

Given Imaging Develops Camera-in-a-Capsule Using MATLAB to Improve the Diagnosis of Gastrointestinal Disorders

Every year, diseases of the gastrointestinal (GI) tract account for more than 30 million office visits in the United States alone. GI tract disorders are easy to cure in their early stages but are difficult to diagnose: Endoscopy and other common test procedures can be so painful or invasive that patients often avoid such exams.

Israeli biomedical company Given Imaging has developed the PillCam® video capsule, a minimally invasive diagnostic tool that substantially improves visual imaging of the small intestine. The swallowable capsule contains a tiny video camera that transmits digital pictures from the GI tract to a receiver fitted against the patient's body. The resulting pictures can be sent electronically to an attending physician anywhere in the world.

Given Imaging relied on MATLAB® and other MathWorks tools throughout the development of the PillCam capsule.

“Because the video capsule was technically complex, MATLAB was essential for us in writing algorithms, testing and checking systems, and planning and building the PillCam,” says Rafi Nave, vice president of R&D at Given Imaging.

THE CHALLENGE

The inventor of the capsule, Dr. Gabriel Iddan, set out to develop an imaging technique that would enable examination of the small intestine without subjecting the patient to pain or discomfort.



The PillCam SB 2 video capsule.

The disposable PillCam SB 2 capsule contains a miniaturized color video camera, a miniature battery, an antenna, and a radio transmitter. The images of the small intestine, captured at a rate of about two per second as the camera passes through the GI tract, are transmitted by radio frequency to an array of sensors on a belt worn around the patient's waist.

Over a period of about eight hours, the camera captures 50,000 images. These images are downloaded to a PC workstation equipped with Given Imaging's proprietary RAPID® (Reporting and Processing of Images and Data) software. This software processes the data and produces a video that the physician can efficiently review to look for abnormalities.

The Given Imaging team needed tools that would enable them to evaluate different algorithms quickly and efficiently.

THE CHALLENGE

Create an alternative to endoscopy and other invasive gastrointestinal imaging procedures

THE SOLUTION

Use MATLAB and companion toolboxes to develop and implement a swallowable video capsule

THE RESULTS

- Fast, efficient development
- Easy access to precise diagnostic information
- Improved patient care

“With MATLAB, we simulated the intended system and fine-tuned it at the early stages of implementation, enabling us to develop critical engineering programs that met requirements on the first iteration.”

Rafi Nave, Given Imaging

THE SOLUTION

Given Imaging's development team selected MathWorks tools because they provided an environment that enabled precise, convenient and, most important, rapid development.

With MATLAB, the team developed and verified algorithms for decoding the information transmitted over the recorder and processing the images. They also used the fast Fourier analysis functions in MATLAB. Throughout the development process, they relied heavily on the data visualization capabilities in MATLAB, specifically, functions for creating contour plots, line plots, and histograms.

The team used Image Processing Toolbox™ for the feasibility study, development, and refinement phases of the image processing project. In addition, the team relied on several capabilities in Signal Processing Toolbox™, including localization, to refine design parameters for visual comparison and for preliminary visualization of algorithm results.

The FDA-approved PillCam SB 2 video capsule has been successfully used with over 1 million patients in 70 countries. The capsule endoscopy procedure has been well-received by patients, and physicians report that the capsule produces excellent images of the small intestine.

Given Imaging continues to use MATLAB for image enhancement and image segmentation and classification, as well as for refining the PillCam capsule. The team also uses Image Processing Toolbox to develop new image processing features and capabilities.

THE RESULTS

■ **Fast, efficient development.** Working in MATLAB, Given Imaging executed elaborate analyses and developed a product model in a matter of months. The team determined that without the contour and 3D plots and other display functions provided in MATLAB and the toolboxes, the project would have been difficult to accomplish.

■ **Easy access to precise diagnostic information.** The capsule provides several types of information, including the timing of the digestive process in the patient and the presence of minute abnormalities. “The camera can detect the shape and precise location of pathologies, such as ulcers or polyps,” says Nave.

■ **Improved patient care.** PillCam capsule endoscopy enables doctors to diagnose disorders of the small intestine, an area of the GI tract that is unreachable with standard imaging methods. Patient management and care have improved as a result.

Learn more about Given Imaging:
www.givenimaging.com

INDUSTRY

- Medical equipment
- Biotech and pharmaceutical

APPLICATION AREAS

- Image and video processing
- Data analysis
- Algorithm development

PRODUCTS USED

- MATLAB®
- Image Processing Toolbox™
- Signal Processing Toolbox™

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