Preview of Award 1925494 - Final Project Report

Cover

Federal Agency and Organization Element to Which Report is Submitted:	4900
Federal Grant or Other Identifying Number Assigned by Agency:	1925494
Project Title:	CCRI: Planning: Development of a Community Resource for Digital Image Research
PD/PI Name:	Iyad Obeid, Principal Investigator Joseph Picone, Co-Principal Investigator
Recipient Organization:	Temple University
Project/Grant Period:	01/01/2020 - 06/30/2021
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Submitting Official (if other than PD\PI):	Iyad Obeid Principal Investigator
Submission Date:	12/17/2021
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	Iyad Obeid

Accomplishments

* What are the major goals of the project?

This goal of this work is a community planning effort for digital pathology. Specifically, it is focused on planning the data and evaluation resources that will enable high performance, automated interpretation of pathology images using machine learning. Digital pathology is a discipline in which slides of biological tissue are automatically interpreted using a combination of extremely high-resolution digital imaging and machine learning. The high resolution of these images, coupled with the complex nature of the artifacts that must be disambiguated for successful diagnoses, pose serious challenges for state-of-the-art deep learning technology.

The field has been limited by a lack of high-quality data (for training machine learning and deep learning engines) as well as standardized community tools and performance metrics, without which competing approaches cannot be compared. To address these issues, we are pursuing a community-building effort around digital pathology. The intellectual merit of this work is that it will create a diverse community of digital pathology researchers. This group will contribute data, software tools, and expertise with the communal goal of improving healthcare outcomes through enhanced analysis of biological tissue. The merit to the medical community will be improved patient outcomes (fewer mistakes, shorter analysis wait-time, reduced costs), whereas the merit to the data science community will be innovative deep learning architectures that are well-suited to the specific problem of biomedical tissue and fluid analysis.

* What was accomplished under these goals and objectives (you must provide information for at least one of the 4 categories below)?

Major Activities: We accomplished two main activities. The first was creating an infrastructure for producing corpora of scanned pathology slides. Although the hardware for this infrastructure was funded by other sources (mainly an NSF MRI award), under the auspices of this project, we perfected the workflow for gathering, scanning, archiving, curating, and cataloging high definition scans of pathology slides. Through our interactions with the machine learning community, we have learned that large, unencumbered image corpora are critical for creating high quality deep learning-based clinical support tools. Before our work, pathology slide image databases have required extensive user agreements (typically involving legal contracting) or have been prohibitively expensive, or have simply not been available. Our work has addressed all of these issues. We have worked with Temple University's IRB and legal counsels to make our data available to the research community without constraint. The combination of improved workflow (for scanning and archiving slides) and reduced regulatory overhead have resulted in a database of over 65,000 high definition pathology slides that are openly available for sharing (www.nedcdata.org)

The support of this project has also enabled the development of tools that were recommended by our research partners. These include tools for viewing and annotating slides, searching and filtering slides, and producing reduced feature sets for machine learning training.

The second main activity was polling the community to determine interest in a digital pathology working group. We conducted interviews with collaborators at, amongst others, the University of Pennsylvania, the University of Washington, Ohio State University, Rutgers University, Proscia Inc, and Blackfynn Inc. We conducted a second tranche of outreach during "teaming" exercises hosted by NIH for the Bridge2AI program. A third tranche was conducted with internal partners in and around Temple University.

The results of these conversations were generally positive. As might be expected, nearly everyone we spoke to was enthusiastic about the prospect of community-based data, tools, and expertise to support digital pathology research. Although some groups felt that they had enough private data available to obviate the need for community-wide assets, the overwhelming consensus was that common data and tools would be beneficial, especially for benchmarking performance on common tasks such as detection of abnormal cells.

At the conclusion of our efforts, we created a core team of experts and successfully applied for funding from the Temple University Office of the Vice President for Research. Our proposal, titled "Automatic Interpretation of Digital Pathology Images Using Deep Learning" was funded for $497k over two years, and includes investigators from Temple University (Engineering, Computer Science), Temple Hospital (Pathology), and Fox-Chase Cancer Center (Oncology, Dermatology, Cytopathology, Molecular Therapeutics, and Pancreatic Pathology).

Our expectation is to keep the tools, data, and algorithms developed under this new award in the public domain, with the long-term goal of supporting community-wide assets for the digital pathology community.

Specific Objectives:

Significant Results:

Key outcomes or
Other achievements:

* What opportunities for training and professional development has the project provided?

Under this award, we have provided part time support for ten undergraduate students. These students have contributed to tool development and have learned and contributed to slide annotation. These students have all been formally added to our IRB and have worked closely with our clinical partners at Temple Hospital (Pathology).

* Have the results been disseminated to communities of interest? If so, please provide details.

We have disseminated results through various publications (see "Products").

Products

Books

Book Chapters
Nabila Shawki M. Golam Shadin Tarek Elseify Luke Jakielaszek Tunde Farkas Yuri Persidsky Nirag Jhala Iyad Obeid Joseph Picone (2019). The Temple University Hospital Digital Pathology Corpus. *Signal Processing in Medicine & Biology: Emerging Trends in Research and Applications* . Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes

Inventions

Journals or Juried Conference Papers
View all journal publications currently available in the [NSF Public Access Repository](#) for this award.

The results in the NSF Public Access Repository will include a comprehensive listing of all journal publications recorded to date that are associated with this award.

Licenses

Other Conference Presentations / Papers
Isabel Hunt Saiyeda Husain Julien Simons Iyad Obeid Joseph Picone (2019). *Recent Advances in the Temple University Digital Pathology Corpus*. IEEE Signal Processing in Medicine and Biology. . Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Zoe Wevodau Benjamin Doshna Nirag Jhala Israh Akhtar Iyad Obeid Joseph Picone (2021). *The Temple University Digital Pathology Corpus: The Breast Tissue Subset*. IEEE Signal Processing in Medicine and Biology. . Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Other Products

Other Publications

Patent Applications

Technologies or Techniques

Thesis/Dissertations

Websites or Other Internet Sites

Participants/Organizations

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Obeid, Iyad	PD/PI	1
Picone, Joseph	Co PD/PI	1

Full details of individuals who have worked on the project:

Iyad Obeid
Email: iobeid@temple.edu
Most Senior Project Role: PD/PI
Nearest Person Month Worked: 1

Contribution to the Project: Contact PI, project oversight, interviews with community members, data and tool development

Funding Support: NSF only

Change in active other support: No

International Collaboration: No
International Travel: No

Joseph Picone
Email: joseph.picone@gmail.com
Most Senior Project Role: Co PD/PI
Nearest Person Month Worked: 1

Contribution to the Project: Pathology corpus and tool development, student management, outreach to partners.

Funding Support: NSF Only

Change in active other support: No

International Collaboration: No
International Travel: No

What other organizations have been involved as partners?
Nothing to report.

Were other collaborators or contacts involved? If so, please provide details.
Nothing to report

Impacts

What is the impact on the development of the principal discipline(s) of the project?

The results of this project have led to tangible improvements in our ability to gather and publish tools and data that are

responsive to the needs of the digital pathology community. We have a long track record of keeping all such assets freely and easily available in the public domain, and will continue to do so for the products of this project. The biggest outcome of this project is that it has enabled us to successfully launch a larger digital pathology project focused on machine learning for robust automated detection of cancerous cells. That project will improve the state of the art for how deep learning is applied in the digital pathology community, and will yield further data and tools that will remain in the public domain. As mentioned earlier, our long term goal remains a community that coalesces around common data and tools for benchmarking performance on various detection problems.

What is the impact on other disciplines?
Nothing to report.

What is the impact on the development of human resources?
Nothing to report.

What was the impact on teaching and educational experiences?
Nothing to report.

What is the impact on physical resources that form infrastructure?
Nothing to report.

What is the impact on institutional resources that form infrastructure?
Nothing to report.

What is the impact on information resources that form infrastructure?
Nothing to report.

What is the impact on technology transfer?
Nothing to report.

What is the impact on society beyond science and technology?
Nothing to report.

What percentage of the award's budget was spent in a foreign country?
Nothing to report.

Changes/Problems

Changes in approach and reason for change
Nothing to report.

Actual or Anticipated problems or delays and actions or plans to resolve them
Nothing to report.

Changes that have a significant impact on expenditures
Nothing to report.

Significant changes in use or care of human subjects
Nothing to report.

Significant changes in use or care of vertebrate animals
Nothing to report.

Significant changes in use or care of biohazards
Nothing to report.

Change in primary performance site location
Nothing to report.