

An Ultra Low Power Image Compressor for Capsule Endoscopy

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Background: Gastrointestinal (GI) endoscopy has been popularly applied for the diagnosis of: diseases of the alimentary canal including Crohn's Disease, Celiac disease and other malabsorption disorders, benign and malignant tumors of the small intestine, vascular disorders, and medication related small bowel injury.

There exist two classes of GI endoscopy; Wired active endoscopy: The wired active endoscopy can enable efficient diagnosis based on real images and biopsy samples; however, it causes patients discomfort and pain to push flexible, relatively bulky cables into the digestive tube.

Wireless passive capsule endoscopy: To relief the suffering of patients, wireless passive capsule endoscopes are being developed worldwide. The capsule moves passively through the internal GI tract with the aid of peristalsis and transmits images of the intestine wirelessly.

The state-of-the-art device is the commercial wireless capsule endoscope product, the PillCam capsule, developed by Given Imaging Ltd.

Statistics:

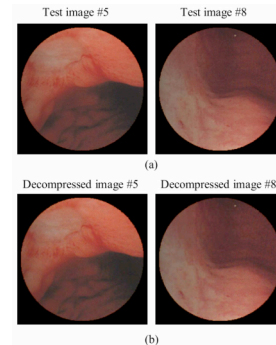
GI images are at the resolution of 256-by-256 8-bit pixels

the frame rate is 2 frames/sec

Drawbacks: First, the PillCam cannot control its heading and moving direction itself. This drawback may cause image oversights and miss a disease. Second, the resolution of de-mosaicked images is still low, and some interesting spots may be unintentionally omitted. Especially, the images will be severely distorted when physicians zoom images in for detailed diagnosis. Increasing resolution may alleviate the second problem; however, it would result in significant power consumption in the RF transmitter, so compression must be used.

The Solution: Meng-Chun Lin, Lan-Rong Dung, and Ping-Kuo Weng developed a new capsule endoscope, called GICam in

November 2005 in Taiwan. Using algorithms specifically designed for capsule endoscopy, they have created a compression technique that significantly reduces power consumption while maintaining image quality. Traditional Image Compression requires two pre processing steps: De-mosaicking and Color Space Transformation. The GICam bypasses both of these steps, reducing power consumption and processing time. Traditional Image Compression uses $YCbCr$ quantization to earn a good compression ratio while the visual distortion is minimized. The GICam uses RGB quantization to save the computation of demosaicking and color space transformation. This also reduces the computing load of 2D-DCT and quantization.



End Result: 512x512 8bit images are now produced, compared to 256x256 8bit images. The developed video compressor only costs 31 K gates at 2 frames per second. It consumes 14.92 mW, compared to 876mW on the PillCam. The video size is reduced by 75% at least, compared to 67%. Image Quality is only 1dB lower than PillCam images, hardly noticeable in the vast majority of applications the capsule endoscope is used.

Sources:

Lin et al. [An Ultra-low-power image compressor for capsule endoscopy](#). Biomedical Engineering Online. Feb 25, 2006. 5-14.

<http://www.pubmedcentral.nih.gov/articlerender.fcgi?tool=pubmed&pubmedid=16504138#B11>

Wikipedia - Wireless capsule endoscopy
http://en.wikipedia.org/wiki/Wireless_capsule_endoscopy