" a classroom language training tutor for children with hearing loss (Cassell et al. 2000).

The interaction is based on Question and answering system follows Turing test that provides the answers based on the patterns in the questions. This technology is also followed by search engines, Natural Language Question-Answering systems, Chatter bots and ECA and the comparative studies are required for developing the best Question Answering system [12].

The search engines select one keyword or phrase from the input and return the relevant document to the user with maximum of hit ratio. The Natural language questions the system that produces response using NLP procedures such as parsing, keyword extraction, lexicon engage in dialogues based on context of the document [9]. Examples of NLP Question answering systems are ASK JEEVES, START, ANSWERBUS etc. The chatter bots provide a precise quick response using pattern matching with simple pre-defined rules implied and the response of an agent could be from static databases, knowledge base, dynamic details from web pages etc,.

Some of the major application areas of Goal oriented CA are language research, customer services and intelligent tutoring, etc. The user request for information and artificial intelligence responses to the request, in addition to that ask for related questions to make user to chat with human and don't escalate the conversation [5]. The structure of the system was designed and developed based on user's skill matrix like computer knowledge, intelligence, communication ability, stress tolerance levels, etc.

2. RELATED WORK

The popular chatter bots are ELIZA, Cypher, Anna, Jabberwacky, Converse, Shakespeare, parry, ALICE and Convagent etc. ELIZA was one of the first developed linguistic CA that demonstrates a simple program play the imitation game with answering questions [11]. Another example of linguistic CA, Converse won a Loebner prize two times in 1997 and 2009.

The ALICE foundation (The Artificial Linguistic Internet Computer Entity) is a widely adopted standard for creating chat bots and mobile virtual assistants with the field of artificial intelligence. ALICE created the AIML (Artificial Intelligence Markup Language) through which is possible to develop software for chatter bot [15]. The AIML language is use to develop an interactive system based on AI for conversation using tags and script of markup languages. Text based CA was developing based on the contexts consisting of pre-defined rules,

which in turn have the list of pattern of sentences as quick responses.

The BASEBALL and LUNAR were natural language interfaces, the questions got from these systems were usually analyzed using NLP techniques which is used to construct a database query. The key constraint of these systems is the knowledge stored in the structured database was capable of answering within the restricted domain. These systems use their own heuristics to store information from web documents in the local knowledge database accessed and used for answer generation.

In this paper, the system provides facility to share information from a knowledge base that satisfies people's need in domain of health. First begin with the concept of AIML programming and Question and answer type classification for the system. Secondly, describe about the architectural design and technology used in health agent, followed by details of constructing the knowledge base. Finally, the evaluation strategies with experimental results are well described with a tuned assessment with help of post-graduate students.

3. ROLE OF INTELLIGENT INTERACTION SYSTEM

The design plays a major role in any application development which acts as the visual face to the user. The system was developed for increasing the high quality experience and interactive service to the user. Among the different categories of chatter bot type of conversational agents, the health care system adapts Question answering method with goal oriented nature is well equipped with relevant domain knowledge. The brain of agent is extended in future with semantic memory give common sense in the area of acupuncture, homeopathy medicines. The doctors prefer this type of agents for providing the basic knowledge of health with less amount of time to common people.

The AIML script is a structured text file that has the requests and response of a chatter bot is within AIML interpreter, they can run as a service for building knowledge base for all possible requests through categories [3].

Some of the AIML interpreters are Rebaccaaiml, Pandorabots, Program AB, D, O, E that acts as the user interface between the human and intelligent agent for providing appropriate responses through an IDE. The basic tags used in AIML are the <category> are the fundamental knowledge bases, <pattern> used to deals with request given by the user to the system, <template> used to deals with the responses to the user [15]. Generally the knowledge base combine with GUI for interaction by a text console, spoken dialog, gestures, 3D virtual Humans that created using Java3D, VHML, BML, etc.

The disadvantage of using chatter bots, is it converse with the user in a generic way whether, the Goal oriented CA is focus on achieving a goal in the particular domain by providing information, advice, selling, etc. using a simple rule based system along with the pattern matching technique. The response was generated by the best match of the utterance give by the user through the pattern.

Commonly, the system of question and answer types are of open domain and information seeking [2], but the health care system is based up on the information seeking on health which is used by native speakers of English. The health care system was designed based on the research through design concept i.e., design driven by research. The design of successful intelligent interactive systems requires intimate knowledge, ability to innovate unique ways of interacting with computation, and facing the new challenges in human abilities, limitations and preferences [8].

The system was designed as an interface for information and service for all kind of people as assistant / personal advisory to suggest about knowledge on body organs, their functionality, taste related to organs, internal organs with outside organs, operational times, energy diets for organs, possible diseases in organs, general health tip etc.

This gives the user a user-friendly environment to continue dialog in smooth manner, it provide easy of use as a public system in hospitals, healthcare centers, fitness center's, etc. Instead of visiting a health advisor, this health agent will save time and money for the users for solving basic needs [13].

4. SYSTEM DESCRIPTION

The functioning of the system is as follows. The design of the health care intelligent agent is developed with a console based model. The request input can be given through console interface to the health advisor is then processed by pattern matching between question and answer patterns with the help of the AIML interpreter.

This can be achieved by pattern matching in which they best fit the answers with the help of mapping the keywords in each request with answer patterns. The natural language input question extracts keywords by removing stop words, stemming the words and left out with the keyword tokens. The question classification is the important in question answering system, in which the questions are analyzed with extracted keywords to determine the expected answer type. The question is tag along with question types like what, which, how, why, who and when for finding the appropriate answers [7]. The answer types should related to question types for easy identification of answers from the knowledge base. The search of answer in the knowledge base using information retrieval methodologies result in set of related answers. The resultant response was generated by the response generator and analyzed how far related to their expected output with speech.

The response generations provides the answers from the Knowledgebase which is verified using the score and rank each answer. The Answer with more score is displayed as the confident answer. Generally, the response generator provides the response to the user by two kinds as communicative activities and non-communicative activities. The communicative activities to the user through Email, Text, Speech, Web page and non-communicative activities as termination of discussion, saving information or escalate from the conversation.

The "Initiative" is the main part of dialogue system in which it provides the control over the conversation throughout based on the conversation whether it has been initiated by user, system and mixed. The health care intelligent system is user initiated one, in which the response could be easily formulated by using natural language understanding and user has control over the

system. The system initiated has a disadvantage of limited space to extend conversation; the system will take the control of the conversation.

The appropriate speech could be generated by speech engines program using the standard Java Speech API [14]. The response text is then processed as that converts each word to phonemes, which gives a speech output using FreeTTS.
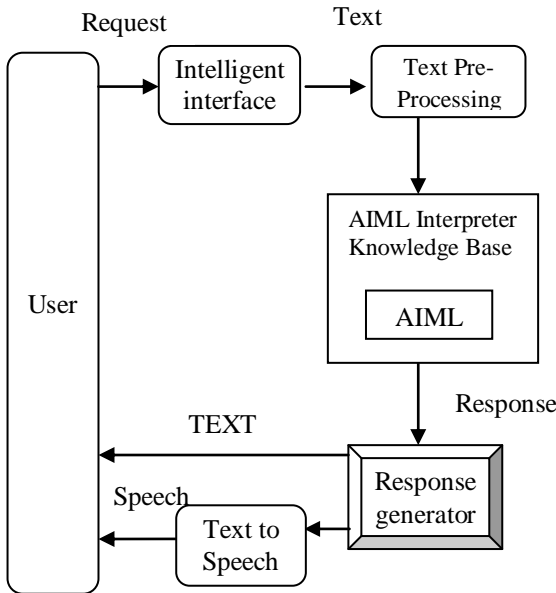

Fig.1. Health Care Intelligent Agent Architecture

5. KNOWLEDGE BASE OF HEALTH CARE SYSTEM

The Field of Artificial Intelligence uses the Knowledge representation as the major part for providing intelligence to the machine and trains them accordingly. The vital goal of knowledge representation is to carry out intelligent behavior with reasoning, logic capabilities to the system. In general the knowledge base of conversation agent has Syntactic analysis, Semantic Analysis, Disclosure analysis, pragmatic analysis for generating the response to the user based on their need [10].

The knowledge has been developed based on the domain information collected from many online resources and stored in Dbpedia, Wikipedia etc that can access by offline dumps also. In advanced Goal oriented conversational agents pattern matching was combined with the rule based system to produces nearest proper responses. This technique answers the research question how useful is this health agent used for remembering information about the health and the handling Knowledge base with new unknown requests.

The keyword in each request is collected from the group of a corpus of input message from the user. The techniques for better response from Conversation Agent is applying natural language processing, semantic similarity and calculate the best score between question and answer pattern.

In AIML files, Category tags representing the rules for matching the words with patterns matching algorithms based on semantic meanings. This can be achieved with the help of tags like <that>, <topic> and <srai> for remembering previous

utterances, domain related questions and randomness of answers for the same question in different ways. The following figure illustrates the various types of conversation between user and advisor.

User> What is liver?
Advisor> The largest glandular organ and secretes bile, has function of storage
User> How liver works?
Advisor> you need medically or general
User> List the functions of liver?
Advisor> Production of certain proteins for blood plasma

Fig.2. Related questions

The user submits the same question in different ways to the advisor knowingly or unknowingly. This can also be taken as a trial for testing the stress level of the advisor. The AIML interpreter matches the keyword and tries to manage the situation with at most care and responds with related answers that lead to make the extensive conversation.

User> What is best food items for liver?
Advisor> You can't live without food.
User> Suggest some healthy food for liver
Advisor> Orange, nuts, carrot
User> Please suggest food for liver
Advisor> You suggest me some food for liver.
User> Tell me food for liver

Fig.3. Same Questions in different ways

When the advisor is with the unknown / unrelated questions, has provided the related answer from the group using <random> tag. The following shows the AIML code for the above type and its corresponding output by using <random> tag for generating randomly generated answers.

```
<topic = "Food">
<category>
<pattern>What is * food </pattern><template>
<random>
<li>You can't live without food.</li>
<li> you must take healthy food regularly</li>
<li> You suggest me some food for liver. </li>
<li>Which is your favorite food? </li>
</random>
</template>
```

Fig.4. Unknown / Unrelated Questions

User> what is the minimum distance for walking?
Advisor> 5 km /everyday
User> What is BMI?
Advisor> Body Mass Index
User> Where to get vitamin D?
Advisor> Sunlight.

Fig.5. General Health tips

The AIML gives the facility of using of additional tag in the template tag called the <srai >tag. The <srai> tag is used in situations like synonymous of inputs can have the same response [15]. Pattern is only checks with the user utterance but not on the grammatical, semantic meaning of the utterance will be enhanced for further development of the agent.

6. EVALUATION STRATEGIES

The Evaluation is the basic strategy for every function and validating the system for analyzing the attainment of the user's need. The evaluation is needed to set right the strategies in the design of an efficient Conversational agent. It gives a clear idea about how far this developed system is near our expected output reached with a different set of input statements. This is measured based on target audience nature and their interaction styles to the agent along with interface experience [6]. The evaluation is done based on subjective and objective metrics to evaluate conversational agent.

Evaluation strategies followed to analysis the functioning styles of the health care agent like repeatedly same questions from the audience, unrelated domain questions, responsiveness, how far randomness of answers is adapted. The agent will satisfy the user with its properties of responsiveness and reactivity as a subjective measure. The system is evaluated with a set of 450 question and answer initially on health domain with details of organs, general health. Each question is evaluated on interface experience on a 5 point scale where high value for positive side.
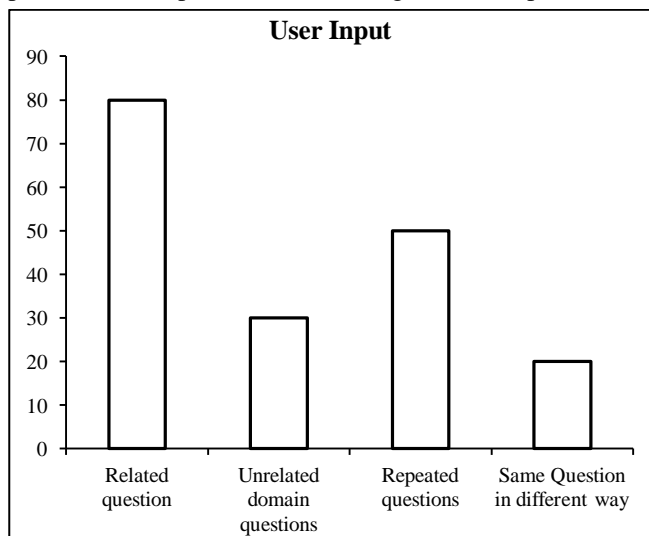

Fig.6. Requests from User

To improve the interactive system to next level, during the conversation interruption occurs due to hardware / software; any human or unknown interruption will be handled with care. Those concerned for better chat leads to continue the conversation with the user without any hesitation and not allowing them to escalate from the conversation.

7. EXPERIMENT RESULTS

Before beginning of the survey with the end users, the user is provided with a brief handout about domain area of the

agent's knowledge base, what and how to interact with the agent. The groups of 10 students are involved in this pre-test with age group of 20-25 (5 females) & (5 Males) for getting a different experience with gender wise. They are requested to interact with an agent for about 10-15 mins through console based entry on health care questions.

The Precision and recall were the conventional methods have been used as an Evaluation metric for the information retrieval systems.

$$Precision = \frac{Number\ of\ correct\ answers}{Number\ of\ questions\ answered}$$

$$Recall = \frac{Number\ of\ correct\ answers}{Number\ of\ questions\ to\ be\ answered}$$

Table.1. Response from the Advisor

Type	Percentage
Intelligent Answer	60%
Interesting Answer	80%
Wrong Answer	20%
Unambiguous Answer	40%
General tips	60%

The Conversation agent needs maintenance to retain about the current state and enhance for future growth of the system. The further enhancement can be made to increase the performance of the agent by analyzing the dialog history log. The log files of conversation are analyzed for finding the holdups in the conversation and impart the knowledge for the agent to resolve the hurdles.

8. CONCLUSION

This intelligent agent was developed to help the user to enhance their awareness about their body parts, workings and diet to be followed, general health tips. The agent provides an easy way to communicate using console text based entry and also facilitate with speech. This text based agents cope with hearing loss people gather information about health rather than speech based CA's. The research through design method is well adapted to reach better results in this system. The future enhancement is to apply gestures, emotional 3D face agent which gives real aesthetic experience to the hard hearing user. The performance enhancement should be done in user modeling, and unknown questions can be included in the knowledge base automatically for future use.

REFERENCES

[1] Xuetao Mao, Jean-Paul Sansonnet and Lin Li, "Textual Conversation Agent for Enhancing Attraction in E-Learning", *Proceedings of International Conference on Computer Science and Information Technology*, Vol. 36, pp. 49, 2012.

[2] Nestori Torma, "Artificial Intelligence: Overview on Question Answering and Chatbots", Technical University of Vienna, 2011.

[3] Ulli Waltinger, Alexa Breuing and Lpke Wachsmuth, "Connecting Question Answering and Conversational Agent", *KI- Kunstliche Intelligenz*, Vol. 26, No. 4, pp. 381-390, 2012.

[4] Tiansi Dong, et al., "A Natural Language Question Answering system as a Participant in Human Q & A portal", *Processing of the Twenty-Second International Joint Conference on Artificial Intelligence*, Vol. 3, pp. 2430-2435, 2011.

[5] Mitkov, "*The Oxford Handbook of Computational Lingustics*", Oxford University Press, 2012.

[6] Sanjay K. Dwivedi and Vaishali Singh, "Research and Reviews in Question answering System", *Procedia Technology, First International Conference on Computational Intelligence: Modeling Techniques and Applications*, Vol. 10, pp. 417-424, 2013

[7] M. Arutselvan, T. Chellatamilan and M. Vijaya Kumar, "A Statistical Language Modeling Approach for Question Answering System", *International Journal of Scientific and Research Publications*, Vol. 3, No. 5, pp. 1-3, 2013.

[8] John Zimmerman, Jodi Forlizzi and Shelley Evenson, "Research through design as method for interaction design research in HCI", *Human Computer Interaction Institute*, pp. 41, 2007.

[9] James O Shea, Zuhair Bandar and Keeley Crockett, "Systems Engineering and Conversation Agents", School of Computing, Manchester Metropolitan University, pp. 1-35, 2011.

[10] James Lester, Karl Branting and Brad Mott, "*Conversational Agent Practical Handbook of Internet Computing*", CRC Press, 2004.

[11] Joseph Weizenbaum, "Eliza- A computer Program for natural language communication between man and machine", *Communications of the ACM*, Vol. 9, No. 1, pp. 36-45, 1995.

[12] Goh Ong Sing, et al., "Towards a more Natural and Intelligent Interface with Embodied Conversation Agent", *Proceedings of the International Conference on Game Research and Development, Cyber Games*, pp. 177-183, 2006.

[13] H. Monkaresi, et al., "Intelligent Diabetes Lifestyle Coach", *OzCHI Workshops Programme*, 2013.

[14] http://www.cloudgarden.com/JSAPI

[15] http://www.alicebot.org.