Medical Applications of Computer Vision

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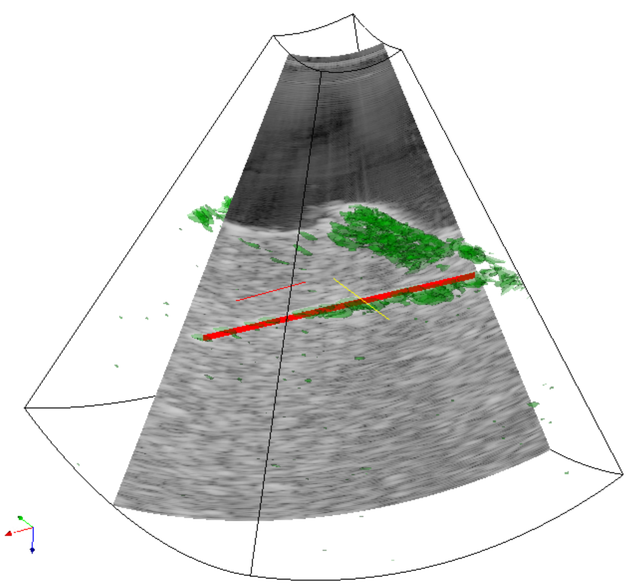
CENTER FOR MACHINE PERCEPTION

Medicine and biology offer a wide range of problems for computer vision starting from measuring of the shape of body surface to interpreting endoscope images, ultrasound, or X-ray images up to analysis and visualization of 3D computer tomography images, MRI, PET, and their variants. Computer algorithms can relieve the physician from routine tasks and let him concentrate on the more difficult problems. Image analysis can give the physician additional information that he can then use to make a better diagnosis.

Localization of Surgical Instruments

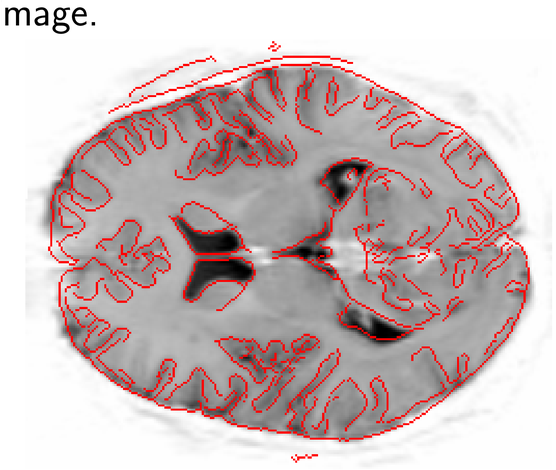
Laparoscopic surgery is very promissing treatment as it minimizes the adverse effects on the patients. Still many issues will have to be resolved to make the laparoscopy as effient as classical surgery. The goal is to offer to the surgeon information about relative position of instruments and tissues being treated or avoided. The method analyses the data from 3D ultrasound system. The algorithm quickly and reliably recognizes the tool in the ultrasound image, which is difficult because of the presence of organs and of the inherent ultrasound image speckle noise.



Localized Surgical Instrument (Red) from 3D Sonography

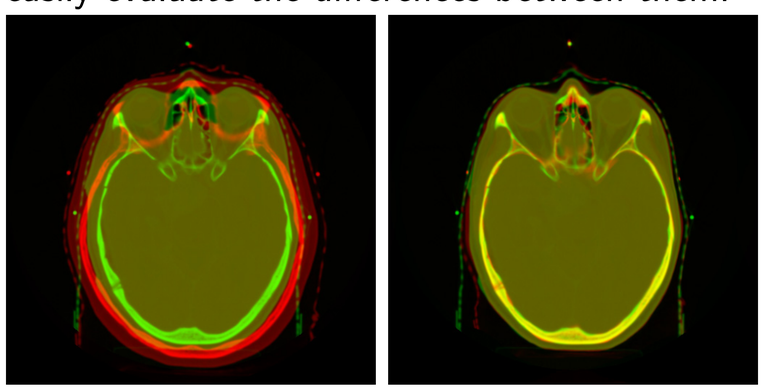
Alignment of Images

Alignment of medical images obtained at different times, by different methods, or from different subjects is often required. An example is to map the structures obtained from functional MRI, which has lower resolution but it is captured in real-time and can detect brain activity, onto standard high quality but slow, anatomical MRI image.



Functional MRI brain slice with superimposed contours from anatomical MRI image

Another example is registration of images of the same patient taken after a certain time interval. Superposing the registered images enables us to easily evaluate the differences between them.



Computer Tomography images before and after surgery in red, resp. green, superposed without (left) and with (right) the help of registration.

Yet another application is compensation for artifacts caused by patient motion. Instead of using mechanical restraint devices to prevent patients from moving, small movement can be now compensated for.

Ultrasound Image Classification

A method of automatic discrimination of Hashimoto thyroiditis from healthy tissue was developed. The method uses texture properties of sonographic images. The method provides instant second opinion on the health state of the thyroid.

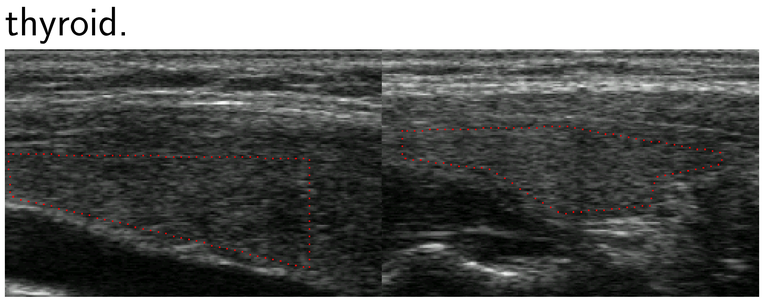
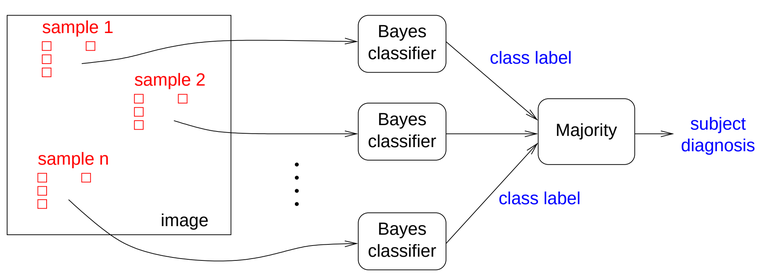


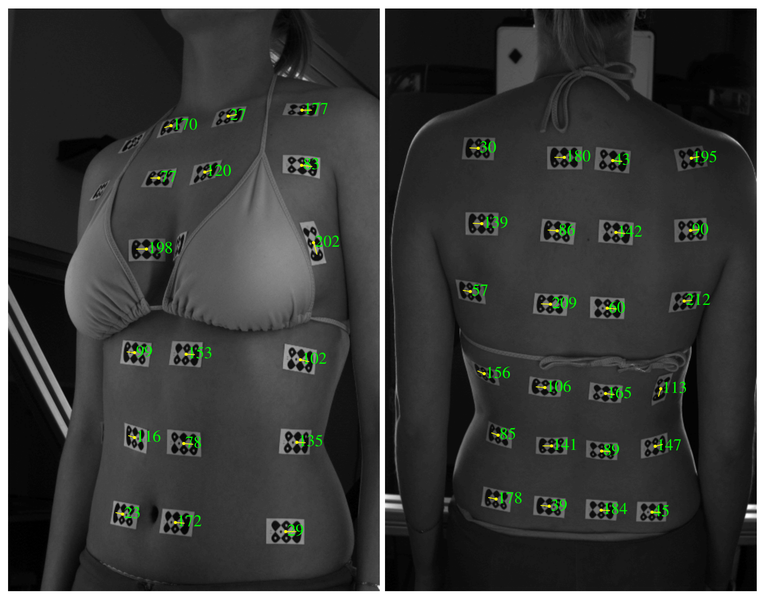
Image of healthy and inflamed tissue



Classification of Hashimoto thyroiditis

3-D Measurement of Breathing

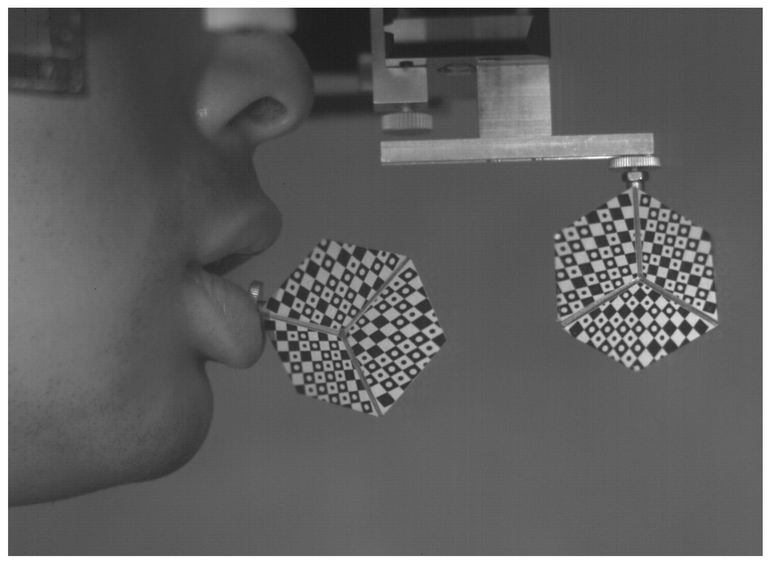
The expertise in 3-D geometry of cameras could of course be used in medicine as well. First application is measuring of thorax motion during breathing. A set of anatomical reference points on the human body were marked and their motion measured in 3-D space. Measurements with submilimeter accuracy was achieved.



Distribution of markers used for photogrammetric measurement of breathing. From their relative motion breathing type can be recognized.

3-D Shape of the Jaw Joint

The measurement of temporo-mandibular joint motion is needed for a correct adjustment of simulating apparatus during prosthetics or restorative dentistry treatment. As the joint is not directly visible, its motion is computed from the measurement of upper and lower teeth positions. The solution is patented.



Measurement of lower jaw joint motion: the targets are attached to lower teeth arc and scull respectively. Their relative spatial motion is estimated from the sequence of images captured during propulsion and latero-pulsion motions by autocalibration of a single camera. All parameters needed to adjust so called articulator are measured.