DEPARTMENT OF THE AIR FORCE
THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
USAF ACADEMY, COLORADO

PROPOSAL FOR RESEARCH – LOW-COST MEDICAL DIAGNOSTICS PLATFORM 16 May, 2013

The United States has a propensity to conduct operations in austere environs where power, accessibility and harsh conditions preclude the use of high-end (i.e. fragile and expensive) medical diagnostics platforms. This research aims to develop a solution to the critical need for point of care devices that are cheap, power-efficient, reliable and transportable.

Diagnostics is a challenging discipline as it usually involves prohibitively expensive and immobile equipment that regularly forces patients to travel great distances at great cost in order to access care. These inherent traits regularly exclude certain populations from receiving proper treatment. Affected populations can range from military members operating in an expeditionary theater to rural communities, especially in developing countries. The immediate impact of this research is clear: it will allow individuals to access healthcare who otherwise would not be able.

Viewing the problem from an electronic hardware standpoint it is easy to see the challenge: the given measures of merit (cost, reliability, power, and transportability) are often mutually exclusive; ex. increasing a component's transportability often decreases its reliability. Dr. Clifford's group has had incredible success pairing low-cost electronics (microcontrollers) with one of the most widely accessible hardware platforms available, a mobile phone, to develop, prototype and test effective diagnostic tools. State-of-the-art signal processing and machine learning are run on these platforms to provide ubiquitous diagnostic care. I plan on leveraging my knowledge of Field Programmable Gate Array (FPGA) technology with my background in signal processing to advance this research.

FPGAs are often used to perform highly repetitive computational tasks at very fast speeds. Concurrent signal assignments paired with the ability to instantiate hardware at the gate level create an ideal platform for increasing computational speed while allowing for high precision in optimizing the amount of necessary hardware components. FPGAs also allow for rapid prototyping of solutions, which can result in swift progression from a mere schematic to field tests. These prototypes easily map to the Register Transfer Level (RTL), eventually resulting in an Application Specific Integrated Circuit (ASIC) layout and fabrication for cost-effective production in volume.

The FPGA could be used to interface between a biomedical transducer, which converts biological phenomena to electronic signals, and a mobile phone. The mobile phone is used to perform high-level signal processing and could pass data to the FPGA in order to perform recurring computational tasks that could rapidly drain the mobile phone's battery. This will result in a low-power (system runs on a mobile phone battery), inexpensive (almost disposable) diagnostics platform that can fit in a uniform pocket. Complex signal processing and machine learning algorithms can run in real time on the systems. The implications of this research are widespread and immediate: many more people will have access to high quality healthcare.

Captain Ryan Silva, Assistant Professor
Department of Electrical and Computer Engineering
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I would be delighted to have Ryan on my research team and I feel he is in a unique position to be an immediate contributor to the important research we are pursuing. I am confident that proper execution of the above proposal would be sufficient for the conference of a DPhil. I also believe that with the proper work ethic, this research can be accomplished within the three-year timeframe Ryan has been given.

Dr. Gari Clifford, University Lecturer in Biomedical Engineering
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