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SACA: Software Assisted Call Analysis – An interactive tool supporting content exploration, online guidance and quality improvement of counseling dialogues

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ABSTRACT

Objective: Nearly 30,000 individual inquiries are answered annually by the telephone cancer information service (CIS, KID) of the German Cancer Research Center (DKFZ). The aim was to develop a tool for evaluating these calls, and to support the complete counseling process interactively.
Methods: A novel software tool is introduced, based on a structure similar to a music score. Treating the interaction as a "duet", guided by the CIS counselor, the essential contents of the dialogue are extracted automatically. For this, "trained speech recognition" is applied to the (known) counselor's part, and "keyword spotting" is used on the (unknown) client's part to pick out specific items from the "word streams". The outcomes fill an abstract score representing the dialogue.
Results: Pilot tests performed on a prototype of SACA (Software Assisted Call Analysis) resulted in a basic proof of concept: Demographic data as well as information regarding the situation of the caller could be identified.
Conclusion: The study encourages following up on the vision of an integrated SACA tool for supporting calls online and performing statistics on its knowledge database offline.
Practice implications: Further research perspectives are to check SACA's potential in comparison with established interaction analysis systems like RIAS.

1. Introduction

Communication of evidence based cancer information in a client-centered, easily comprehensible way is the main task of the Cancer Information Service (CIS, KID) of the German Cancer Research Center [1–3]. Information is provided via a toll-free hotline, an email service, a comprehensive website and written material. Just recently, the CIS was appointed National Reference Center for Cancer Information. This implies high demands regarding quality of performance with respect to information content and communication. Also, contributions to health services research and reporting are expected, such as identification of specific information needs and possible gaps in provision of care and support reflected in the inquiries.

In 2009 about 28,000 users contacted the service for information and counseling. Of these, 46% were patients, 32% relatives or friends, referring to an individual case of cancer in their inquiry and asking mainly about treatment options and guidance to appropriate healthcare services. 17% were general public with questions mostly concerning risk factors and primary or secondary prevention of cancer.

With respect to the described tasks of the CIS it would be of high value to preserve relevant information contained in these inquiries. Unfortunately, with current routine e-documentation little information is kept of the calls apart from core data like age, sex and type of caller, situation referred to, and a rough classification of the major subjects of inquiry. Earlier-on, contents of inquiry and information provided were documented in free text, but this concept was abandoned due to time consumption and poor validity. Examination of random samples revealed considerable discrepancies between the actual call contents and the summaries given.

Therefore, it was desirable to develop another method of content extraction – preferably automated, online and guided interactively – with a resulting data base of dialogue extracts permitting retrieval and analysis of single calls as well as arbitrary statistical evaluations or comparisons of selected sets of calls, e.g. regarding specific needs in different disease situations or age groups.

With the aim of quality assurance of the service provided, algorithms are being developed for following and supporting the

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interactions online, regarding appropriateness of communication style and information, through context sensitive speech recognition and detection of non-verbal cues.

The process of communication and information giving at the CIS recognizes the special requirements with respect to cancer communication as well as telephone counseling, and the information specialists/counselors are trained accordingly. The interactions follow a structure of perception and eliciting of needs and concerns, individualized information giving at the caller's pace and level of understanding, while the counselor at the same time is alert to emotional cues and reactions on the caller's part. It is quite clear that this is a complex and demanding task, which needs consequent reinforcement and support.

The aim to capture content as well as to support the communication process in the most impartial and least time-consuming way and with maximum data protection was the starting point for developing the concept of Software Assisted Call Analysis (SACA).

While the primary goal of SACA is to facilitate statistical call evaluation and to support the provision of service at the CIS – and in a broader sense the service of health/medical call centers which play an increasing role in health care – it appeared in the course of the project that this tool might also deserve evaluation in comparison to other communication and interaction analysis systems used in communication research, such as RIAS, which has also been tested with cancer consultations (this topic will be discussed in Section 4.3). The SACA features may stimulate comparisons of both tools, taking into account possible advantages – such as automated online performance with the possibility of arbitrary posthoc evaluations.

2. Methods

The SACA software tools are based on speech recognition techniques. They capture and extract content and context on the counselor's part, detect phase specific keywords on the caller's side, and generate a structured mapping of the entire dialogue, recognizing and annotating also characteristics of communication style, like length and share of talking of caller vs. counselor, pauses, tempo, or tonality. The result is a quite comprehensive, if abstracted, representation of the dialogue.

2.1. Speech recognition

This concept means the automatic translation of spoken language into written text. Today, in the so-called *trained mode* (where the recognition or translation software is adapted to a specific speaker) and under optimal conditions (especially regarding acoustic environment and technical equipment) a recognition rate of more than 95% may be expected. In the *untrained mode* however (speaker is "unknown" to the software) only some few words embedded within phrases can be detected by a technique known as *keyword spotting*.

Altogether this may appear a bit disappointing when the aim is to capture a complete/comprehensive interaction. But apart from the fact that a 100% correct transcription of a trained/untrained dialogue is utopian with current software, this would not be very helpful anyway, because the contents identified could not be analyzed automatically due to their unstructured form.

This leads to the concept of tackling *Software Assisted Call Analysis* in several steps:

1. Online extraction, structuring and storing of substantial contents of a call via speech recognition techniques, preserving the different tracks (caller and counselor) and the sequence of utterances and events.
2. Investigation of correlations e.g. between certain utterances, topics or word choice and non-verbal signs or cues.
3. Use of the content stored in the database to provide online support to the counselor, e.g. by on-screen insertion of resources appropriate to meet the caller's request.
4. Offline retrieval, exploration and statistical evaluation of content as well as comparison and clustering of interactions.

More details will be given in Sections 2.1.1 and 2.1.2. With further development of the program, the steps should gradually merge together, such that the course of the dialogue will be supported by automatic and interactive access to the complete knowledge stored so far.

An overview of current topics regarding *human language technology* in general can be found in [4–7]. *Telephony applications* in particular are discussed in [8,9]. To our knowledge, though, such technologies have not yet been applied or adapted to the field of communication in healthcare.

More general thoughts and concepts are discussed in Signposts to Tomorrow's Human–Computer Interaction [10], while Experiences with Commercial Telephone-based Dialogue Systems are discussed in [11–13].

Current software tools widely used in real-life situations are e.g. *Dragon Naturally Speaking* (Nuance Communications Inc.), *SpeechMagic* (Philips Speech Recognition Systems GmbH) and *Voice Pro* (IBM Corporation), all of which can perform speech recognition on part of a known speaker (i.e. the counselor); *SymSpot* (Sympalog Voice Solutions GmbH), *AudioClipping* (Com Vision Betreibergesellschaft mbH) and *SpeechAgent* (SpeechConcept GmbH) on the other hand accomplish keyword spotting for and unknown speaker's part (i.e. the caller). With SACA, a version of Dragon Naturally Speaking is used.

Let us look at the course of a caller–counselor dialogue: a (unknown to the speech recognition software) caller introduces himself, more or less in detail, and states his concern, asks one or more questions. The (known) counselor paraphrases, elicits more details to clarify the situation, the caller's concerns and expectations (perception), then leads over to information giving, reconfirms understanding and appropriateness. Further questions, concerns and emotions may arise on the caller's side, more eliciting is required, more information is provided – and so on until the needs have been met and the interaction comes to closure. Overall, it has to be noted that the dialogue is not dominated, but structured and guided by the counselor who follows a communication strategy and listens to the caller to establish rapport and to capture the concerns.

2.1.1. What is the essence of a dialogue?

In other words, which data should be extracted, structured and stored automatically? For the purposes of the CIS, e.g. the following features are of interest:

Meta data. These data characterize the caller socio-demographically ("at first glance"), e.g. by sex, age, marital status, professional education, place of residence or level of language. Some formal aspects, like e.g. time and duration of a call, are generated and stored automatically in its log file.

Needs and concerns. Here, primarily health and particularly cancer related topics will be concerned, like a case of cancer, symptoms and treatment (in the caller's language), or anamnesis, diagnosis, therapy and course of illness (from the counselor's point of view), and, most importantly, details regarding individual information needs and concerns.

The context sensitive combination of all these data allows for online support of the interaction (i.e. quality assurance) and posthoc (offline) arbitrary statistical evaluations of caller characteristics and needs.