Designing Spoken Dialogue Systems based on Doctor-Patient Conversation in the Diagnosis Process

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Abstract: The paper describes the use of doctor-patient interaction in order to design a spoken dialogue system. In this paper we analyze doctor and patient information seeking and information provision behavior. In our experiments we found a difference in information seeking and information provisioning behavior of doctors and patients, although statistically not significant. We identify some important roles that can be used as a springboard to design a spoken dialogue system. Finally, we conclude that analyzing face-to-face doctor-patient interaction can serve as an effective starting point to design spoken medical dialogues.

1 INTRODUCTION

Speech is one of the most effective means of communication for humans. It plays a great role especially in man-machine interactions. Speech is natural and the vast majority of humans are already fluent in using it for interpersonal communication. In the last two decades there have been a lot of advances in the application of spoken dialogue systems in different areas: academia, military, and telecom companies. A dialogue system is one of the promising applications of speech recognition and natural language processing. Spoken language interaction with computers has become a practical possibility both in scientific as well as in commercial terms.

Spoken dialogue systems can be viewed as an advanced application of spoken language technology. Spoken dialogue systems provide an interface between the user and a computer based application that permits spoken interaction with the application relatively in a natural manner (McTear, 2002). Fraser 1997, cited by (McTear, 2002), defines spoken dialogue system as "computer systems with which humans interact on turn-by-turn basis and in which spoken natural language plays an important role in the communication". Spoken dialogue systems enable semi-literate and illiterate users to interact with a complex application in a natural way using speech. Current spoken dialogue or/and IVR (Interactive Voice Response) systems restrict users in what way they can say and how they can say it. However, users of speech-based dialogue systems often do not know exactly what information they require or how to obtain it- they require the support of the dialogue system to determine their precise requirement (a system directed dialogue). For this reason, it is essential that the spoken dialogue system is be able to engage users in the dialogue rather than simply respond to predetermined spoken commands.

The propelling factor of this study is the adoption and application of speech technology and its impact on the healthcare sector in developing countries where a significant number of the population is illiterate or semi-literate. In this paper we analyze the doctor-patient conversation in order to find out if we can emulate the methods and techniques used in the conversation to design medical spoken dialogue system that can be accessed easily by non-educated or semi-educated population with the objective of searching health information remotely.

Nowadays, mobile becomes an appropriate medium to minimize the burden of healthcare in developing countries. Several researchers, for example (Black et al., 2009; Bickmore and Giorgino, 2006; Foster, 2011), are engaged in mobile based applications such as mHealth, mLearning, mBanking, mAgriculture etc. The expansion of the mobile network and the increment of mobile phone users in Ethiopia provide a fertile ground to adopt and implement mobile based healthcare applications. Designing a medical dialogue alike doctor-patient interaction is very cumbersome, the advancement of speech recognition requires another level to fully understand human speech. It requires at least to design and develop a

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medical dialogue system resembling human-like conversation to reduce the error of speech recognition. Our main motivation is to understand whether face-to-face doctor-patient interaction plays a vital role in designing human-like medical spoken dialogue system for the healthcare domain in the case of Ethiopia using Amharic language. To the best of our knowledge this is the first study that not only analyzes the doctor-patient conversation but also designs and models a medical dialogue system in the case of Ethiopia.

In this paper we address the following question: Is it possible to design a spoken medical dialogue system based on doctor-patient face-to-face conversation in the diagnosis process? The paper is organized as follows. The state of the art of medical dialogue systems is discussed in section 2. The analysis of the experiment is presented in section 3. Section 4 explains the proposed spoken dialogue system. Finally, section 5 concludes the paper and gives future directions.

2 SPOKEN DIALOGUE SYSTEMS IN HEALTHCARE

The healthcare domain has gleaned the benefits of the advancements of Information Communication Technology. During the last two decades, these interfaces have been adopted as part of tele-medicine technologies (Bickmore et al., 2006; Bickmore and Giorgino, 2006), which enable the delivery of a variety of medical services to sites that are at a long distance from providers.

The ultimate goal of a dialogue system is to provide health information for stakeholders primarily using spoken dialogue. Such a system can be used for a wide range of applications including: patients self-treatment and management, disease remote monitoring, diagnosis, health education etc. In line to this Bickmore and Giorgino ((Bickmore et al., 2006)) say that automated dialogue systems are increasingly being used in healthcare to provide information, advice, counseling, disease monitoring, clinical problem identification, as well as enhancing patient-provider communication.

However, a dialogue system in the healthcare domain is not without challenges. Clinical practice ordains complicated guidelines, ontologies and procedures. This makes the dialogue system more complex and cumbersome to handle. Bickmore and Giorgino also mention some of the challenges of spoken medical dialogue system: criticality (emergency cases), confidentiality (privacy such as HIV/AIDS regimen etc.) and mixed initiatives (patient-centered vs. system-centered). They point out that incorporating medical and behavioral ontologies and deep knowledge of health communication strategies are very important for further development of medical dialogue systems.

Bickmore and Giorgino argue that face-to-face communication together with written instructions remains one of the best methods for communicating health information to patients with low literacy level. They report that face-to-face consultation is effective because providers can use verbal and nonverbal behavior, such as head nods, hand gesture, eye gaze cues and facial displays to communicate factual information to patients, as well as to communicate empathy and immediacy to elicit patient trust. According to Durling and Lumsden ((Durling and Lumsden, 2008)) a spoken dialogue takes half the time needed to achieve the same task using keyboard and mouse, regardless of the participant's ability to correct their input. By highlighting the business side of speech recognition in healthcare, Parente et al., cited by Durling and Lumsden, show that, in their opinion, the adoption of speech technology is worthwhile. The use of speech recognition has, in fact, seen the most successful adoption in the healthcare domain.

2.1 Diagnosis Systems

Diagnosis, according to Webster's dictionary,*is the act or process of deciding the nature of disease or a problem by examining symptoms*. In the medical domain, many diagnosis systems are proposed and used such as decision support systems, agent based systems, and intelligent systems (fuzzy logic, expert system, neural networks and the like). Mobile diagnostic technology is a relatively new concept in telemedicine. As suggested by the term itself, it involves two key characteristics: mobility and remote diagnosis (Celi et al., 2009). The aim of using mobile technologies for healthcare is to support the patients outside of the medical and/or home environment.

2.2 Doctor-Patient Face-to-Face Interaction

The main goal of a doctor-patient conversation is a focused gathering with a common goal pursued by its participants. Typically, a patient visits a doctor with the purpose to be relieved from feeling unwell possibly caused by an illness; the doctor's purpose of the interaction with the patient also is to relieve the patient. When both parties appear to fail to comprehend or understand each other's goal, the interaction may be dysfunctional. Studying and analyzing the doctor-patient interaction helps to convey empa-

thy and obtain a trusted spoken dialogue system, especially when used by the semi-literate and illiterate rural people. The analysis should help to design a full-fledged medical dialogue system. As we pointed out in the previous sections, the main idea here is not to analyze the effectiveness and efficiency of the face-to-face doctor-patient interaction but rather the implications towards designing and modeling 'human-like' medical dialogue system.

A good interaction and a quality relationship between doctors and their patients is now widely recognized as a key factor in improving not only patient satisfaction but also treatment outcomes across a wide range of healthcare disciplines. The use of specific doctor communication skills has been associated with improved adherence regimens, improved psychological outcomes, more detailed medical histories and fewer malpractice suits, in addition to increase patient satisfaction (Bickmore et al., 2005). Doctor's listening behavior is a necessary ingredient for an interaction in which patients are describing and expressing themselves freely and openly (Nevile, 2006).

To test the doctor's listening behavior, the relative frequency of each category of information seeking and information giving behavior is calculated for the doctor-patient interactions, representing the number of dialogue acts in any particular category as a proportion of the total number of dialogue acts made by the speaker. A relative frequency of medical topics addressed in every interaction is calculated for all interactions. The doctor as a facilitator of doctor-patient interaction should demonstrate a high frequency of supportive and encouraging behavior in the presence or absence of patient desired behavior. Even though a patient's characteristics are very important to the quality of interaction, the doctor's facilitating behavior is essential since it allows patients either to express themselves or to repress (Nevile, 2006).

3 FINDING CULTURAL DEPENDENCIES

Information seeking behavior includes seeking information about medical topics. Direct, assertive and embedded question types are posed by both parties. On the other hand, information provisioning or information giving is providing a direct answer to a question, elaborating the question by providing supplementary information and deviating or changing the topics of the interaction without prompting from the interacting partner.

In this study we group the doctor-patient conversation into two categories: information seeking behavior and information provisioning behavior. Information seeking consists of utterances about information gathering, checking and cueing. Information provisioning contains utterances dealing with explanation, confirmation, and giving instructions. Both information seeking and information provisioning are analyzed against medical topics: illness, symptoms, diagnosis, treatment, exam/test and history (medical history) for both doctor and patient.

In the analysis we remove backchannels. Backchannels contain, greetings, and acknowledgment that carry little information value for healthcare doctors and patients. Removing backchannels should not affect the quality of information obtained from the interaction. We use a two-way ANOVA (Analysis of Variance) to see the difference between doctor and patient in the two criteria and medical topics or themes. Additionally, we check the number of questions posed by doctors and patients. Finally, we analyze the overall interaction process.

3.1 Methodology

The focus of this research is to design a spoken medical dialogue system on the basis of doctor-patient face-to-face interactions, to understand the weak and strong side of the interaction and to utilize actions taken place during the interaction. We have conducted a number of observational studies in which we recorded the interaction between patients and health professionals. Based on these observations we design the content of the conversation including question and declarative statements, the order of presentation of content, how a system responds to questions and words, sentence structure and tone used, to closely match the user expectations of what a health professional might ask, respond and sound like. In-depth interview studies show that this is perceived by patients as a successful conversation (Migneault et al., 2006).

The doctor-patient interactions are analyzed as follows. We classify the elicitation process based on semantic entities as shown in figure 1, leading to the following topics: (i) Illness, (ii) Symptoms, (iii) Diagnosis, (iv) Previous Treatment, (v) Current Treatment and (vi) Exam. Questions and Explanations are targeted towards the following variables proposed by (Nowak, 2011): (i) information, (ii) confirmation, (iii) checking, (iv) explanation, (v) cue and (vi) giving instruction.

First we address the efforts taken by both doctor and patient to identify problems and attempting to recommend. This includes the process of elicitation (information gathering), explanation, confirma-

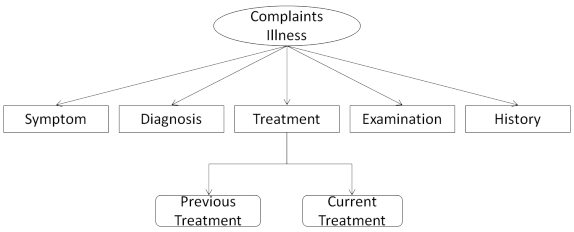

Figure 1: Semantic Entities of Doctor-patient conversation.

tion, checking, cue and giving instruction. We transcribed the audio recordings manually and tabulating into three categories: Information elicitation or information seeking and information provisioning or (information giving) in the case of the doctor and the patient in the interaction. We analyzed 29 conversations done by 4 doctors and 29 patients among 50 patients. We chose only patients coming for diagnostic purposes and ignored follow-up patients since it doesn't include the elicitation criteria (information gathering/seeking and information provisioning) and medical topics (illness, symptoms, diagnosis, treatment, exam/test and history) for diagnostic purpose.

3.2 Results

We have collected data to find out how, in the Ethiopian context, patients elicit information during a doctor-patient conversation. Therefore we have audio-taped 50 real doctor-patient interactions. The conversations took 6-7 minutes on average. The statistical analysis of the face-to-face doctor-patient interaction has resulted in the following findings. Out of 29 medical interactions, comprising of 442 turns, 171 (38%) turns classified as Information gathering, 167 (38%) utterances are uttered by doctors to elicit health information and only 4 (1%) of the utterances are uttered by the patients. Table 1 shows the breakdown of the doctor contributions to the doctor-patient interactions into (variable, topic) combinations. Table 2 shows this breakdown for the patient contributions. We may interpret this table as an estimator for probabilities as Prob (v—t, a) for variable v, topic t and actor a (either doctor or patient).

Table 1: Doctor utterances in medical information elicitation process in face-to-face interaction.

	Illn	Smpt	Diag	P.Tr	C.Tr	Exam	Hist	Total
Information	34	110	9	5	0	1	8	167
Confirmation	0	2	0	0	0	0	0	2
Checking	1	5	9	8	1	4	1	29
Explanation	6	4	9	3	1	5	0	28
Cue	2	1	2	0	1	0	1	7
Instruction	0	0	3	1	0	5	2	11
Total	43	122	32	17	3	15	12	244

Our first conclusion is that the interaction is mainly led by the doctor. The first dialogue act is a question posed by the doctor like 'How are you feeling?'. Then the patient explains complaints or feelings (s)he has. The doctor then will ask additional questions to identify causes, symptoms, and illnesses.

Table 2: Patient utterances in medical information request in the face-to-face diagnosis processes.

	Illn	Smpt	Diag	P.Tr	C.Tr	Exam	Hist	Total
Information	1	2	0	0	0	1	0	4
Confirmation	6	36	1	4	2	2	1	52
Checking	0	28	2	2	0	0	2	34
Explanation	12	76	5	6	0	1	3	103
Cue	0	0	4	1	0	0	0	5
Instruction	0	0	0	0	0	0	0	10
Total	19	142	12	13	2	4	6	198

Table 3 and 4 show information seeking and information provision of doctors and patients. We see that information seeking behavior of doctors (46%) is higher than that of patients (10%). Whereas, patients' information provisioning behavior (35%) is much higher than doctors' (9%). Besides, symptoms 60%, illness 14%, diagnosis 10%, treatment 8%, exam test and history 4% are addressed. In these doctor-patient interactions the medical topic has been given much attention during information seeking and information provision (about 122 turns used by the doctor for information seeking and 142 turns by patients to reply the questions posed by the doctor about the symptoms). The most prominent divergence appears in the fact that doctors most frequently initiated questions targeted towards information (68%), much less frequently towards checking (12%), and even less frequently towards explanation (11%), giving instruction (5%), cue (3%) and conformation (1%). The patients merely were answering the questions posed by the doctor.

Table 3: Information seeking and information provision behavior of Patient.

	Illn	Smpt	Diag	P.Tr	C.Tr	Exam	Hist	Total
InfoSeek	1	30	2	2	0	1	2	38
InfoProv	18	112	10	11	2	3	4	160

Table 4: Information seeking and information provision behavior of doctor.

	Illn	Smpt	Diag	P.Tr	C.Tr	Exam	Hist	Total
InfoSeek	35	115	21	14	1	10	11	207
InfoProv	8	7	11	3	2	5	1	37

3.3 Discussion

As discussed in the preceding section, turn taking is a dialogue act. A turn is defined as speaking without interruption. From the doctor-patient audio recordings we found that the number of turns of doctors is 276 and 238 of the patients. This figure indicates that the doctor speaks in long turns 56% over patients 46%. In general, patients talk less than doctors and most

of their interaction is in the form of giving information in response to doctor questions. Many studies indicate that doctor's dialogue acts encourage patients to discuss their opinions, express feelings, ask questions, and participate in decision making. This helps the doctor to more accurately understand the patient's goals, interests, and concerns as well allows the doctors to better align his conversation/interaction with the patient's agenda (Goold and Lipkin, 1999; Verlinde et al., 2012). On the contrary, some studies report that doctors often underestimate patients' desire for information, while overestimating their medical knowledge (Bickmore et al., 2006). Thus, allowing patients to ask questions, express concerns and state preference helps the doctor to infer matters that are important to patients in relation to their compliance.

Our findings show that the dialogue is initiated by the doctor in order to seek information about the patients health compliance and illnesses. Moreover, the dialogue is controlled by doctors to gather additional information about the illness (such as symptoms, illness history and medication). Generally, the request for information sets the initial purpose or goal that motivates the speaker's actions for the remaining section of the dialogue. The request for information further specified by one or more discourse segments. Asking questions and providing answers play a significant role in the process of the medical consultation. Mainly, the aim of doctor-centered behavior is efficiently gathering sufficient information to make a diagnosis and consider treatment options in the least amount of time necessary. This is in contrast to patient-centered interactions that can recognize patients as collaborators who can share not only their biomedical states (physical condition and well being) but also knowledge of their psychological situations (personality, culture, social relations, etc.). The result of quantitative analysis shows, there still is an equal distribution of information seeking (questions) between the dialogue participants, with almost all elicitation initiated on the part of the doctor. The data also demonstrate that both doctors and patients emphasize on asking and responding about symptoms and illnesses. For example from a total of 442 dialogue acts, 122 and 142 dialogue acts are used to elicit symptom information by doctors and patients. Generally, 59.7% of the interaction was devoted to seeking and giving information about symptoms and 14% of illnesses. The finding show a significant difference (F= 14.02, P=0.0026, alpha= 0.05) between doctors' and patients' information seeking behavior in f-test, but no significance difference is found in patients' and doctors' information giving behavior.

We also analyzed the data using two-way analysis of variance. We found that the information seeking score of doctors is higher than for patients, but the difference is statistically not significant. The score of information giving behavior of patients was higher than the doctors, but similarly there is no significant difference. The first impression about people often turns into long-term perceptions and reputations. So doctors in their first encounter should make good eye contact, shake patient's hand and introduce himself. In the face-to-face interaction we recorded that there were no greetings and introduction during the initial doctor-patient interaction. In each dialogue sentence or clauses the participant (doctor/patient) utterance is categorized into semantic entities (figure 1) in which the dialogue theme is emphasized. Since the conversation is between a doctor and patient for diagnosis purpose we identify the main concepts evolved in the interaction process. Compliant, symptoms, treatment, illness, exams, history, and prescription are the most common entities used in the doctor-patient conversation.

3.4 Cultural Aspects

Cultural differences may be an obstruction for effective doctor-patient interaction. The cultural perceptions of health, sickness, and medical care of patients and families may differ with that of the doctors. Speaking the same language and being born in the same location does not automatically mean sharing all the elements of a particular culture. Studies have shown that a patient's culture will affect the way they perceive their body, illness, and disease. This is also true for the doctors as their own families and communities have also helped to shape these cultural beliefs within them. Each participant in the medical interview brings with them the culture in which they were raised. At times, differing cultural beliefs can have an adverse effect on the care that one receives. Communication problems arise when the patient and doctor do not share the same culture.

Culture competencies in medical interaction provide a patient centered care by adjusting their attitudes and behaviors to the needs and desires of different patients and account for emotional, cultural, social, and psychosocial issues on disease and illness. Medical competencies relate directly with the doctor-patient interaction that are required by the doctors to conduct an effective interview and to create an acceptable plan of diagnosis and treatment. Studies indicate that issues that may cause problems in cross-cultural encounters are authority, physical contact, communication styles, gender, sexuality, and family.

Hofstede (Hofstede et al., 2010) has identified five

cultural dimensions. (1) Power Distance focuses on the perceived degree of equality, or inequality. According to Hofstede et al., [2010] "A high power distance ranking indicates that inequalities of power and wealth have been allowed to grow with the society. In these societies equality and opportunity for everyone is stressed". In large power distance cultures, ones social status must be clear so that others can show proper respect. In line with this, Hofstede et al. assert that the power distance exhibited in society also is reflected in the relationship of doctors and patients. They say that "in countries with large-power distance cultures, consultations take less time, and there is less room for unexpected information exchanges". The findings indicate that the average time spent on face-to-face consultation is 4-6 minutes. This result confirms that power distance plays a major role in doctor-patient interaction. According to Hofstede, Ethiopia is a large power distance country, so the interaction is dominated by doctors and patients rarely participated in treatment and diagnosis decision makings.This is true especially for illiterate and rural people. The power distance of literate people and doctors is better compared to the illiterate. In line with this (Verlinde et al., 2012) said that doctors asked less educated patients and low income patients more questions about their disease and medical history. Likewise, our findings indicate that doctors' information seeking behavior is more than that of patients'. Generally, in Ethiopia, patients treat doctors as superiors, consultations are shorter and controlled by doctors.
(2) Hofstede's cultural dimension indicates that Ethiopia as a low individualism country. The implication of individualism in healthcare particularly in doctor-patient interaction goes with patient autonomy, the possibility of choice, flexibility of social roles, less conformity, and psychosocial information exchange (Meeuwesen et al., 2009)
(3) Ethiopia is a masculine country (Hofstede's cultural dimension); however, regardless of other dimensions, masculinity doesn't reflect on the patient - doctor interaction in diagnosis and treatment. Some studies revealed that there is a difference between female and male doctors in creating partnerships, with patients and dealing with psychosocial issues during the conversation. Meeuwesen et al., [2009] stated that the more masculine a county, the more instrumental (disease centered) interaction will dominate, the less attention will be paid for psychosocial issues and more frequently the majority of doctors will be men or male. The analysis result shows that mainly the interaction between doctors and patients was on the theme of symptoms 60% and illnesses 14%. Eventually the theme of the conversation is disease-centered.
(4) Uncertainty Avoidance in the healthcare domain primarily deals with patients' emotionality or anxiety, or stress and doctor's task-orientation, preferences of technological solution and degree of medication. In countries with strong uncertainty avoidance (Meeuwesen et al., 2009) the more disease-centered (instrumental talking), the less affective talking and the more biomedical exchange can be expected. This a true scenario in Ethiopia cases; since doctors indulge themselves in diagnosing the illness. In the experiment, we have not found a single introduction (greetings) communication act. Hofstede further explained that "doctors in uncertainty tolerant countries more often send patients away with comforting talk, without any prescription. In uncertainty avoiding countries doctors usually prescribe several drugs, and patients expect them to do so" (Hofstede et al., 2010).
(5) Regarding long-term orientation, as Ethiopia doesn't have data we left out in our analysis.

4 A SPOKEN DIALOGUE MODEL

Eliciting user requests in the medical spoken dialogue is the main challenge for developers and implementers of the system. Unlike a face-to-face doctor-patient interaction it is very hard to analyze the patients' attitudes and emotions. As a result the eliciting techniques should be patient centered; and the main role of the doctor is a facilitating behavior, focused and unfocused open questioning, request for clarification, summarizing and empathy. Thus, the dialogue system should act like human which can help to elicit the patients' request in order to provide accurate consultation, diagnosis and treatment.

To the best of our knowledge eliciting user medical requests using spoken medical dialogue based on some suggested principles is not assessed, and there is no any results obtained. Our objective is using the best practice of in-person doctor-patient interaction activities to be adopted in the spoken medical dialogue system to search medical information using mobile phones.

4.1 A Simplified Dialogue System

Spoken medical dialogue tends to be patient centered. Thus the system should facilitate the interaction and ask open questions in which the patients can express not only knowledge of their biomedical state (illness and complaints) but also knowledge of their psychological and social situations (personality, culture, relationships). As discussed before, the face-to-face in-

teraction in Ethiopia is doctor dominated. However, in the dialogue system it is impossible to detect the non-verbal behavior of the patient. Thus, the elicitation should be dominated by the patient in order to seek biomedical as well as psychosocial situations of the patient. Doctor's behavior that encourages patient active participation includes asking open ended questions, ensuring and confirming patient comprehension, requesting patients' opinions, and making statements of concern, agreement and approval. Hence, spoken dialogue to resemble human-human interaction, should encourage patients to take part actively in the interaction process. Instead of being expecting responses from patients, the system must take a facilitative role in order to provide time and space for patients to speak out what their symptoms, illnesses, suggestions and to participate in decision making.

From the analysis of the in-person interaction of doctors and patients, it was found that there are some gaps that should be filled. The main gaps observed in the face-to-face interaction is doctor domination as well as we identified that the social status of patients and doctors inhibits the interaction process. Other factors that affect the face to face interaction are illiteracy and culture. In rural Ethiopia, the illiteracy rate is higher than in urban areas, so patients from rural areas visited find the interaction with the doctor is difficult; the doctor may consider that non educated rural patients do not express themselves so that a doctor prefers to ask some closed questions and open leading questions to elicit the user requirements. But even when doctors and patients born and live in the same area, they do not necessarily have the same understanding of social norms and cultures. Consequently, the non-literate rural patients are more conservative of their values and cultures; some of the illness may not be disclosed in public so to keep their culture or values they reserved from disclosing their feelings, symptoms and illnesses. For instance, a study conducted in USA revealed the gap between doctors and Ethiopian migrants in disclosing illnesses and diseases. According to this study, the migrants did not want to be told if their disease is life threatening; whereas, doctors in US disclose the nature of the illness, the risks of the illness (curable and incurable) and the magnitude of the illness (treatable or non-treatable) (Beyene, 1992).

From the face-to-face doctor-patient interaction we deduce the user request elicitation model displayed in figure 2 for spoken dialogue system for healthcare application. The model consists of four components: opening initiatives, asking information, giving information and closing. Figure 2 displays user request elicitation process for the spoken dialogue systems in a healthcare scenario based on doctor-patient face-to-face dialogue.

4.2 Design Dialogue System

Data validity, accuracy and integrity are the vital points to be considered in designing a spoken dialogue application; since automatic speech recognition(ASR) technology is not perfect. The design of spoken dialogue technology should take into account the possibility of speech recognition errors and improve the overall accuracy using dialogue actions such as re-prompts, conformations, error correction and handling etc. Secondly, it should provide equal access to novice and experienced end users of the system. Thirdly, it should also consider individual differences such as personalization and user context. Finally, before developing the dialogue system it is very important to conduct a face-to-face interview or pay live observation while a doctor is treating a patient (if possible video tape the conversations). The most commonly applied methods to design a spoken dialogue include human-human dialogues and design by simulation. Thus, our interest lies on to look into doctor-patient interactions as a means to design medical spoken dialogue.

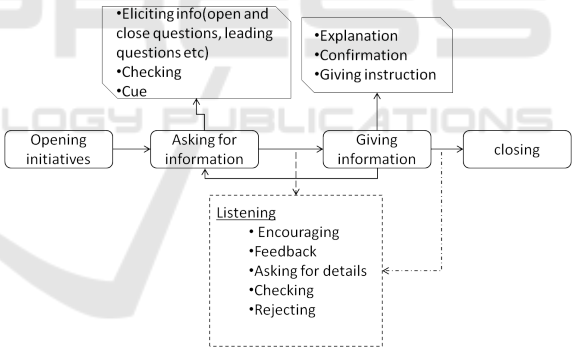

Figure 2: User request elicitation process.

4.3 Designing a Dialogue based on Doctor-Patient Interaction

Human-human dialogue provides an insight how humans accomplish a task-oriented dialogue. The doctor-patent interaction studies take place in the early stages of the speech application life cycle. They act as a starting point for spoken dialogue design and help to define requirements. The purposes of doctor-patient interaction studies are to help the designer see the task form the user point of view, develop a feeling for the style of interaction, and acquire some specific knowledge about the vocabulary and grammar used in the diagnostic process.

Doctor-patient interaction (natural dialogue) study differs significantly from the wizard-of-oz studies, that have been used extensively by others in the design of spoken dialogue systems. Researchers who use the wizard-of-oz techniques begin the process with a pre-experimental phase that involves studying natural human dialogues. Whereas the natural dialogue takes place prior to any system design or functional specifications (Yankelovich, 2008). The main purpose is to launch the design process.

Before designing the medical dialogue system, we wanted to discover how doctors and patients interact in the diagnosis process. From the analysis of the doctor-patient interaction, we found that the interaction is doctor-centered as well as we found that patients question asking behavior is hampered by the cultural influences such as: distance power, high uncertainty avoidance and the like (see section 3.5).

It is impossible to produce a medical dialogue system design based entirely on doctor-patient face-to-face interaction. Rather it can play an important role in the early stages of the development life cycle, and serve as an effective starting point for spoken medical dialogue system design.

5 CONCLUSIONS

We have analyzed the interaction in 29 audio-taped doctor-patient diagnosis dialogues in the Gamby Teaching hospital. The study is mainly conducted to investigate the information seeking and information provisioning behavior of doctors and patients. The finding shows that there is no statistical significant difference between doctor information seeking and patient information seeking behavior. Similarly, we didn't find any significant difference between patients information provisioning and doctors information provisioning behavior. From this analysis we conclude that studying face-to-face interaction between doctor and patients is an effective starting point for spoken medical dialogue system design. We also found an influence of culture on doctor-patient interaction; so cultural values should be incorporated while designing and developing a medical dialogue system. Finally, based on our results, we propose a model to assist user requirements elicitation in order to develop a medical spoken dialogue system. In the future we will implement our model to develop a medical dialogue system.

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