Proposed Research Essay
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Title: *Creating the Smart Operating Room of the Future*
Key Words: *Pervasive Computing, Ubiquitous Computing, Smart Environment, Mobile Computing, Real-time Monitoring Systems, Artificial Intelligence, Interoperable Medical System in Operating Room,*

Hypothesis: *Through the use of pervasive computing, artificial intelligence, modern database systems and medical messaging standards, the workload of the medical staff in an operating room can be significantly reduced to decrease the amount of medical error and improve workflow efficiency.*

Broader Impacts

In 2000, the Institute of Medicine published an article that over 98,000 people a year die from medical error in hospitals in the U.S. That is more than died in car accidents, breast cancer, or AIDS.[1] The operating room has long been a source of inefficiency and chaos in hospitals. These factors have, on occasion, lead to the performing of incorrect procedures, the administering of life-threatening medicines, and the leaving of tools or supplies inside a patient.

We propose to use pervasive computing and artificial intelligence technologies to build a context-aware operating room of the future which will drastically lower the occurrence of medical error and increase efficiency. The application will infer the context of the events by analyzing sensor data streams in light of domain knowledge and patient history. Key "medically significant" events will be generated which can be used to automate the creation of medical records, the managing of supplies, the tracking of personnel, tools and medicines, and the recording of context specific information for the surgeon in the post-operative report. Our vision requires research into an array of technologies from sensing technologies, machine learning, and medical systems interoperability amongst others.

Intellectual Merit

Currently, we are working on creating a Context-Aware Surgical Training (CAST) center at the University of Maryland Medical Center. We are building a pervasive computing environment that detects the arrival of a trainee and mentor and will set up the Simulation Center based on predetermined training metrics. The application will then guide the trainee through the procedure and log the evaluation of the trainee's performance to a learning environment. This research will serve as the stepping stone to build the architecture for the pervasive computing environment in my proposed research.

One of the key issues of medical research today is the development of an infrastructure that will promote the interoperability of different medical systems. The Healthcare and Information Management Systems Society is a non-profit organization whose sole

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[1] Sungmee Park and Sundaresan Jayaraman. Enhancing the quality of life through wearable technology. IEEE Engineering in Medicine and Biology Magazine, 22:41-48, 2003.

purpose is to promote the creation or improvement of medical systems that collect, store, and transfer clinical data through local and wide area networks using industry standards though its IHE initiative, Integrating the Healthcare Enterprise. [2] Thus, one of the challenges in our research would involve the creation of an operating room that could adhere to such standards. HL7 is one of the most popular medical exchange messages systems for clinical data such as laboratory reports and orders and for the workflow within a hospital, such as admissions and transfers. [3] However, we would need to find or develop a standard messaging system that fits into the context of an operating room.

The most significant contribution of this research to medicine and science will be the personalizing of the operating room of the future. The application will be capable of knowing the medical doctor's preferences for the given surgery and notify the medical personnel of what is missing for the procedure and where it can be found. It will be able to alert the doctor if a drug to which a patient is allergic to has entered the room or if blood of the wrong blood type has been delivered, whether all tools and supplies have been accounted for prior to suture. It will be able to assist with the documentation of the procedure by using a rule based engine that infers context.

The development of the knowledge base will involve not only interviewing domain experts to develop rules, but also the use of artificial intelligence and machine learning on data that is collected from patients prior to and during surgery. Domain experts would be used to time stamp the data while the surgery is occurring. Eventually the application will be able to analyze a patient's medical history and the data gathered for one week prior to the surgery to develop a customized rule base for a particular patient and a given procedure. This rule base will be used to create a personalized context model for the procedure which will assist in improving healthcare and reducing inefficiency in the operating room.

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[2] Medical Systems Interoperability Demonstrated at HIMSS. Medical Device link, The Online Information Source for the Medical Device Industry, http://devicelink.com/mx/issuesupdate/05/02/HIMSS.html
[3] http://www.hl7.org.uk/version2group/v2.asp