A Pen-based Interface for Generating Graphical Reports of Findings in Cardiac Catheterization

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Abstract

This paper introduces a pen-based interface for the graphical reporting of findings in cardiac catheterization. The user can interactively draw, erase, move, and deform coronary arteries as well as record stenoses on them. The lo-cation and degree of each stenosis is represented visually and the doctor can record various treatments such as by-passes and stents on the diagram. In addition, the system automatically extracts semantic information from the graphical representation and stores it in XML format. The system can also generate a table in the format specified by the American Heart Association. This system is useful not only as a tool for efficiently generating reports of findings but also as an effective explanation tool for patients.

Categories and Subject Descriptors (according to ACM CCS): I.3.6 [Computer Graphics]: Methodology and Techniques

1. Introduction

Electronic medical recording systems [GIN07] have become widespread due to the improvement in hardware performance and user interfaces. However, usability is still an issue and medical professionals need more such user-friendly interfaces. To make these systems accessible to inexperienced users and to reduce the overhead of data entry, we have been developing various pen-based elec-tronic medical recording systems. Pen-based computing is an active research area for both user interfaces and com-puter graphics. One problem with these free-form pen-based systems, however, is that their output does not easily fit into a structure that lends itself to further machine proc-essing or interface with other more traditional recording systems. Our goal in the project presented in this paper was to bridge this gap between free-form diagramming and more structured recording.

One strength of pen-based systems is that they make it easy to draw and add diagrams to medical records. This is particularly useful in ophthalmology, otolaryngology, and dentistry in which diagrams play an important role in medical records. Indeed, the frequent use of diagrams makes it difficult to use traditional GUI-based medical recording systems in these areas. Cardiac catheterization is one of these areas in which the diagram is an indispensable tool for medical recording. Existing electronic medical recording systems rely on structured templates, but it is difficult to create an appropriate report of findings or treatment plan using these predefined templates. Most ex-isting diagram editors are implemented as bitmap paint tools, not vector graphics. This makes it difficult to edit the geometry afterward and requires that a large amount of data be transmitted and stored.

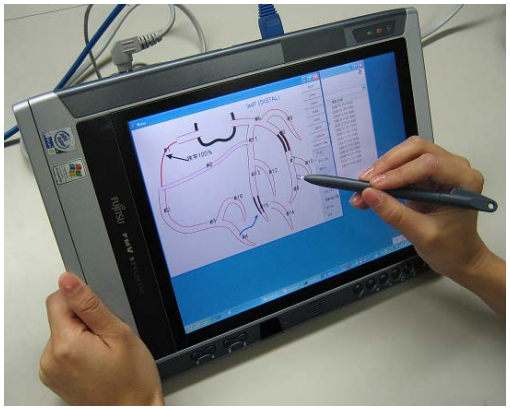


Figure 1: *A screenshot of our system in use.*

We therefore developed a pen-based interface for graphical reporting of findings in cardiac catheterization (Figure 1). The user can freely "sketch" coronary arteries and stenoses on the screen using a pen on a template of coro-nary features. The location and degree of each stenosis, and various treatments such as bypass and stents, are visually represented. We developed an algorithm that can extract semantic information from the graphical representation and store it in XML format. The system can also generate a table in the format specified in the AHA (American Heart Association) committee report [AEF*75]. This system is useful not only as a tool for efficiently generating reports of findings but also as an effective explanation tool for patients.

2. User Interface

Figure 2 shows screen snapshots of our system. The user can draw on the diagram template using a pen as if drawing on real paper. Our system shows the name of each coro-nary artery and segment (e.g., proximal, middle, or distal) at the upper right of the screen when the cursor is over any vessel. We use the naming scheme defined in the AHA committee report. The system can show border lines of coronary artery segments if required. The user can freely sketch coronary arteries (Figure 3) and stenoses (Figure 4) on the screen template. The location and degree of each steno-sis, and various treatments such as bypass and stents are visually represented on the screen (Figure 5). The diagrams use vector graphics for easier editing of the input, as well as for reducing requirements in data storage and transmis-sion bandwidth.

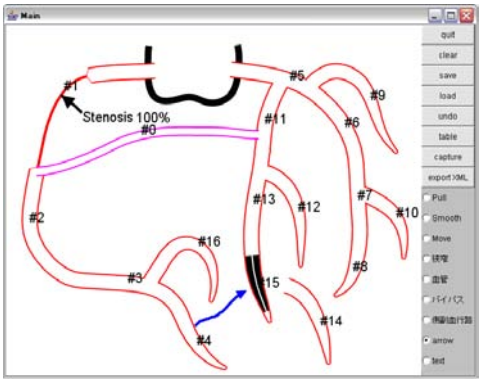


Figure 2: *Recording example of cardiac catheterization.*

3. Dataset Structure and Cooperation with Other Sys-tems

Many doctors use coronary angiography (CAG) to repre-sent coronary stenosis pathology. CAG compactly shows the location and severity of stenoses. Our system supports the conversion of the graphical record to a CAG-compliant table dataset. The table is represented in the format speci-fied in the AHA committee report and stored as an XML file. Figure 6 shows the relationship between our system and CAG. The top screen in Figure 6(a) presents an example of recording stenoses using our system; the middle screen of Figure 6(a) shows the CAG dataset it produces. Any other system that supports this format can use the data file as shown in the bottom screen of Figure 6(a). The user can also edit the exported CAG table. When this happens, our system automatically updates the corre-sponding stenosis on the coronary diagram including the information on the severity and character of the stenosis (Figure 6(b)).

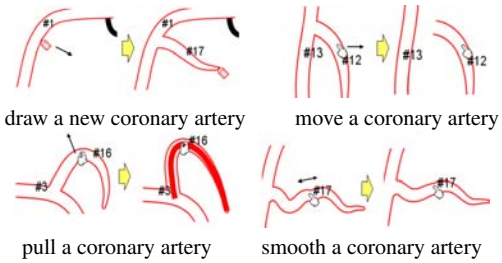


Figure 3: *Editing operation of a coronary artery. We use a pulling interface and smoothing interface for curves introduced in [IMH05].*

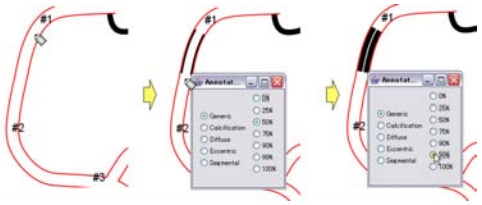


Figure 4: *Recording a stenosis.*

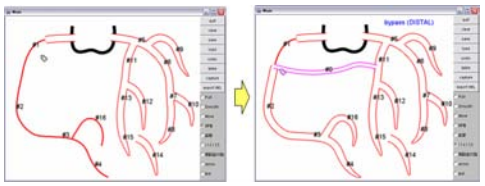
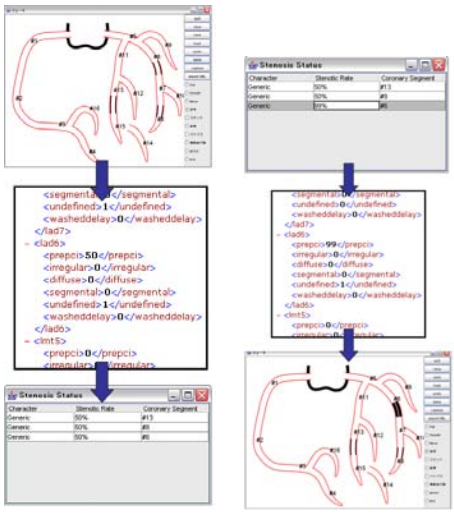


Figure 5: *Drawing a bypass. If the bypass connects an open coronary artery to a closed one (a), the system automatically opens the closed coronary artery to indicate that blood flow has resumed (b).*



(a) (b)

Figure 6: *Example of the automatic relationship between the coronary diagram and the CAG table.*

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