THE ROLE OF SOFTWARE APPLICATIONS IN DETECTING POLYPS FOLLOWING WIRELESS CAPSULE ENDOSCOPY

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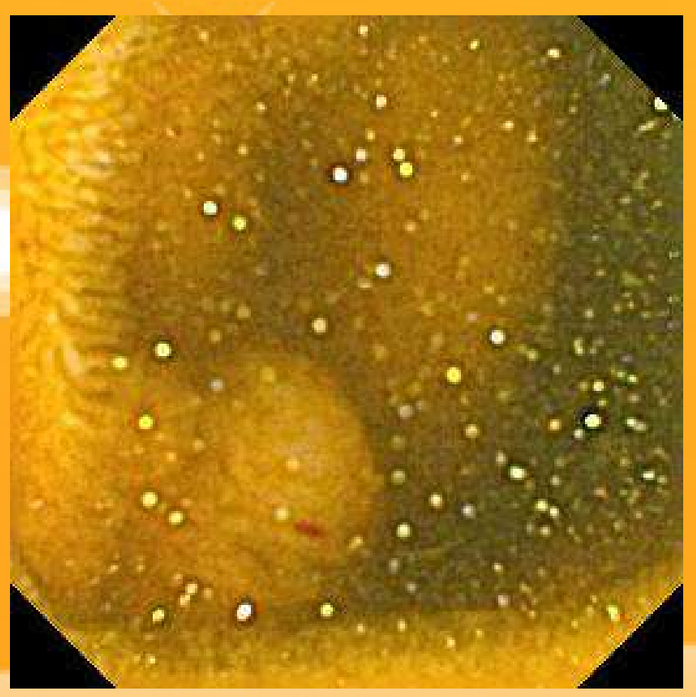
Gastrointestinal polyps

Wireless capsule endoscopy (WCE) is a modern imaging technique used for the overall investigation of the gastrointestinal tract. It offers a set of more than 50000 individual snapshots of the patient's digestive tract.

Automatic lesion detection is a process that would help physicians reduce the time spent for the WCE images analysis, by indicating specific sections that contain potential lesions, as well as their classification with a certain probability.

A **polyp** is an abnormal tissue protuberance visible on the mucosa surface of the digestive tract. The presence of a stalk determines the polyp's type: sessile (no stalk) or pedunculated (with a stalk).



Main characteristics

SHAPE

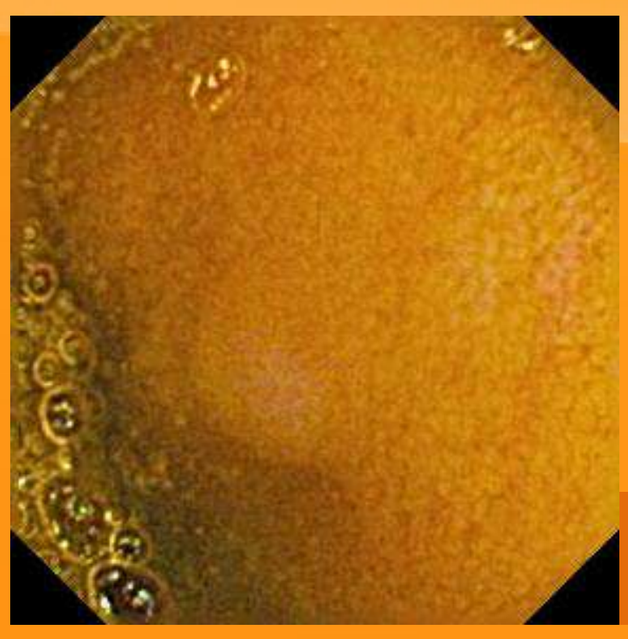
Polyp's main characteristic is the partially oval / round shape (similar to hemispheres or spheres), generally visible as faint contours on the intestinal mucosa, induced by the light produced from the 6 LEDs of the capsule.

The initial approaches using software applications for shape detection included contour oriented algorithms and edge detection filters, like Sobel, Canny or SUSAN. Several authors also employed some oriented Gabor phase congruency patterns, therefore they relayed on the phase responses of a Gabor filter bank, which yielded better results than the previous methods. The computation of the associated curvature is a measure of the polyps' protrusion and is an important phase in automated polyps' detection process.

TEXTURE

Polyps represent protrusions from the surrounding gastrointestinal mucosa, thus their textures are relatively similar. There are cases when polyps are accompanied by small ulcerations, that gives then a particular aspect characterized by modified texture relative to the normal tissue ones.

Software applications usually employ Local Binary Patterns (LBP) for texture analysis, with multiple variations (uniform, rotation, mono-LBP). Gabor filters are also used, in combination with LBP analysis. More recently, authors introduced fractal analysis in defining polyps' texture.



COLOUR

Colour is a feature less determinant for gastrointestinal polyps. There are authors that have analysed this feature individually and have used it for global image analysis. More recent software applications decomposed original images according to colour components expressed in various colour spaces; then, each sub-image was analyzed using Gabor filters or wavelet transforms, leading to a more relevant image descriptor.

Automatic detection process

Software applications used for automatic detection of polyps within images obtained following wireless capsule endoscopy generally follow an algorithm with multiple steps: original image pre-processing, segmentation, edge detection associated with region(s) of interest identification, texture analysis combined or not with colour information, followed in the end by the classification of specific areas.

Classification may be done using neural networks, support vector machines or any other algorithm based on pre-defined weights applied on the previously detected features that composed the WCE image. Various authors have combined feature detection and classification algorithms, reporting sensitivities and specificities up to 94.3%, thus proving that automatic polyp detection is a feasible and reliable process.

Conclusions

SW applications oriented on automatic polyp detection try to emulate the examining physician, thus they are initially based on the same detection process as applied by human observers. Most of the algorithms proposed for automatic polyp detection relay on retrieving geometric details, followed by a textural analysis, of the detected region, most of the times combined with the corresponding colour analysis (with a smaller weight), and a subsequent classification either on particular regions or the entire image. Usually, all image descriptors are involved in the decision making, for which several learning / decision algorithms are employed. The entire process was developed according to the human analysis process, but it takes into account the powerful computation capabilities of nowadays computers and processing algorithms.

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Selective references

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