Focus Area I:
Imaging-centered data analytics for better diagnosis and treatment of cancer and other diseases

Focus Area II:
Operational excellence, process and quality improvement, work flow efficiency

Focus Area III:
Clinical unitization (focused diseases: glioblastoma multiforme (GBM), hepatocellular carcinoma (HCC), prostate cancer, oropharyngeal squamous cell carcinoma (OPSCC), migraine, Alzheimer’s disease; imaging modalities: CT, DECT, MRI, PET)
ASU-Mayo Clinic Imaging Informatics Laboratory (AMIIL)

Collaborators at Mayo Clinic

**Radiology**
- Amy Hara, Prof., MD
- Ross Mitchell, Prof., Ph.D.
- Alvin Silva, Asso. Prof., MD
- Leland Hu, Assi. Prof., MD
- Joseph Hoxworth, Assi. Prof., MD

**Neurology**
- Christine Zwart, Program Coordinator, Ph.D.
- Todd Schwedt, Asso. Prof., MD
- Catherine Chong, Research staff., Ph.D.

**Radiation Oncology**
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**Medical Physics**
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**ASU Faculty**
- Teresa Wu, Prof., Ph.D.
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ASU-Mayo Clinic Imaging Informatics Lab (AMIIL)
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Mission Statement
The ASU-Mayo Clinic Imaging Informatics Laboratory (AMIIL) is a collaborative effort between the School of Computing, Informatics, and Decision Systems Engineering at ASU and the Department of Radiology at Mayo Clinic Arizona. Our goal is to improve patient care by analyzing and managing information in radiology images and databases. We achieve this goal by developing novel informatics, statistics & machine learning, and systems engineering approaches.

Thrust Areas

Thrust I: System Informatics and Process Improvement
- Operational efficiency; process optimization, lean six sigma

Thrust II: Basic Radiology Informatics & Analytics research
- Imaging processing and fusion
- Statistical modelling and machine learning

Thrust III: Clinical Applications and Proven Value
- Targeting important diseases: Brain Tumor, HCC, Fatty Liver
- Focusing on multi-fold clinical outcomes: diagnosis, treatment response, reoccurrence, survival, quality of life
- Utilizing multi-source information: multi-modality imaging, genomics, lab tests, biopsy, demographics
- Involving multi-disciplinary medical experts: radiologists, oncologists, hepatologists
Medical image viewing on mobile devices has become an important tool in diagnosing patient data effectively and efficiently. The traditionally used medical image viewing system, GREADS, does not provide the option of viewing medical images on mobile devices. A new mobile medical image viewing software, Resolution MD (ResMD) Mobile, is an advanced medical viewing product that allows access to radiology diagnostic images and reports from mobile devices (e.g., iPhone, iPad, etc.). It integrates all the tools necessary to make a diagnosis, including 2D images, MIP/MPR, 3D images, and interactive collaboration between physicians and radiologists. This project aims to determine if ResMD is better than GREADS in diagnostic quality, access time to images, technical reliability, and clinician satisfaction.

YesBoard

A common practice in radiology is to rely on employee initiatives to schedule and track imaging events. This situation not only causes process inefficiencies but also increases patient wait time and decreases service quality. In order to optimize the process and improve the care quality, a new system that automatically organizes and publishes the information in real time is needed. The YesBoard project allows physicians and allied health staff to monitor radiology CT and MRI machines together with patient data and workflow in real time through any device with an internet connection and a browser. It will help to monitor CT and MRI patient data including high risk factors for intravenous contrast, wait times, equipment availability and workflow using a consolidated graphical presentation. This information will be collected and then analyzed in order to streamline the process and optimize staff and machine scheduling. This project is expected to significantly improve the situational awareness of the current radiology care, improve process efficiency, optimize machine utilization and reduce costs, and provide good quality of care to patients.

MR Elastography

A common procedure for diagnosing hepatocellular carcinoma (HCC) is biopsy, a procedure that can result in mortality and misdiagnosis from sampling errors. Imaging techniques, such as ultrasonography, CT, and MRI, have been used. However, there are a large number of false positives from using these techniques. MR Elastography (MRE) is a novel, multi-parametric image enhancing technique that can be used to assess the mechanical properties of human tissues. MRE adds image signatures derived from MR intensity that can be effective in evaluating external structural determinants. The objective of this study is to show that MRE can accurately (1) determine the risk of developing HCC, (2) discriminate HCC from nonmalignant nodular models, (3) assess response to therapy at timepoints earlier than conventional imaging techniques, and (4) predict the risk of HCC recurrence.

Dual Energy CT in Fatty Liver

Characterizing renal stone composition has become an important issue for doctors in prescribing proper therapy. Renal stones require different treatments. Conventional MultiDetector CT is the most commonly used technique but has not been found to be very accurate for stone characterization. Recent studies utilizing dual energy CT have shown promise in differentiating uric acid from non-uric acid stones in vivo. However, there are still several problems with classifications of non-uric acid stones, especially in vivo. This study is designed to evaluate the utility of DE-CT for different types of renal stones.

Model Based Iterative Reconstructing for CT dose reduction

Model Based Iterative Reconstructing (MBIR) focuses on reducing the dose of CT applied to hospital patients. It involved in the CT dose reduction: (1) dose reduction following endovascular aneurysm repair (EVAR), (2) dose in Texture characterization is an important problem in medical image analysis. As biological tissues become abnormal during the progression of a disease, their underlying texture may also change. Current magnetic resonance imaging (MRI) images of tissues are not capable of providing microscopic information that can be assessed visually. However, histological alterations that are present in some illnesses may bring about texture changes in the MRI image that are amenable to quantification through texture analysis. This study will concentrate on texture analysis (TA) of hepatocellular carcinoma (HCC). A comparative experiment will be performed between two different TA methodologies: (1) Haralick's Co-occurrence Matrix, the traditional method, and (2) FPTT-RIST, a new TA methodology based on B transform. The goal is to determine which TA methodology is faster and more accurate.
Project Example I: Imagenomics for Characterizing Invading Cancer Cell Genomic Diversity

- Collaborative research between ASU, Mayo Clinic Arizona, and Translational Genomics Research Institute

**Clinical question:**
Cancer cell invasion to surrounding normal issues greatly contributes to treatment failure

Glioblastoma multiforme (GBM) tumor

Tumor cell invasion
**Project Example I**: Imagenomics for Characterizing Invading Cancer Cell Genomic Diversity

*State of the art:*
- Gene expression data focused
- Identify differentially expressed genes between tumor cells and invading cells

*What is needed:*
- Multi-platform genomic data integration
- Understand genetic basis of invasive behavior
- New biomarkers correlated with invasive severity and treatment response
- Novel combination therapies to address both tumor core and invading area

*Project goal I:*
Multi-platform integrative genomic data analysis for invasion biomarker identification
**Project Example I**: Imagenomics for Characterizing Invading Cancer Cell Genomic Diversity

*Further clinical question:*
Can imaging inform genomic diversity without biopsy?

- Our group has found imaging texture features correlated with expression, promoter methylation, and copy number aberration of hallmark genes for a few cancers.
- Imaging texture analysis extracts spatial information from image pixels at fine-to-coarse scales and quantifies tumor heterogeneity that cannot be seen by naked eyes.

**Project goal II:**
Correlating imaging texture features and genomic diversity and identifying imaging surrogate markers

A: tumor image
B-D: texture analysis reveals texture features at different scales that cannot be seen by naked eyes
**Project Example II**: Health Informatics for Efficient and Quality-Assured Health Care Operation

*A big hurdle to health care operation:*
Information is stored in disparate data sources and in non-standardized formats, hindering many operational questions from being addressed.

- Is it OK to schedule a CT scan for my patient in two weeks without radiation overdose?
- Which scanner will be available at the time my patient arrives so he won’t have to wait?
- Are there too many adverse safety events this month in my department, what are they, and what are the root causes?

Where is the information?
How to analyze it?
How to present it?
**Project Example II**: Health Informatics for Efficient and Quality-Assured Health Care Operation

*Our Objective:* Track, standardize, correlate information in disparate data sources, analyze the information, and present the result in user-friendly formats

**Example Project – Radiation Dose Index Tracker**
- Track cumulative radiation dose amount from multi-time, multi-imaging, multi-scanner medical records
- Real-time query and alarming

Software system architecture

Real-time query/reporting

Real-time alarming
Thank you!