Focussing User Studies: Requirements Capture for a Decision Support Tool.

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Abstract

We are designing an innovative decision support tool to assist radiologists in the evaluation of brain tumours. The system combines Magnetic Resonance Spectroscopy (MRS) and pattern recognition techniques to provide radiologists with additional information about brain tumours. Initial user studies involved workplace interviews, software prototyping, and multidisciplinary design discussions. We have gained several insights relevant to system design. Also many important issues for future studies were raised. This paper describes these issues and how they inform ongoing user studies. Issues include; 1) the validity of findings, 2) their translation into requirements, 3) their communication within a multidisciplinary development team.

Keywords

Medical decision support systems, workplace studies, requirements capture, prototyping, user-centred design.

Introduction

Our initial user studies have employed workplace interviews, rapid software prototyping and multidisciplinary design discussions. So far we have focussed studies mainly on radiologists, the perceived users of the system. These studies have provided us with many useful and interesting implications for design. They have also posed a number of questions.

- Are we designing a decision support tool, a report enhancement tool, or a new way of working?
- How do we study a work practice that is currently undergoing change and which is in the very early stages of its evolution?
- Who should we be studying: radiologists (the report writers), neurosurgeons (the decision-makers), or the neuropathologists (whose roles could be affected by the system)?
- How do we study complex human interactions in the limited access context of medical settings?
- Time constraints inevitably mean studies involve a limited number of practitioners in a restricted variety of contexts. How do we validate our findings as generalisable?
- Findings drawn from qualitative data are subjective. How do we ensure different researchers would have reached the same conclusions?
- How do we translate user study findings into design requirements and communicate these throughout a multidisciplinary development team?
- Early software prototypes have proved an extremely useful aid to communication. However, they may have constrained innovation. How should we encourage the sharing of novel design ideas?

In addressing these issues we are open to the idea of Ôbegging, borrowing, or stealingÕ techniques from other disciplines. However, we are also aware of the potential dangers in applying Ôbegged, borrowed and stolenÕ techniques without the accompanying domain expertise and theoretical understanding; see

First we describe the rationale for building a decision support tool for radiologists. Then we describe the methodology employed in our initial user studies, relevant findings and some limitations. Finally we indicate how our early studies are focussing further studies.

System Rationale

When clinicians have reason to suspect the presence of a brain tumour the usual procedure is to request a radiological examination. During this examination, Magnetic Resonance Images (MRI) are often obtained and evaluated by radiologists. These may reveal the presence of abnormal brain structures. However, it is rarely possible to make a sufficiently accurate diagnosis from these images alone and a biopsy is often required. Biopsy involves the surgical extraction of tissue from the area of the tumour and is, needless to say, unpleasant. Also, this kind of surgery cannot be constantly repeated to follow tumour evolution or response to treatment [6].

Our intention is to provide a system that ultimately reduces the need for biopsies. This might be achieved by providing radiologists with additional information about the biochemical composition of tumours. Such information can be acquired non invasively and painlessly in the form of Magnetic Resonance (MR) spectra. Currently MRS is underused in clinical practice, primarily because most radiologists do not have the expertise necessary to interpret brain spectra.

A solution to this problem might be to automate the classification of brain tumour spectra. A variety of pattern recognition techniques have been developed to this end and have been demonstrated with relatively high success [6]. If we can make these techniques available to radiologists in an accessible manner it should be possible to discriminate between some of the brain lesions that they currently find difficult to distinguish.

However, historically a major problem for medical system design has been the rejection of innovative systems by their intended users [2]. Often this has been due to insufficient understanding of the usersÕ requirements and the context of their work. As Cuthbert [personal communication] notes, clinicians are unlikely to adopt systems which ignore their modus operandi, or appear to challenge their expertise. It is therefore essential for us to develop an understanding of radiologistsÕ work, needs and expectations, and to use this knowledge to inform system design.

Initial User Studies

Aims for the initial user studies were; 1) to develop preliminary models of radiologistsÕ work and the organisational and physical context it takes place in, 2) to begin to develop collaboratively a vision of an appropriate decision support tool.

The proposed decision support system is innovative and its development requires multidisciplinary teamwork. Radiologists, spectroscopists, pattern recognition experts and software developers all have their own specialised vocabularies and consequently communication can be difficult. It is, therefore, extremely important to reveal and resolve any miscommunications at an early stage in the design process. Design dialogues focussed on external representations, such as prototypes, can help to establish a shared understanding. To this end we implemented a first software prototype in Java. User studies took place at two radiological diagnostic centres during working hours. This facilitated observation and demonstration of the radiologistÕs work in context.

1. Radiologists were asked to describe and demonstrate the radiological examination process. ÒLiveÓ observation of this process is complicated because: 1) it is relatively unlikely that a patient with a brain tumour will be examined during the visit, 2) it is inappropriate to interrupt and ask for clarifications while the radiologist is engaged in examining and reporting on a case.

2. The prototype system was installed and demonstrated on the radiologistsÕ PCs. They were then given an opportunity to interact with it and ask questions. The flexibility of the prototype was emphasised and suggestions were encouraged. Radiologists were then asked to comment on the prototype and to describe how they might use it, or a similar system, in the examination process.

3. Multidisciplinary design discussions followed the interviews. These involved a spectroscopist, a pattern recognition expert, the radiologist and the researcher.

Data Analysis

The interviewer analysed transcripts of the interviews to identify trends and consensus. These were summarised as lists of initial requirements and suggestions. Diagrammatic representations of the current and envisaged radiological examination process were also produced. The summaries and diagrams were iteratively refined and validated in follow up interviews with the radiologists and in the design discussions. In future studies we intend to design questionnaires based on the refined process models and requirements. These will be subject to quantitative statistical analysis. Follow up interviews also provided an opportunity to demonstrate new versions of the prototype modified in response to radiologistsÕ design suggestions.

Outcomes

These early studies are helpful in focussing the direction of future studies. They have also proved to be an extremely rich source of data and provided us with potentially useful information that can be structured in a number of areas.

- An initial model of the organisational and physical context the radiologistsÕ work takes place in.
- A preliminary task model of the current MR examination process.
- A preliminary task model of the envisaged decision support tool enhanced process.
- Implications for future user studies.

Some of these implications are summarised below.

- We need to consider the radiological examination process and the role of a decision support system within the wider context of patient handling. The users of radiologistsÕ reports are stakeholders in a system intended to assist brain tumour diagnosis. All of these report users should be identified and considered by future studies.
- Neurosurgeons, not radiologists, take the decision to biopsy or not. We need to understand the collaboration between radiologists and neurosurgeons and the part the radiological report plays in the biopsy decision.
- Human decision-making requires explanation. Automated classification of brain tumour spectra must be supported by evidence. Tools are required that enable radiologists, with limited expertise in spectroscopy, to report significant spectral findings. Artefacts already in use by some radiologists suggest the possible form of these tools. Examples are images of ÒtypicalÓ spectra from

different types of tumour, and brief written guidelines on spectral features characteristic of particular tumour type.

- Radiological reports typically describe findings from the MR images and occasionally suggest a diagnosis or diagnoses. They may also include a short paragraph or sentence describing findings from MRS. Issues of accountability and the expression of diagnostic certainty will be very important in systems supporting radiological work.

Our initial studies used interviewing, dialogue and prototyping techniques. These have provided us with a wealth of data in a relatively short time, much of which appears useful for the design of our system. However, as mentioned in the introduction, there are several limitations:

- We are designing a system intend for use internationally by radiologists working in potentially very different contexts and possibly with varying needs and expectations. To date our studies have involved three radiologists in two centres located in the same city. We need to validate our findings at a reasonable number of radiological centres and across national borders.
- We have not studied the relationship between radiologist and neurosurgeon, the radiological report, or the artefacts currently used to support brain spectra evaluation.
- Development of the proposed system requires collaboration between experts from a number of disciplines. We need to develop an approach for translating our findings into design requirements and communicate these successfully throughout this team.

Conclusion

The success of our approach to early user studies can be gauged not so much by the answers supplied as by the issues brought into focus. We are currently exploring how to address these issues.

- We hope to study a larger number and wider variety of participants in more varied contexts in a comparatively shorter time by focussing on iteratively refining models of our current understanding and filling in any gaps.
- We intend to identify possible international differences in clinical practice by broadening studies to include clinicians working in centres in the four European countries participating in an extension to this project. We also hope to use more widely distributed questionnaires to gain further international feedback on findings from these centres. Possibly, we will also make requirements models and process models available over the web, set up a system for users to comment on them and invite commentary from a wider audience than it is possible to involve directly in user studies.
- We may be able to address issues of limited access to significant interpersonal interactions, by adapting what Plowman refers to as Õethnography by proxyÕ[4]. Essentially this involves asking our informants to collect focussed data on our behalf.
- Information on how a decision support system might affect work practice may be obtained by introducing a functional prototype in context. Longitudinal data on its usage and influence on the reporting process could be collected, perhaps also Õby proxyÕ.
- Diagrammatic representations could be used to structure and communicate findings. Viller and Sommerville [7] describes how UML can be used to express findings from ethnographic studies. Alternatives might be the various work model diagrams employed in Contextual Design [1].
- Narrative descriptions of concrete task scenarios could also be a valuable means of communication. Rosson and Carroll [5] describe how scenarios can be built collaboratively by developers and users.

- We could make these representations available and support their interactive refinement at multidisciplinary meetings. These would also serve as a forum for exchanging design ideas. The generation and sharing of these ideas might be encouraged by the use of paper prototypes. However, our development team is distributed internationally and physical meetings may not often be possible. We are considering how we can support these processes at a distance.

We expect that by broadening the range of techniques we employ both in the next round of user studies and in the structuring, analysis and communication of data and findings, we will be able to address some of the outstanding issues raised by our preliminary studies.

Acknowledgements
We thank the following for their participation:
Ar s, C. Departament de Bioquimica i Biologia Molecular, Universitat Autonoma de Barcelona.
Capdevilla, A. Centre Diagn stic Pedralbes, Cetir Grup M dic. Barcelona.
Maj s, C. Institut de Diagn stic per la Imatge, Centre Bellvitge. Ciutat Sanit ria I Universit ria de Bellvitge (IDI¥Bellvitge).

Further user studies will form part of the INTERPRET project, funded by the European Commission as part of the Information Society Technologies Programme. Information available on-line at <http://carbon.uab.es/INTERPRET>.

References

1. Beyer, H. & Holtzblatt, K. Contextual Design: Defining Customer-Centered Systems. (1998).Morgan Kaufmann, San Francisco.
2. Coiera, E. The impact of culture on technology [Editorial] eMJA (1999). On-line at <http://www.mja.com.au/public/issues/171_10_151199/coiera/coiera.html>
3. Forsythe, D. E. "ItÕs Just a Matter of Common Sense": Ethnography as Invisible Work. CSCW Vol.8, Nos 1-2, (1999), 127-145.
4. Plowman, L. Rethinking the Role of the Fieldworker for CSCW: Ethnography by Proxy. CSRP No. 417. (1996) School of Cognitive & Computing Sciences, University of Sussex, Falmer, Brighton, BN1 9QH, UK.
5. Rosson, M. B. & Carroll, J.M. Integrating Task and Software Development for Object-Oriented Applications. in Proc.CHIÕ95 (Denver CO, May 1995), ACM Press, 377-384.
6. Tate, A. R., Griffiths, J. R., Mart nez-P rez, I., Moreno, A., Barba, I., Caba as, M. E., Watson, D., Alonso, J., Bartumeus, F., Isamat, F., Ferrer, I., Vila, F., Ferrer, E., Capdevila, A., Ar s, C. Towards a method for automated classification of 1H MRS spectra from brain tumours. in NMR in Biomedicine 11,(1998) 177-191.
7. Viller, S. & Sommerville, I. Coherence: An Approach to Representing Ethnographic Analyses in Systems Design. Human-Computer Interaction Vol. 14. (1999) 9-41.