**Recent Advances in the Temple University Digital Pathology Corpus**

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The Neural Engineering Data Consortium (NEDC) is developing a large open source database of high-resolution digital pathology images known as the Temple University Digital Pathology Corpus (TUDP) [1]. Our long-term goal is to release one million images. We expect to release the first 100,000 image corpus by December 2020. The data is being acquired at the Department of Pathology at Temple University Hospital (TUH) using a Leica Biosystems Aperio AT2 scanner [2] and consists entirely of clinical pathology images. More information about the data and the project can be found in Shawki et al. [3]. We currently have a National Science Foundation (NSF) planning grant [4] to explore how best the community can leverage this resource. One goal of this poster presentation is to stimulate community-wide discussions about this project and determine how this valuable resource can best meet the needs of the public.

The computing infrastructure required to support this database is extensive [5] and includes two HIPAA-secure computer networks, dual petabyte file servers, and Aperio’s eSlide Manager (eSM) software [6]. We currently have digitized over 50,000 slides from 2,846 patients and 2,942 clinical cases. There is an average of 12.4 slides per patient and 10.5 slides per case with one report per case. The data is organized by tissue type as shown below:

Filenames:

tudp/v1.0.0/svs/gastro/000001/00123456/2015\_03\_05/0s15\_12345/0s15\_12345\_0a001\_00123456\_lvl0001\_s000.svs

tudp/v1.0.0/svs/gastro/000001/00123456/2015\_03\_05/0s15\_12345/0s15\_12345\_00123456.docx

Explanation:

*tudp:* root directory of the corpus

*v1.0.0:* version number of the release

*svs:* the image data type

*gastro:* the type of tissue

*000001:* six-digit sequence number used to control directory complexity

*00123456:* 8-digit patient MRN

*2015\_03\_05:* the date the specimen was captured

*0s15\_12345:*  the clinical case name

*0s15\_12345\_0a001\_00123456\_lvl0001\_s000.svs:* the actual image filename consisting of a repeat of the case name, a site code (e.g., 0a001), the type and depth of the cut (e.g., lvl0001) and a token number (e.g., s000)

*0s15\_12345\_00123456.docx:* the filename for the corresponding case report

We currently recognize fifteen tissue types in the first installment of the corpus. The raw image data is stored in Aperio’s “.svs” format, which is a multi-layered compressed JPEG format [3,7]. Pathology reports containing a summary of how a pathologist interpreted the slide are also provided in a flat text file format. A more complete summary of the demographics of this pilot corpus will be presented at the conference.

Another goal of this poster presentation is to share our experiences with the larger community since many of these details have not been adequately documented in scientific publications. There are quite a few obstacles in collecting this data that have slowed down the process and need to be discussed publicly. Our backlog of slides dates back to 1997, meaning there are a lot that need to be sifted through and discarded for peeling or cracking. Additionally, during scanning a slide can get stuck, stalling a scan session for hours, resulting in a significant loss of productivity. Over the past two years, we have accumulated significant experience with how to scan a diverse inventory of slides using the Aperio AT2 high-volume scanner. We have been working closely with the vendor to resolve many problems associated with the use of this scanner for research purposes. This scanning project began in January of 2018 when the scanner was first installed. The scanning process was slow at first since there was a learning curve with how the scanner worked and how to obtain samples from the hospital. From its start date until May of 2019 ~20,000 slides we scanned. In the past 6 months from May to November we have tripled that number and how hold ~60,000 slides in our database. This dramatic increase in productivity was due to additional undergraduate staff members and an emphasis on efficient workflow.

The Aperio AT2 scans 400 slides a day, requiring at least eight hours of scan time. The efficiency of these scans can vary greatly. When our team first started, approximately 5% of slides failed the scanning process due to focal point errors. We have been able to reduce that to 1% through a variety of means: (1) best practices regarding daily and monthly recalibrations, (2) tweaking the software such as the tissue finder parameter settings, and (3) experience with how to clean and prep slides so they scan properly. Nevertheless, this is not a completely automated process, making it very difficult to reach our production targets. With a staff of three undergraduate workers spending a total of 30 hours per week, we find it difficult to scan more than 2,000 slides per week using a single scanner (400 slides per night x 5 nights per week). The main limitation in achieving this level of production is the lack of a completely automated scanning process, it takes a couple of hours to sort, clean and load slides. We have streamlined all other aspects of the workflow required to database the scanned slides so that there are no additional bottlenecks.

To bridge the gap between hospital operations and research, we are using Aperio’s eSM software. Our goal is to provide pathologists access to high quality digital images of their patients’ slides. eSM is a secure website that holds the images with their metadata labels, patient report, and path to where the image is located on our file server. Although eSM includes significant infrastructure to import slides into the database using barcodes, TUH does not currently support barcode use. Therefore, we manage the data using a mixture of Python scripts and manual import functions available in eSM. The database and associated tools are based on proprietary formats developed by Aperio, making this another important point of community-wide discussion on how best to disseminate such information.

Our near-term goal for the TUDP Corpus is to release 100,000 slides by December 2020. We hope to continue data collection over the next decade until we reach one million slides. We are creating two pilot corpora using the first 50,000 slides we have collected. The first corpus consists of 500 slides with a marker stain and another 500 without it. This set was designed to let people debug their basic deep learning processing flow on these high-resolution images. We discuss our preliminary experiments on this corpus and the challenges in processing these high-resolution images using deep learning in [3]. We are able to achieve a mean sensitivity of 99.0% for slides with pen marks, and 98.9% for slides without marks, using a multistage deep learning algorithm. While this dataset was very useful in initial debugging, we are in the midst of creating a new, more challenging pilot corpus using actual tissue samples annotated by experts. The task will be to detect ductal carcinoma (DCIS) or invasive breast cancer tissue. There will be approximately 1,000 images per class in this corpus. Based on the number of features annotated, we can train on a two class problem of DCIS or benign, or increase the difficulty by increasing the classes to include DCIS, benign, stroma, pink tissue, non-neoplastic etc.

Those interested in the corpus or in participating in community-wide discussions should join our listserv, *nedc\_tuh\_dpath@googlegroups.com*, to be kept informed of the latest developments in this project. You can learn more from our project website: [*https://www.isip.piconepress.com/projects/nsf\_dpath*](https://www.isip.piconepress.com/projects/nsf_dpath).

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