Project Heart

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Description:

Noninvasive medical diagnostic technologies have rapidly expanded in recent years, aided by computational techniques including machine learning (ML) and artificial intelligence (AI). However, invasive procedures are still necessary in certain clinical scenarios, and these carry with them increased patient risk and healthcare costs. For patients with heart failure or severe pulmonary disease, right heart catheterization (RHC) is commonly performed to evaluate cardiopulmonary function and vascular hemodynamics. RHC is resource-intensive, time-consuming, and can be occasionally life-threatening in the case of pulmonary artery injury leading to exsanguination requiring emergent surgical repair to prevent death. To alleviate these burdens on the healthcare system and improve patient outcomes, we propose development of a novel ML-based methodology for human heart simulation and diagnosis based on three main signals – ECG (time series), MRI (video) and CT (video). The resulting simulated heart model will be a personalized digital representation of cardiac structure and function and will allow for simulated treatment without involving patient risk. In the process of creating these tools, the research Team will develop several ML and AI models for simulating all aspects of the heart (utilizing deep learning and feature combinations). The final solution will provide a noninvasive simulated cardiac model, including hemodynamic and visual representations of the heart, during which cardiologists and cardiac surgeons can evaluate cardiac structure and function. The model will give a possibility to the medical doctor to digitally observe the heart and trial potential interventions without the need for invasive diagnostics or potentially dangerous procedures.

The solution will be tested in hospitals in three main countries: Poland, United States of America, and Ukraine. On the basis, of discussions with experienced cardiac experts including surgeons and cardiologists, we will be able to determine the utility of our simulated heart model. With real-time feedback, , additional models will be trained to increase the efficiency and accuracy of the solution. If the models do not provide actionable utility to healthcare providers, the Team will include additional signals to train the models on broader scope of the data. Additional sources of data can also lead to improvements in the worked-out simulation procedures. The models will be trained on deidentified data coming from hospitals in Poland, USA, and Ukraine.

Finally, it needs to be pointed out that the worked-out model will be implemented in the form of ready-to-use software. It means that the end user (hospital or healthcare provider) will provide their own patient-level data on a local machine and the individual patient simulated heart model with be displayed on a screen, thus avoiding potential patient privacy concerns with a centralized (online) simulation tool. The proposed solution will be tested in the hospitals by experienced cardiac experts. The created algorithms and simulation results will be described in peer-reviewed research papers and presented at top-ranked clinical and machine learning conferences.

Consortium:

1. Carnegie Mellon University (United States of America) – Consortium Leader
2. Łukasiewicz – Poznań Institute of Technology (Poland)
3. University of Pittsburgh Medical Center (United States of America)
4. We are looking for experienced partner from Ukraine – especially in the scope of cardiology