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An Interactive Shared Decision Making System for Dental Treatment Planning

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Abstract

Patients would be more satisfied if they are involved in the decision making process for the medical treatment. In reality, however, since the decision making process is time-consuming and complex, it would be hard to make full interaction between doctors and patients in terms of shared decision making. We propose a prototype system by combining two techniques: namely, Ontological Engineering and Analytic Hierarchy Process (AHP). The ontology provides machine processible conceptualization that bases interoperation and collaboration and, the AHP gives instant evaluation of health care options in a subjective manner. Our system is designed to support an optimal treatment planning for dental restorations. The proposed shared decision making system can consider diverse values of dental restorations: time, cost, esthetic and quality values.

Keywords:

patient-centered care, AHP, permanent dental restoration, communication, ontology

Introduction

Frosch and Kaplan define the concept of shared decision making as a process in which the patient and clinician consider outcome probabilities and patient preferences to reach a mutual agreement on the appropriate health care decision[1]. The decision making process could be time-consuming and complex; doctors and old patients would be less satisfied than young patients if the process got long and complicated [1-3]. To solve these problems, the interview or interaction should be simplified in the shared decision making procedure.

To build simple and agile interactions with patients, we combined two techniques, an ontology and an Analytic Hierarchy Process (AHP)[4]. An ontology provides machine processible conceptualization that bases interoperation and cooperation among different systems. The AHP is the technique to satisfy subjective needs of decision maker, and the availability of AHP is also extensible used in shared decision making area [3, 5].

In this paper, we propose a shared decision making system prototype that interacts with patients and a doctor based on an ontology and the AHP. This system is designed to make optimal treatment planning for dental restoration. The system helps both patients and a doctor interactively consider various patient conditions such as financial status and preference of a patient as well as patient's problems.

Method

An ontology is a basement to serve proper information for both of human and system. We define classes about dental restoration method and related information. The classes have various properties to make an effective use of a decision making process, AHP.

The instance of an ontology makes knowledge that can adapt to different situations. Instances of this ontology could be crated for one hospital or one patient. Figure 1 shows an instance of AmalgamRestoration. A value of hasFinancialConstraint can be changed for different hospital that has a different price system. A locatedIn property presents a location of problem tooth that depends on each patient.

We use AHP to suggest the best treatment option for each patient. First, we import the ontology and make alternatives from instances of TxOption class and subclasses. Second, we use common properties of those instances as criterions. Third, we visualize overall expected outcomes and detail properties of each alternatives. Finally, we give a user-interface to change the relative importance of criterion.

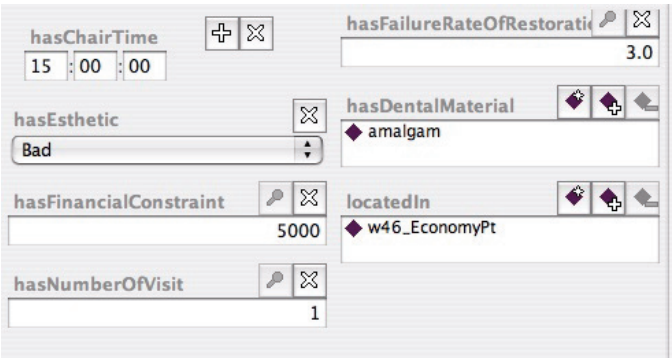

Figure 1 – An instance of amalgam restoration class

Implementation

The prototype was implemented using a described architecture to support a dental restoration treatment planning. The sub-goal of this system is providing an effective user-interface to be understood and interact with a patient.

This system is implemented as a multi-platform system based on Eclipse RCP[1]. We use a part of the JAHP[2] as a module to support the AHP. Each part of this system is described as following:

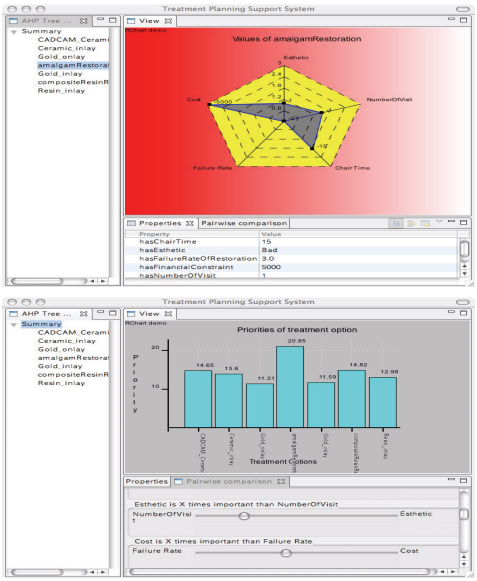

Figure 2 – Interfaces of implemented system

- Alternative Tree View
- Alternative Tree View is comprised of summery item and alternatives sub items. When the item is selected, graph and properties view will be updated to show proper graph and properties of alternative.
- Graph View
- Graph view visualizes current state by user-friendly graph. Radar graph summarizes merits and demerits of alternative at a glance. Bar graph shows expected outcome to compare treatment options.
- Pairwise comparison view
- Pairwise comparison view helps human to make pairwise comparison matrix that represents relative importance of properties. In this view, relative importance is visualized by slide bars and user can easily modify them by dragging. It affects bar graph immediately. It can be used iterative process of user to find proper solution.
- Properties View

  Properties view describes properties of treatment options based on ontology. Each property represents a characteristic of alternatives. It gives more detail information than graph view.

Conclusion and Future Works

In this paper, we built a prototype system using an ontology and an AHP technique to support an optimal treatment planning for dental restorations. This system showed: (1) A system can give instant evaluations of the treatment options for dental restorations; (2) A system can consider diverse values of dental restorations: time, cost, esthetic and quality values.

More generally, we showed the prototype architecture that an AHP integrated with an ontology: it could provide simple and agile interactions for shared decision making, and interoperations with other systems.

We have limited the scope of research to choose a best option among the provided options. Meanwhile, medical examinations could be collected from medical equipments; a reasoning functionality of an ontology could extract possible treatment options for a patient from the medical examinations. The development of these processes would help us to make a complete treatment support system for dental restorations.

Acknowledgement

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1 http://wiki.eclipse.org/index.php/Rich_Client_Platform
2 http://www2.lifl.fr/~morge/

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