INDIAN INSTITUTE OF TECHNOLOGY DELHI
DEPARTMENT OF BIOCHEMICAL ENGINEERING & BIOTECHNOLOGY

2018-19 Seminar Series

Friday, 28th December, 2018

Shachi Mittal

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Title: Transforming Cancer Diagnosis with Molecular Data: A Chemic al Imaging based Data Analysis Platform

Background and Significance

Breast cancer is diagnosed via histopathology, a process that involves biopsy, tissue staining followed by manual examination by a pathologist. This is susceptible to under-diagnosis, over-diagnosis and low concordance rates across pathology labs. To overcome this, a combinatory and quantitative diagnostic approach utilizing imaging coupled to pattern recognition tools is needed for holistic patient analysis. Infrared spectroscopic imaging, in particular, combines the morphologic imaging capability of optical microscopy and the chemical specificity of vibrational spectroscopy to provide quantitative chemical tissue characterizations. This does not perturb the tissue samples in any way making it available for further analysis and can be computed to resemble conventional stained images enabling integration into the current clinical or research workflows.

Project Description

In this study, we have developed two models that capture the essential characteristics of both the epithelium based disease states and stroma related microenvironment as shown in the figure below with high degrees of accuracy. It is apparent that different disease states elicit altered stromal response as evident in Figure 1. The presence of desmoplastic stroma around the tumor cells (labelled as malignant) is indicative of tumor-stroma interactions.

Summary

The aim of my study is to integrate the above models with novel imaging systems for real time patient diagnostics and survival predictions. This will provide rapid, objective and automated diagnostic and prognostic information for clinicians to improve patient care. This will address the long recurring need of reducing pathologic inter and intra- observer variability, thereby affecting surgical treatment and hence patient outcomes.

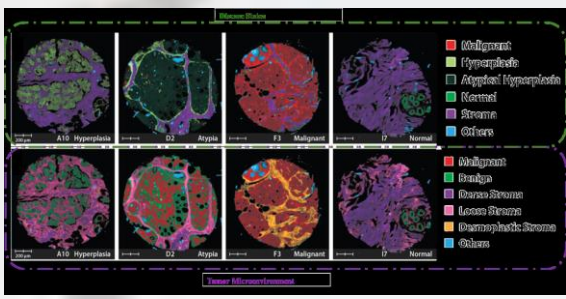

Figure 1: Digitally analyzed Infrared images using machine-learning models to characterize tumor disease states and the corresponding microenvironment [1].

References

Mittal, Shachi, et al. "Simultaneous cancer and tumor microenvironment subtyping using confocal infrared microscopy for all-digital molecular histopathology." *Proceedings of the National Academy of Sciences*. 2018, 115 (25) E5651-E5660

All are welcome

Seminar will be held in DBEB Seminar room at Block I, Room 223 at 4 pm

For additional information, contact Seminar coordinator Dr. Preeti Srivastava at preeti@dbeb.iitd.ac.in or Dr. D. Sundar at sundar@dbeb.iitd.ac.in

SHACHI MITTAL

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EDUCATION

University of Illinois at Urbana-Champaign 2015-Present
Ph.D. Candidate, Department of Bioengineering
GPA:3.93/4.00

Indian Institute of Technology (IIT), Delhi 2009–2014
B.S. and M.S, Biochemical Engineering and Biotechnology
GPA: 9.2/10.00 (Department Rank 1)

SCHOLASTIC ACHIEVEMENTS

- **Invited Speaker, Annual Engineering PhD Summit in EPFL, Switzerland** (2018)
- **Winner, Baxter Young Investigator Award** (2018)
- **Winner, Eastern Analytical Symposium Graduate Student Research Awards** (2018)
- **Nadine Barrie Smith Memorial Fellowship** (Summer, 2018)
- **Poster Award**, International Society of Clinical Spectroscopy (2018)
- **Beckman Institute Graduate Fellow** (2017-2018)
- **Winner**, Poster competition, Biophysics Graduate Research and Networking Symposium (2017)
- **Runner-up**, Tissue and Microenvironment (TiMe) Day Poster Competition (2017)
- **Big Data Summer Fellowship** (July 2017)
- **Illinois Distinguished Fellowship** (2014-2017)
- **Silver Medalist**, Department of Bioengineering, Indian Institute of Technology, Delhi
- **Gold Medalist**, securing the highest CGPA amongst the graduating girls of IIT Delhi, 2013
- **Boss Award,** the best hardcore experimental project in Biochemical Engineering and Biotechnology
- **Khorana Scholarship**: Amongst 30 students from the country to pursue Govt. of India sponsored summer internship in USA (University of Illinois at Urbana Champaign), 2013
- **Three-time Winner IITD Semester Scholarship** for being among the top 7 percent students
- **All India Rank 127** in National Level Science Talent Search Examination, 2008
- **All India Rank 298** in National Science Olympiad, 2008

PUBLICATIONS

1. **Mittal, S.,** Yeh, K., Leslie, L. S., Kenkel, S., Kajdacsy-Balla, A., & Bhargava, R. (2018). Simultaneous cancer and tumor microenvironment subtyping using confocal infrared microscopy for all-digital molecular histopathology. *Proceedings of the National Academy of Sciences*, 201719551.
2. Kenkel, S., Mittal, A., **Mittal, S.,** & Bhargava, R. (2018). Probe-sample interaction-independent Atomic Force Microscopy-Infrared (AFM-IR) spectroscopy: towards robust nanoscale compositional mapping. *Analytical chemistry*.

3. Gupta, S., **Mittal, S.**, Kadjacsy-Balla, A., Bhargava, R.and Bajaj, C. A Fully Automated, Faster Noise Rejection Approach to Increasing the Analytical Capability of Chemical Imaging for Digital Histopathology. Submitted
4. Ostadhossein, F. , Misra, S.K, Mukherjee, P., Ostadhossein, A., Daza, E., Tiwari, S., **Mittal, S**., Gryka, M.C., Bhargava, R. and Pan, D. Breast Cancer Therapy: Defined Host–Guest Chemistry on Nanocarbon for Sustained Inhibition of Cancer. *Small*, 2016
5. Devtter, B.M., Kenkel,S., **Mittal, S.** and Wrobel, T.P.(2016).Characterization of structure of low-e substrates and consequences for IR transflection measurements. *Vibrational Spectroscopy*.
6. **Mittal, S**., Wrobel, T.P., Leslie, L.S., Kadjacsy-balla and Rohit Bhargava (2016). A four-class model for digital breast histopathology using High- Definition Fourier transform infrared (FT-IR) spectroscopic imaging. Prog. Biomed. Opt. Imaging - Proc. *SPIE*.
7. Rathore, A. S. (corresponding author, PI), **Mittal, S. (student first author),** Pathak, M. and Mahalingam, V. (2014). Chemometrics application in biotech processes: assessing comparability across processes and scales. *Journal of Chemical Technology and Biotechnology*, 89(9), 1311-1316.
8. Mayerich, D. M., Walsh, M., Kadjacsy-Balla, A., **Mittal, S**. and Bhargava, R. (2014). Breast histopathology using random decision forests-based classification of infrared spectroscopic imaging data. *SPIE Medical Imaging* (pp. 904107-904107). International Society for Optics and Photonics.
9. Rathore, A. S. (corresponding author, PI), **Mittal, S. (student first author)**, Pathak, M. and Arora, A. (2014). Guidance for performing multivariate data analysis of bioprocessing data: Pitfalls and recommendations. *Biotechnology progress*, 30(4), 967-973.
10. Rathore, A. S. (corresponding author, PI), **Mittal, S. (student first author),** Lute, S. and Brorson, K. (2012). Chemometrics applications in biotechnology processes: Predicting column integrity and impurity clearance during reuse of chromatography resin. *Biotechnology progress*, 28(5), 1308-1314.

CONFERENCE PRESENTATIONS

- **International Society of Clinical Spectroscopy, SPEC,** Glasgow, June 10-15, 2018: Digital Molecular Histopathology for Efficient Breast Cancer Management.
- **USCAP 2018 Annual Meeting**, Vancouver, March 17-23, 2018: Digital and Rapid Diagnosis of Ductal Carcinoma In-Situ and Tumor Grading for Improved Patient Care.
- **USCAP 2017 Annual Meeting**, San Antonio, March 4-10, 2017: Correlating Infrared Imaging based Automated Breast Tumor Staging Models with Immunohistochemical (IHC) Stained Images.
- **BMES 2016 Annual Meeting**, Minneapolis, October 5-8, 2016: High definition infrared spectroscopic imaging: towards automated cancer histopathology.
- **SciX 2016**, Minneapolis, September 18-23, 2016: Comprehensive breast tissue characterization and model comparisons using high definition infrared spectroscopic imaging.
- **Beckman Graduate Student Seminar** 2016, Illinois, October 5, 2016: Automated breast cancer diagnosis to aid current clinical practices.
- **SPIE Digital Pathology Conference**, San Diego, California, United States 27 Feb-3 March 2016: A four class model for digital breast histopathology using high-definition Fourier transform infrared (FT-IR) spectroscopic imaging.
- **American Chemical Society 249th National Meeting**, Denver Colorado, March 22-26, 2015: Building a High Definition Breast Tissue Classifier: Applications in FT-IR based Histopathology.

INTERNSHIPS

Automated Classification of Breast tissue for Cancer Diagnosis May 2013 – July 2013
Beckman Institute for Advanced Science and Technology, UIUC Prof. Rohit Bhargava

- Developed a software to classify tissues for histopathological studies using IR images.

Process comparability optimization May 2012 – July 2012
Biocon Pvt. Ltd, Bangalore Ankur Bhatnagar

- Analyzed multiple bioreactor runs using multivariate analysis to identify trends, clusters and patterns in the data and performed experiments at various scales of operation.

MENTORSHIP EXPERIENCE

- Discoveries in Bioimaging REU (May 2015 – July 2015; May 2018 – July 2018)
  - Mentored 1 undergraduate student per summer for 8 weeks
- Student mentoring (June 2015 – August 2015; June 2016 – August 2016)
  - Mentored 1 high school student and 1 undergraduate student for 8 weeks
- researcHStart (June 2015 – August 2015; June 2016 – August 2016)
  - Mentored 1 high school student per summer for 8 weeks

OUTREACH ACTIVITIES

President, Aayush, University of Illinois August 2016 – Present

- Initiative to provide better healthcare facilities in developing countries
- Leading a team of 6 to create healthcare awareness and setting up a research wing on campus
- Primary goal: Interdisciplinary research program to bridge demographic and economic silos

Student Head, National Service Scheme at IIT Delhi April 2012 – April 2013

- Led a 3-tier team of 30 members to manage the activities of 1300+ volunteers
- Initiated independent teaching projects serving approx. 100 underprivileged kids around campus
- Launched state-wide campaign 'Stree' to address the issue of women empowerment

Study on the Education System of India, NRCVE, IIT Delhi January 2013 – May 2013

- Studied the present education system in the context of traditional Gurukul systems
- Proposed an intermediate system using surveys conducted in IIT, high schools and Gurukuls.

Student representative, Board of Student Publication IIT Delhi April 2011 – April 2012

- Event Coordinator, Literati- Annual Literary Festival
- Worked in a team of 25 students to launch periodic institute magazines.
- Awarded for Significant Contributions in literary Activities.

Survey Project: Literacy in Slums, Humanities and Social Sciences, IIT Delhi July 2011 – Dec 2011

- Performed a comparative analysis of educational aptitude of children taught by NGO's and government schools.