The Autonomous Physician

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Summary: The availability of healthcare, its distribution and timely delivery is one of the great challenges of mankind. Despite consumption of 18 percent of the US gross domestic product, millions of Americans and exponentially more throughout the world remain markedly underserved. In addition, in times of disaster, emergency, war, extreme and remote locations, and manned deep space travel, this problem is vastly magnified. The Autonomous Physician project will impact these problems through the synthesis, integration and execution of emerging and scalable technologies poised to revolutionize the healthcare industry.

Need for the work: History shows that automation is the key to meeting the needs of a growing human population at a faster rate and lower cost. Today's challenges for humanity are many but one of the most important of these is providing accessible, reliable, quality, low cost, and rapid healthcare anywhere, and not just in the big cities.

Goals and Objectives:
1. Deep Learning Module (DLM) - Development of self-structuring medical data base creation contributing to markedly accelerated deep learning methods - a current limitation of existing techniques. DLM is heavily based on effective Convolutional Neural Network (CNN) machine learning. Necessary components include anonymized health informatics database, dedicated highly parallel computer processing, and development of self-assembling diagnosis and outcomes for condensation of best practices algorithms.
2. Rapid Patient Identification and Documentation Module (RAPID) - Portable patient information, diagnoses and treatments facilitating rapid field implementation. Patient identification and tracking is key to patient safety and efficacy of management. Coupled with remote sensing technologies inclusive of machine vision, remote vital signs assessment and tracking allows for the first step of patient triage and care.
3. Autonomous Intervention Medical Support Module (AIMS) - Coordinated autonomous robotics and robotic assisted medical interventions. Rapid advances in guided robotics and miniaturization are one of the most rapidly growing areas of medical device development. Industry leaders such as Intuitive Surgical, creator of the da Vinci surgical system, are now joined by smaller, leaner systems that would integrate well with AI development.
4. Imager Module (MATRIX) - Advanced medical imaging specifically created for field transportable and portable applications. Due to the need for low power, high temporal and spatial resolution imaging, ultrasound is uniquely suited for a diagnostic and guided intervention role. The MATRIX imager represents a unique solution crafted to facilitate both diagnostic and interventional roles. Two different designs are proposed, one backward compatible with existing devices and one newly created specifically for optimized large field imaging and multipoint intervention.
5. Instruments on Demand Module (IDM) - Materials development with an emphasis on demand and tuned synthesis with recyclable options for closed system use. Unique materials and a combination of additive (3d printing) and subtractive techniques combined with a repository of

descriptive files (STL, 3MF, Microsoft Structured, etc.) allow for on site creation of unique or specialized tools for treatment and intervention, including inkjet-printed nanoparticle based sensors for health status monitoring.

Activities: An integrated convergent systems approach will be used to develop the Autonomous Physician. The principle architect of the system will be Dr. David Bolus, Chief of Body Intervention at UAB. The development of the system will be managed by Dr. Alan Eberhardt in coordination with Engineering Innovation Technology Development (EITD) within the UAB School of Engineering (SoE). Convergence of capabilities will be achieved with Dr. Bolus' organization at the UAB Hospital and the UAB School of Medicine. Collaborators from the SoE Departments of Biomedical Engineering, Mechanical Engineering (Mechatronics), Materials Science and Engineering, and Electrical Engineering (Big Data Analytics); the College of Arts and Science (CAS) with Computer Science, Chemistry, Physics, Nano-technology, Psychology; and Schools of Optometry, Dentistry, Health Professions, Public Health, Nursing, and Business are extremely well suited for optimization of the next generation systems designed to be driven by Artificial Intelligence (AI).

Impact: Each of these modules represents a revolutionary step forward in their respective areas. However, when integrated together as a grand system, the sum represents a true paradigm shift contributing to the future of autonomous medicine. The Autonomous Physician will provide much needed healthcare services in poor sections of big cities, rural areas, remote locations, manned deep space travel, war zones, and during emergencies and disasters. It will lead to technologies that will create broad leaps in medicine and other arenas. Early ethics and psychosocial integration will serve as a bridge to optimal utilization. The financial return to the institution and state leading the development and implementation of this technology is enormous. Financial return may be overshadowed by the penumbra of recognition as a critical thought and technology leader influencing spinoff industries potentially seeding a new "Silicon Valley" of modern healthcare, bringing jobs and investment to UAB, Birmingham, the state of Alabama, and the Southeast.

Qualifications: While many of the technologies are being incrementally explored, no large-scale development and coordinated integration yet exists. We believe the key to success and early execution lies with simultaneous fusion of key science and engineering targets. Necessary elements include highly specialized medical care, voluminous quality health data, medical informatics, robotic and materials engineering expertise - all available at a large multi-specialty and multi-discipline institution such as the University of Alabama at Birmingham. UAB's EITD is renowned in the integration of state-of-the-art technologies, miniaturization, and systems development for NASA, Department of Energy, Department of Defense, Lakeshore Foundation, and the Commercial Industry. EITD is certified for device development with ISO-9000 and AS-9100 (Aerospace).