



Design and development of a digital scanning microscope (DSM) for

Client Overview

The client is an interactive global pathology laboratory chain headquartered in USA.

Statement

The client was looking to expand their business to emerging markets like China and India and hence was in need to come up with cost effective digital scanner suitable for these growing markets.

Shift from conventional microscope to digital microscope/scanner has now become a forefront of modern pathological development. Instead of analyzing pathology slides manually using a microscope, a digital scanning microscope (DSM) is employed now-a-days for automated scanning and imaging of pathology slides. Once scanned, the digital images can be stored, distributed and analyzed using image processing and/or web based applications.

The client wanted to develop a DSM for whole slide imaging (WSI) of the 15 pathology slides, later scalable up to 120 slides. The DSM would be an automated system wherein once the slides are loaded; each of the slides is picked, scanned under a digital microscope and deposited back into the slide basket. The task is executed using various optical and electro-mechanical devices and components. Development of DSM demands a careful and precise coordination of several technologies involving optics, mechanics, electronics and software, to ensure image quality and scan speed.

Design Guidelines and Specifications of the DSM:

The DSM has been designed under the following system specifications/guidelines:

- Typical dimensions of the pathological slides = 1” by 3”
- Pixel scale ~0.5 microns per pixel
- Optics should be chosen to achieve the maximum resolution possible/compatible with the above pixel scale.
- Standard Koehler illumination method is to be used.
- Scanning time should be kept as minimum as possible. Typically <5 minutes to scan 15mm X 15mm tissue area.
- Slide capacity : 15 (Scalable up to 120 with an add-on Carousel)

DSM Design and Development at Optra Systems:

Towards the development of DSM, the following sub- systems were designed and developed at Optra Systems:

- Optical imaging system of the DSM
- Stepper Motors based scanning module of the DSM
- Slide pickup- deposit mechanism of the DSM
- Microcontroller based embedded control system of the DSM
- Instrument control software
- Image viewer and analysis software

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Features of Opto-Mechanical System of the DSM:

- Designed using off-the-shelf components
- Uses a 20x microscope objective to scan the sample under observation
- Provides pixel scale of ~0.4 microns per pixel
- 1.4 megapixel high resolution camera with Firewire connection for faster data transfer.
- Koehler illumination is used along with off-the-shelf condenser lens
- Stepper motors based scanning mechanism to ensure better speed and resolution

Features of Instrument Control System and Software of the DSM:

- Micro-controller based control system architecture based on ATMEL AVR series of microcontroller.
- On board control of stepper motors using Allegro micro-stepping translator driver
- Quadrature encoder based feedback control for precise motion control of stepper motors.
- USB 2.0 interface for system control
- USB and Firewire controls for camera connection
- In house provision for power supply.

Outcome:

The digital scanner or digital scanning microscope (DSM) has been designed and developed to provide automated digital imaging of up to 15 pathology slides in a single operation. The system is designed by considering commercially available solutions for various, optical, mechanical and electronic components to satisfy the requirements of image quality and speed. DSM is now fully operational providing high resolution images with faster scan speed and available at 1/3 rd of the market cost for such scanners.

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About Optra Systems

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