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Title: Introduction of an Integrated Pathology Image Management, Artificial Intelligence, and Reporting System

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Author Questionnaire

1. **Microscopy**: Does your protocol require the use of a dissecting or stereomicroscope for performing a complex dissection, microinjection technique, or something similar? **NO**

2. **Software:** Does the part of your protocol being filmed include step-by-step descriptions of software usage? **YES , all done**

3. **Filming location:** Will the filming need to take place in multiple locations? **NO**

Current Protocol Length
Number of Steps: 09
Number of Shots: 23 (20 SC)

Introduction

Videographer: Obtain headshots for all authors available at the filming location.

1.1. **David Zhang:** Our research focuses on developing a novel platform which includes integrated pathology information system (PIS), image management system (IMS) and artificial intelligence (AI) to advance modern pathology. The question NovinoAI is trying to answer is whether such platform can be developed and used in pathology practice, research and education.

1.1.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B-roll: 2.3.1.*

What technologies are currently used to advance research in your field?

1.2. **David Zhang:** technologies include computer engineering, digital scanning, computational pathology and AI model training.

1.2.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera.

What are the current experimental challenges?

1.3. **David Zhang:** One of the most important challenges is the availability of a platform which allows AI to be integrated and to perform tasks in seamless manner.

1.3.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B-roll: 4.2.1*

What significant findings have you established in your field?

1.4. **David Zhang:** we demonstrated that integrated platform can be developed and used in pathology practice, research and education with desirable accuracy.

1.4.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B-roll: 2.2.1*

What research questions will your laboratory focus on in the future?

1.5. **David Zhang:** we are continuing to develop more models including foundation models for future research.

1.5.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera.

Videographer: Obtain headshots for all authors available at the filming location.

Testimonial Questions (OPTIONAL):

Videographer: Please capture all testimonial shots in a wide-angle format with sufficient headspace, as the final videos will be rendered in a 1:1 aspect ratio. Testimonial statements will be presented live by the authors, sharing their spontaneous perspectives.

How do you think publishing with JoVE will enhance the visibility and impact of your research?

1.6. **David Zhang,** publishing our paper and video in JoVE will help to share the platform and knowledge to pathology research community: (authors will present their testimonial statements live)

1.6.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B-roll: 2.3.1.*

Title Card

This research was designed with strict adherence to data privacy standards and regulatory frameworks, including the Health Insurance Portability and Accountability Act (HIPAA)

NOTE: Add the above statement just like how we add the ethics card

Protocol

2. Digitization of Slides

Demonstrator: David Zhang

2.1. To begin, open a web browser and navigate to the prod flexlis website **[1]**. Enter the pre-registered user email and click **Continue** to proceed **[2]**. An email will be sent to the registered address **[3]**.

2.1.1. WIDE: Talent sitting at a workstation and opening the browser.

2.1.2. SCREEN: JOVE68270_SCRRENSHOT2_ZHANG-2025-07-01-12-20-33.MP4 00:18-00:26.

2.1.3. SCREEN: JOVE68270_SCRRENSHOT2_ZHANG-2025-07-01-12-20-33.MP4 00:36-00:39.

2.2. Go to the email inbox and click on the provided sign-in **link** to access the Accession List window **[1]**.

2.2.1. SCREEN: JoVE68270_screenshot_3_Instruction-of-how-to-use-FlexLIS-(1).mp4 01:07-01:12

2.3. Now, turn on the power of the digital scanner **[1]** and load the previously stained-glass slide into the scanner **[2]**.

2.3.1. Talent switching on the digital scanner.

2.3.2. Talent placing stained slide into the scanner tray.

2.4. Press the **Start** button to begin scanning the glass slide. The scanned images will automatically get uploaded to the system via direct interface and will appear arranged in case format, similar to a pathologist's slide tray **[1]**.

2.4.1. SCREEN: JoVE68270_screenshot_3_Instruction-of-how-to-use-FlexLIS-(1).mp4 02:20-02:27.

3. Analysis of the Specimen Data

3.1. In the Accession List window, view the list of assigned cases and corresponding slide images in the Image Review window **[1]**.

3.1.1. SCREEN: JOVE68270_SCRRENSHOT2_ZHANG-2025-07-01-12-20-33.MP4 04:15-

04:20.

3.2. In the Accession List window, click the down arrow next to the case labeled PN24-00004 *(P-N-24-oh-4)* to reveal stains ordered by staff and AI, such as PIN4 *(Pin-4)* **[1]**. A green dot on the microscope icon indicates AI analysis is complete **[2]**. A red dot next to the accession number signifies cancer detected by AI **[3]**. The Reviewed/Ready/Total *(Reviewed-Ready-Total)* values show the image category counts **[4]**. An exclamation mark after the image number signals quality issues such as missing or blurry images **[5]**.

3.2.1. SCREEN: JOVE68270_SCRRENSHOT2_ZHANG-2025-07-01-12-20-33.MP4 04:30-04:37.

3.2.2. SCREEN: JOVE68270_SCRRENSHOT2_ZHANG-2025-07-01-12-20-33.MP4 04:49-04:55.

3.2.3. SCREEN: JOVE68270_SCRRENSHOT2_ZHANG-2025-07-01-12-20-33.MP4 05:07-05:12.

3.2.4. SCREEN: JOVE68270_SCRRENSHOT2_ZHANG-2025-07-01-12-20-33.MP4 05:20-05:25.

3.2.5. SCREEN: JOVE68270_SCRRENSHOT2_ZHANG-2025-07-01-12-20-33.MP4 05:32-05:39.

3.3. Next, click the **User** icon next to case PN24-00004 to open the Pathologist Review window **[1]** and observe the Specimen Summary Table listing all specimens alphabetically **[2]**. View AI-generated results for each specimen, including diagnosis such as benign, HGPIN *(H-G-pin)*, ASAP *(A-sap)*, or cancer, along with descriptions like Gleason scores, tumor length, and grade group **[3]**. Then, examine the color-coded AI diagram showing cancer in red, ASAP in orange, and benign in black **[4]**.

3.3.1. SCREEN: JOVE68270_SCRRENSHOT2_ZHANG-2025-07-01-12-20-33.MP4 06:10-06:15.

3.3.2. SCREEN: JOVE68270_SCRRENSHOT2_ZHANG-2025-07-01-12-20-33.MP4 06:28-06:33.

3.3.3. SCREEN: JOVE68270_SCRRENSHOT2_ZHANG-2025-07-01-12-20-33.MP4 07:05-07:10.

3.3.4. SCREEN: JOVE68270_SCRRENSHOT2_ZHANG-2025-07-01-12-20-33.MP4 07:06 (hold frame). *Video editor: Please highlight the 4 icons showing Benign, HGPIN, ASAP, Cancer in black, green, yellow and red boxes respectively*

3.4. Now, click the **Microscope** icon to open the Image Review window **[1]** and view the

corresponding slide image **[2].** Examine the AI annotations, with red highlights marking cancer and green highlights showing Gleason 4 **[3]**.

3.4.1. SCREEN: JOVE68270_SCRRENSHOT2_ZHANG-2025-07-01-12-20-33.MP4 07:40-07:45.

3.4.2. SCREEN: JOVE68270_SCRRENSHOT2_ZHANG-2025-07-01-12-20-33.MP4 007:48-07:54.

3.4.3. SCREEN: JOVE68270_SCRRENSHOT2_ZHANG-2025-07-01-12-20-33.MP4 08:15-08:18 and 08:30-08:33.

3.5. Click **C** to view image C, then click **D** to view image D and so on **[1]**. Finally, click the **AI Feedback** icon to view detailed AI analysis output **[2]**.

3.5.1. SCREEN: JOVE68270_SCRRENSHOT2_ZHANG-2025-07-01-12-20-33.MP4 09:00-09:10.

3.5.2. SCREEN: JOVE68270_SCRRENSHOT2_ZHANG-2025-07-01-12-20-33.MP4 10:15-10:20.

Results

4. Results

4.1. The AI model for prostate cancer detection achieved an accuracy of 97 percent **[1]**, with a precision of 96 percent **[2]**, sensitivity of 98 percent **[3]**, specificity of 96 percent **[4]**, and F1 score of 97 percent **[5]**.

4.1.1. LAB MEDIA: Table 1_RE.xlsx. *Video editor: Highlight the "Accuracy" column*.

4.1.2. LAB MEDIA: Table 1_RE.xlsx. *Video editor: Highlight the "Precision" column*.

4.1.3. LAB MEDIA: Table 1_RE.xlsx. *Video editor: Highlight the "Sensitivity" column*.

4.1.4. LAB MEDIA: Table 1_RE.xlsx. *Video editor: Highlight the "Specificity" column*.

4.1.5. LAB MEDIA: Table 1_RE.xlsx. *Video editor: Highlight the "F1-score" column*.

4.2. The AI-assisted histopathology system accurately annotated Gleason 3, Gleason 4, and Gleason 5 regions on prostate biopsy slides using a color-coded mask overlay **[1]**.

4.2.1. LAB MEDIA: Figure 7. *Video editor: Focus on the slide image section marked with red, green, and blue outlines*.

4.3. The AI system automatically extracted key pathological metrics including tumor length, percentage, Gleason scores, and grade group from the prostate biopsy **[1]**.

4.3.1. LAB MEDIA: Figure 7A. *Video editor: Highlight the right-hand black background pane*.

4.4. The AI-based urine cytology model automatically identified diagnostically significant cells, including high-grade urothelial carcinoma, atypical cells, and suspicious cells, each outlined with color-coded boxes **[1]**.

4.4.1. LAB MEDIA: Figure 8. *Video editor: Highlight the multiple cells outlined in red, purple, and other distinct colors*.

1. accession

- Pronunciation link (Merriam-Webster): https://www.merriam-webster.com/dictionary/accession
- IPA: **/ək**ˈ**seʃ.ən/**
- Phonetic Spelling: uh-KE-shuhn

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2. HGPIN (High-grade Prostatic Intraepithelial Neoplasia)

- This is an abbreviation; pronounce each letter individually and then the full form: *H-G-P-I-N*, *High-grade Prostatic Intraepithelial Neoplasia*.
- HGPIN is commonly used in prostate pathology
- Full IPA (medical abbreviation spelled as letters): **/eɪtʃ ˌdʒi pi ˌaɪ ɛn/**
- Phonetic Spelling: *aitch-gee-pee-eye-en*, *high-grade proh-STAT-ik IN-tray-uh-pee-THEE-lee-uhl nee-oh-PLAY-zhuh*

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3. Gleason

- Pronunciation link (Merriam-Webster Medical): https://www.merriam-webster.com/medical/Gleason%20score
- Alternate confirmation: “GLEE-suhn”
- IPA: /ˈ**gli**ː**sən/**
- Phonetic Spelling: *GLEE-suhn*

1. peristalsis

- Pronunciation link (Merriam-Webster): https://www.merriam-webster.com/dictionary/peristalsis YouTube+5YouTube+5How To Pronounce+5OpenMD+15Merriam-Webster+15How To Pronounce+15
- IPA: /ˌ**pɛrə**ˈ**stɔlsɪs/** or /ˌ**pɛrə**ˈ**stɑlsɪs/**
- Phonetic Spelling: *PER-uh-STOL-siss*

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2. peristaltic

- Pronunciation link (Merriam-Webster): https://www.merriam-webster.com/dictionary/peristaltic Merriam-Webster
- IPA: /ˌ**pɛrə**ˈ**stɔltɪk/** or /ˌ**pɛrə**ˈ**stɑltɪk/**
- Phonetic Spelling: *PER-uh-STOL-tik*

3. urothelial

- Pronunciation link (Merriam-Webster Medical rhymes): https://www.merriam-webster.com/rhymes/adv/urothelial WikipediaOpenMD+13Merriam-Webster+13Definitions+13
- Alternate audio sources: HowToPronounce.com & Forvo YouTube+3How To Pronounce+3How To Pronounce+3
- IPA (based on medical usage): /ˌ**jʊərəˈθiːliəl**/
- Phonetic Spelling: *YUR-uh-THEE-lee-uhl*

4. cytology

- Pronunciation link (Merriam-Webster): https://www.merriam-webster.com/dictionary/cytology How To PronounceHow To PronounceMerriam-Webster+14Merriam-Webster+14Oxford English Dictionary+14
- IPA: /**saɪˈtɑlədʒi**/
- Phonetic Spelling: *sigh-TAL-uh-jee*