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Supporting visual reasoning about the quality of interactions in cooperative healthcare between patient and health practitioners

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RESEARCH

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Abstract

Health care is increasingly being viewed as a team effort between practitioner and patient, with the recognition of the quality of interaction as a potential problem in such team effort. The paper addresses this problem, providing a solution that enables to record, monitor and analyse the quality of such interactions. It is based on a visual language used to represent the quality of interactions. The shape and behaviour of the visual elements and expressions are based on the physicality of human movement. The visual expressions resemble musical scores. As the behaviour of the visual elements corresponds to our bodily knowledge, commonly understandable to humans, the information about the quality of the interactions, expressed in this language is easily digestible by people with a broad range of backgrounds. The paper presents also the visual reasoning technique that works with the setting and a high-level view of the underlying ICT architecture. The practical utilisation is demonstrated with an example from occupational therapy.

Introduction

Patient progress in the healthcare environment is a dynamic process that happens through various interactions: with health care professionals, through diagnostics, with treatment components, to name a few. The importance in recording and representing this broad spectrum of interactions has been well recognised in recent research (Gerhard, Moore & Hobbs, 2003) including the analysis of the complex professional-patient interactions subject to human error (Dhillon & Rajendran 2005). In the domain of healthcare interactions play essential role and yet the information about them and their quality is underutilised.

Studies of information technologies within various healthcare settings have focused on issues of accessibility, for instance to electronic health records (Berg & Haterink, 2004) or generalised spread of access online for self help such as NHS Direct Online. In contrast, in this paper, the focus is on the capture and utilisation of situated information in the interaction process in consultations, or other health contexts. Authors note that procedures in health can exhibit high variation between health professionals and that the management of decisions has to consider that (i) guidelines do not account for differences among individual patients both subjective and objective: (ii) the 'missing piece' is the patient who all too often is made invisible in their own health journey.

The notion of the embodied process is central to the approach taken. Often the patient is treated for the 'issue,' the health problem, but scant attention is paid to the whole human being and the context they operate within beyond the presenting state of their health problem or illness. Mol and Law (2004) have proposed the use of ethnographical research to enhance healthcare with an aim of including the presence of the patient, both as an object of investigation and as subject of their experience of their health journey. Yet the ability of the patient to make informed decisions requires access to better management of clinical decision making as a means of ensuring quality (Sepucha, Fowler & Mulley 2004).

Systems of interaction

In this paper a system of reflective action to model the interaction process is proposed. There are a number of systems of interaction analysis that provide common features as noted by Ford, Hall, Ratclie, & Fallowfield (2000). These are, (i) an observational medium (e.g. review of video/audiotape or transcript); (ii) notable behaviours of interest (e.g. verbal, problem solving strategies etc.); (iii) some classification system for categorising behaviours and an operational approach for measuring these behaviours (e.g. units of speech/ utterances, interacting parties, some type of rating procedures and/or scales for qualitative measurements). There are also various categories derived from the observational analysis that deal with measurement types, such as, linguistic derived content types, non-verbal behaviours and so on.

The interaction system proposed in this paper has several discerning characteristics to the above approaches. These are:

- that representations and analysis of interactions can be constructed from the information provided by embodied parameters of actions;

- that the dynamics of interaction processes can be interpreted and represented through the dynamics of interaction modelled on aspects of human movement;
- that a visualisation layer capable of reflecting the interaction process to participants in real time (or with minimum system lag) is beneficial for enhancing co-reference through the visual representation of the interaction process
- that access to inter-action sequences inherently express an ethnographical perspective, and
- that a participatory approach to interaction where the patient 'writes' into the interaction process as well as the health practitioner can be modelled.

Current electronic patient records and the information technology tools for accessing them do not map clinical interactions as visual processes and do not support access to utilising the implicit knowledge that is embedded in them. Too often the interface between client and health care professional is limited in its application by:

(i) Cultural and or language barriers. Parties involved in the interaction may use different language (in broad sense, including many aspects of non-verbal behaviour that are considered to be performing social actions of various kinds). Scant attention has been given to how identity characteristics shape the interaction process (McKinlay, Ling, Freund, & Moskowitz, 2002).

(ii) Little or no record of the interaction process that produced the recorded output specifically from the patient perspective. Typically focus has been on supporting technology for collection of patient data; however, the technology fails when necessary to make visible the healthcare interactions and the reciprocal effects of the interaction encoded in the underlying data in real time Most communication studies of interactions are assessed from the perspective of the doctor, not the patient, and not assessed as reciprocal and dynamic phenomena between two or more persons (Roter & Hall, 2006, p48).

(iii) No information about the "big picture" of how clinical interactions unfolded linked to the context and the outcomes (technically, such information is not in the patient records). The benefit of visual representations of 'histories' (sequences of interactions) has not been assessed but the importance of such representations has been noted for considerable amount of time, (Watzlawick, Beavin, & Jackson, as early as 1967, noted that a system of interaction analysis needs to have a mechanism that addresses inter-action sequence and how such a sequence can be incorporated into the coding method).

The conceptual modelling for designing visual elements

In order to address the notion of the informed patient and the inclusion of situated interaction information the model proposed here develops a novel approach for encoding the information about the structure of health-care interactions and a visual language for presenting these interactions at different levels of granularity that provide for the needs of different interacting parties. The underlying representation and the visual language are derived from the bodily knowledge of human movement we have access to. The principles and methodology for designing visual languages representing interactions rely on the fact that humans can recognise intuitively constructs in interactions modelled on human movement and can communicate meaning about interactions through such constructs. Hence, as shown in (Deray and Simoff, 2006 and 2007) a visual language whose elements and their behaviour are derived from these constructs, can provide efficient means for representing information about the quality of interactions consistently at different levels of granularity. This result is supported by the research in kinaesthetic thinking and reasoning - thinking in terms of the body's motor images or remembered movements (Dourish, 2001; Root-Bernstein and Root-Bernstein, 2001). If such constructs can convey meaning then the principles of human movement can provide the foundations for a language to encode interaction dynamics. To describe health/medical interactions in terms of human movement we require movement elements, dynamic parameters and a notational system to guide reasoning in relation to the behaviour of these objects.

Methodology

For the purpose of this work we consider conceptual spaces that describe physical systems, which usually include some formal description of such systems and a formal representation (language) for describing the systems. If both domains can be represented as physical systems then inherent features of a physical system in one domain (the "source") can be used to develop formal representation of the physical system in the other domain (the "target"). Figure 1 presents compactly the conceptual modelling with the translational mapping illustrated through the labelled steps. This conceptual modelling approach is inspired by Lakoff and Johnson's (1980) approach to metaphors. These concepts then are formalised to construct representations for interaction systems. The proposed visualisation methodology is based on consistent semantic mapping and rigorous underlying formalism. The mapping allows expression of the target domain, on the right-hand side that, in this example, will use constructs from human movement to describe interactions. In the process, in Figure 1, on the left-hand side the source domain human movement (a) is interpreted and formalised through the methodology developed in Movement Observation Science (b) (see Newlove & Dalby, 2004), deriving the constructs of *elasticities* and *qualities* (c). These two groups of constructs provide *shaping affinities* for expression of interaction (e) visualised in the Production element. A Production element is a visual expression of an interaction. The target domain (d), the domain of interactions, is expressed through the shaping affinities represented in the behaviour of the elasticities and qualities (f). The patterns of interaction (g) between involved parties [P_1 and P_2 in Fig 1] are expressed through the behaviour of these constructs.

The mapping, illustrated by the process in Figure 1 takes concepts that describe two frames of reference of human movement - (i) body position [the place of the body in space]; and (ii) body dynamics [the motion that causes and expresses change from one position of the body to another], and develops the requirements towards their computational representations in the interaction domain. The later includes the functions that take interaction parameters as arguments and return the values that drive visualisation elements, and the form and behaviour of the visualisation elements. The set of constructs considered in this research include the following elasticities – the *rising and sinking* (RS-) elasticity and the *contraction and extension* (CE-) elasticity. Elasticities are descried through the computational models of their qualities. In its current development the RS-elasticity includes four qualities, presented here in terms of their interpretation in the interaction domain:

- *flow* (q_1^{R-S}), which characterises the obstruction (e.g. language/social/cultural, etc);
- *transition* (q_2^{R-S}), which characterises the smoothness of the actions run within the interaction;
- *exertion* (q_3^{R-S}), which correlates to the amount of effort required for an interaction to achieve some perceived position; and
- *control* (q_4^{R-S}), which indicates the amount of control applied in the interaction.

The CE-elasticity currently includes a single quality – *intensity* (q_1^{C-E}), which indicates the strength of the interaction.

Once defined these concepts form the backbone of the visual language Kinetic InterActing (KIA) for expressing interactions and reasoning about their dynamics. Figure 2 shows KIA essentials - the visual elements that correspond to respective elasticities and their aggregation. The RS-elasticity corresponds to the visual primitive Effort Shape element and the CE-elasticity corresponds to the visual primitive Body element. Together they are composed into a Production element – the main expressive unit in KIA (Figure 2a). The behaviour of elasticities describes the reciprocal effects between parties in the interaction.

A sequence of production elements forms a visual expression in KIA, a Production, which encodes the information of how interactions unfold and provides insight into the interaction process. Productions correspond to the concept of histories as they provide rich and compact view of the different sets of interactions, allowing to grasp the macro-picture of the interaction flow and to compare across different sets.

By placing an emphasis on the dynamics of how interactions unfold the formalism supports reflection upon the nature of interaction and how such a phenomenon can be taken in account. The research has developed means for the interpretation of the behaviour of the elasticities and their associated qualities in terms of the interactions they represent. The next section demonstrates on example how KIA supports reasoning about interactions in health care.

Reasoning with KIA

This example, from the domain of occupational therapy, deals with the suitability of an elderly patient for discharge from hospital to her own home where she lives alone. The interaction follows the assessment of the patient by obtaining some measure(s) of 'fitness.' Practitioner A interacts with patient B through actions that are verbal and non-verbal. A fragment of the segmented data is presented in Table 1 (":" is used to indicate turn taking in the actions). Real time video analysis is favoured as it supports capturing both vocal and non-vocal actions and avoids the inherent subjectivity of coders. (see Penner, L., Orom, H., Albrech, T., Franks, M., Fosterr, T., and Ruckdeschel, J., (2007) for an overview of video as an observation medium).

The time length of each action and the numbers of actions by A and B, respectively in different segments are the arguments in the functions that compute the values of the different qualities in the representation of the interactions. This is illustrated in Figure 3. The extraction of interaction parameters (action lengths, various numbers of actions) is performed during the data segmentation and action sequence analysis. This is performed for all segments S_1, …, S_4 (the details are indicated only for segment S_1). Extracted parameters are used by the KIA engine to compute the parameters of the visual elements VE(S_1), …, VE(S_4) for the respective segments S_1, …, S_4 and to compose the visual expressions as sequences of these elements. The visual expression in Figure 2 corresponds accurately to the data in Table 1 (the range of the elements is [0; 1]).

Depending on the needs different views can be delivered to the parties requesting the information. For instance, the overseeing practitioner in Figure 3 has requested the information about the ranges of all the qualities for the whole session, when the entire interaction has been provided to the patient. In the later, flow (q_1 in the PDA display) indicates that there has been an average communication between the parties; transition (q_2) indicates that communication between parties occurred with reasonably quick responses to actions of fairly short lengths; exertion (q_3) indicates complex level of interaction as it shows greater effort, especially in the last segment; control (q_4) shows some flexibility in the middle of the session (segments S_2, and S_3) with a dominance of the practitioner towards the end. Other views may emphasise the dynamics of a specific quality or provide detailed interpretation and interpretation guidelines.

Delivery of KIA expressions to the points of decision making

The visual expressions of the information about the interaction process can be delivered through various output technologies to the parties involved. Such parties may not necessarily be directly involved in the interaction but through their role may be embedded in the interaction context. For instance, interactions, in the case of paediatrics, can involve small groups in the form of the family 'unit' that may be in flux, with different members of the family unit contributing input at various times. In medical teams the overseeing practitioner may consult with remote specialist; or a junior practitioner may access the interaction history as the representation through direct feedback functions as a research tool through which on the job learning can be supported. Figure 4 presents a high level overview of the output modes for the information about the interaction process through KIA.

Ideally, a record of the interactions should be included in the electronic patient record. The record (whether video, audio or text transcripts) is then segmented into action sequences. The output of the sequence analysis is provided to the KIA engine. KIA prepares the models of the visual expressions and enables the delivery to different devices. In addition to the desktops or laptops (h) that operate in practitioners offices, PDAs (d) provide access to information from and to various locations in a hospital; optiportals (video walls) (f) can be utilised for teaching and as a research tool; remote care delivery (g) facilitates remote interaction between practitioners and patients, as well as collaboration between practitioners. Due to the oscillating form of the qualities, the sonification of KIA's expression can be used for rising alert, or if the visual display is crowded with other visualisations, and / or if such information is provided to people with visual disability.

Discussion of implications

The work, presented in this paper, addresses the problem for capturing and disseminating to related parties information about the quality of interactions between health care practitioners and patients. Such information can be utilised (i) directly in the healthcare process; (ii) for reflection and improvement of the interaction process, and; (iii) for in-depth research on the interaction patterns and success of the healthcare outcomes.

The paper presented the approach and respective methodology, and demonstrated the practical implementation on an example from occupational therapy. This example also demonstrated the potential in extending electronic patient records with capability to include interaction profiles of consultation and treatment processes, and the incorporation of such profiles in the healthcare process. Proposed ICT design is simple and compact. It can operate on different devices and support visual reasoning about the quality of interactions in different healthcare contexts and at different points of healthcare delivery. These are expected to attract more attention to the actual structure of the interactions between patient and practitioners and facilitate them. In the context of the current drive for preventive healthcare, the improvement in practitioner-patient interactions is expected to lead to improvement of the overall outcomes of the health care process.

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PEER REVIEW

Not commissioned; externally peer reviewed

CONFLICTS OF INTEREST

There are no competing interests to be declared by the authors

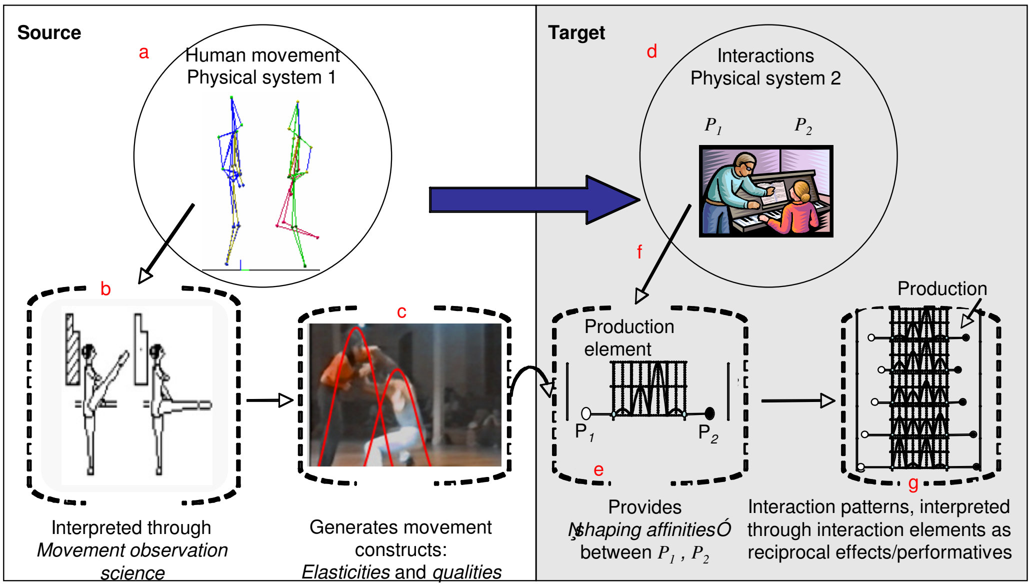
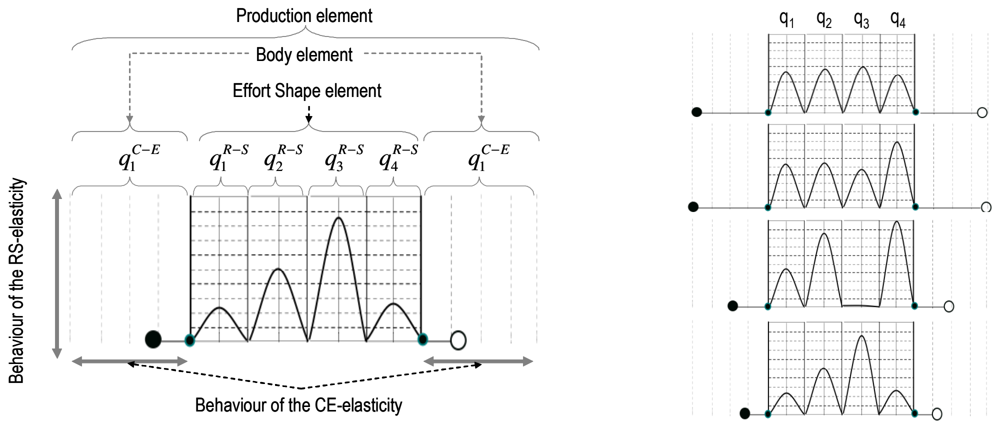


Figure 1. Linking the domains of human movement and interactions through a mapping as two physical systems.



a. Visual elements and their aggregation b. Visual expression

Figure 2. Visual elements and expressions in KIA

Action sequences	Subtasks	Decision forks
A1-A4:B1 A5-A8:B2-B3:A6-	Introduction to patient	A4-DF Root
A7:B4:A6-A7:B4:A8:B5-B6 A9:B7-	Establish motivation	A5-DF1
B8:A10-A11:B9-B10:A12:B11-B12:A13:B13	Ability to self-manage	A9-DF2

Table I. A fragment of the action sequences in Segment 1 of practitioner (A) patient (B).

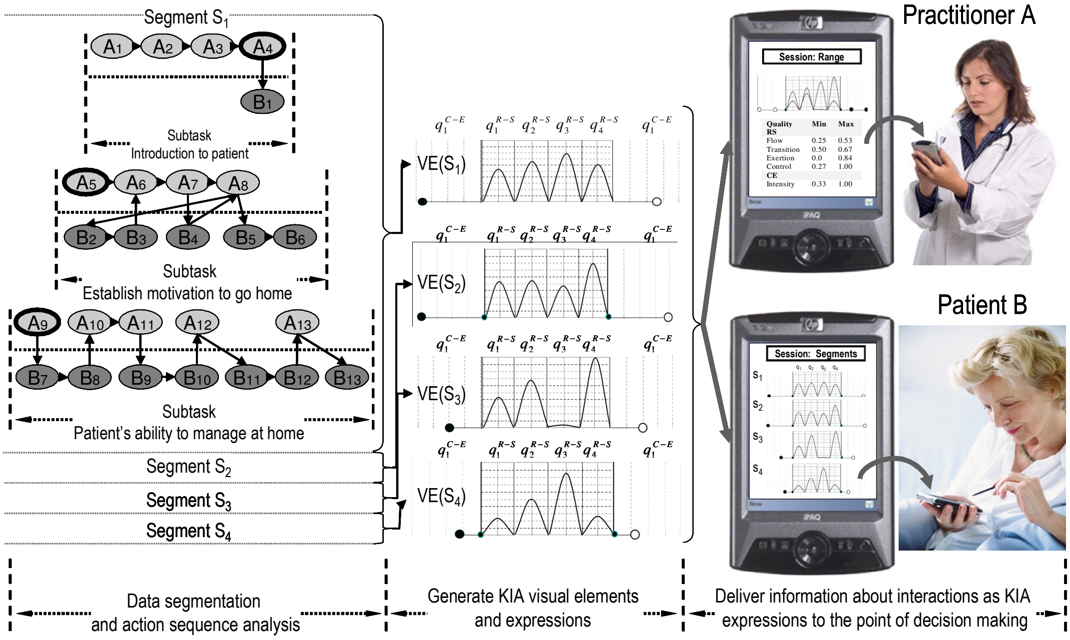


Figure 3. Generating and delivering the information about interactions in Table 1.

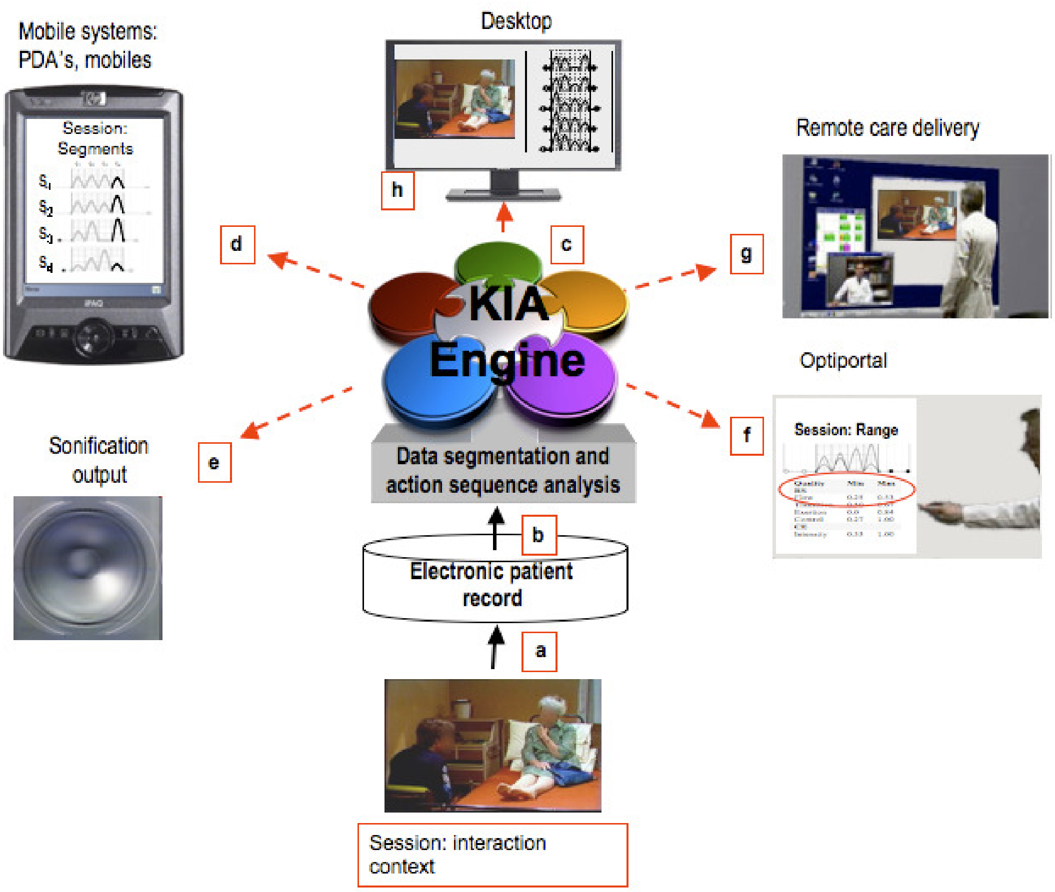


Figure 4. Delivery of information about interactions to the point of decision making using KIA