Liang Lab: Image Analytics and Informatics

Behind the great success of biomedical imaging, a crisis is looming: the number of imaging examinations is growing exponentially; the workload of image interpretation is increasing dramatically; the health-care cost related to imaging is rising rapidly—we are facing a grant new challenge: ***image data explosion***, a manifestation of ***big data*** in biomedical imaging. However, what is paramount are not the images themselves, rather the clinically relevant information contained within the images. Therefore, associated with image data explosion is a ***fundamental limitation*** in interpretation, integration, and translation of image data into actionable information and knowledge for diagnosis, therapy and surgery, a ***large-scale unmet clinical need*** across ***multiple specialties*** including radiology, cardiology, gastroenterology, etc***.*** To address this need, we are developing comprehensive, high-performance systems that automatically and quantitatively extract clinically important ***imaging biomarkers*** from *multiple* image modalities to support clinical decision making in diagnosis, therapy and surgery and facilitate ***precision medicine***. Examples of our current projects follow:

- **Computer-aided diagnosis and prognosis of pulmonary embolism.** The US Surgeon General has declared pulmonary embolism (PE) a major national health problem. CT pulmonary angiography (CTPA) is the diagnostic standard for suspected PE. However, incorrect CTPA interpretations are frequent in general clinical practice, and the wealth of CPTA imaging information useful for PE prognostication is barely utilized for the personalized management of PE patients. Therefore, the goal of this project is to integrate diagnosis with prognosis in a single unified framework.
- **Personalized cardiovascular disease risk stratification.** Cardiovascular disease (CVD) is the #1 killer in the US, but it is largely preventable—the key is to identify at-risk individuals prior to adverse events. For stratifying individual CVD risk, carotid intima-media thickness (CIMT), a noninvasive ultrasound method, has proven to be valuable. However, interpreting CIMT images is tedious, laborious, and time consuming, a serious limitation that hinders widespread utilization of CIMT in clinical practice. To overcome this limitation, we are developing an innovative informatics solution to fully automate CIMT image interpretation process.
- **Ensuring high-quality colonoscopy.** The primary modality for screening and prevention of colorectal cancer is (optical) colonoscopy. However, during colonoscopy, a significant number of polyps are missed—the pooled miss-rate for all polyps is 22% (95% CI, 19%-26%). To reduce the polyp miss-rate of colonoscopy, we are developing computer algorithms to ensure high-quality colonoscopy procedures, resulted in software systems with "built in" alerts that recognize polyps and distinguish poor video quality.
- **Personalized proton therapy for lung cancer**. Lung cancer is the leading cause of cancer deaths. Intensity modulated proton therapy (IMPT) is revolutionizing radiotherapy because of its extraordinary capability of precisely depositing maximum cell killing energy in tumors while protecting surrounding healthy tissues. However, the use of IMPT for lung cancer is hindered by a serious limitation: IMPT is highly sensitive to uncertainties caused by patient setup, respiratory motion, anatomic changes, etc. We are aiming to overcome this limitation by developing novel algorithms to achieve personalized proton therapy by explicitly accounting for patient-specific information that can be extracted from the weekly CTs.

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