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Computer Science 519
Homework I
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Computer Vision

Obviously there are many fields that take advantage of computer vision, to name a few are as follow: medical imaging, diagnostics, military weapon system, remote sensing, face recognition and etc… Let us take a look at some of these areas where computer vision is used.

Medical imaging is the one that I am most interested in. A lot of progress and achievements have been done to date and the results are unbelievable. The following are a few of the areas in medical imaging that I have read in the past few days: MR Imaging of Cervical Carcinoma, Comprehensive MR Imaging of Acute Gynecologic Diseases, Dynamic MR Imaging of Pelvic Organ Prolapse, and Pediatric Renal Masses.

Cervical carcinoma is the third most common gynecologic malignancy and is typically seen in younger women, often with serious consequences. The International Federation of Gynecology and Obstetrics (FIGO) staging systems provide worldwide epidemiologic and treatment response statistics. MR imaging examination obviates the use of invasive procedures such as cystoscopy and proctoscopy, especially when there is no evidence of local extension. Brachytherapy and external beam therapy are optimized with MR imaging evaluation of the shape and direction of lesion growth. In general, T2-weighted MR imaging more clearly delineates cervical carcinoma and is preferred for evaluation of the lymph nodes. Dynamic gadolinium-enhanced T1-weighted imaging may help identify smaller tumors, detect or confirm invasion of adjacent organs, and identify fistulous tracts.

Rapid advances in techniques of magnetic resonance (MR) imaging have enabled diagnosis of acute gynecologic conditions, which are characterized by sudden onset of lower abdominal pain, fever, genital bleeding, intraperitoneal bleeding, or symptoms of shock. The chemical-selective fat-suppression technique not only helps establish the characteristics of lesions that contain fat components but also increases the conspicuity of inflammatory lesions. T2*-weighted images are useful for identification of hemorrhagic lesions by demonstrating deoxyhemoglobin and hemosiderin. Contrast material–enhanced dynamic subtraction MR imaging performed with a three-dimensional fast field-echo sequence and a rapid bolus injection of gadopentetate dimeglumine allows evaluation of lesion vascularity and the anatomic relationship between pelvic vessels and a lesion and allows identification of the bleeding point by demonstrating extravasation of contrast material.

A variety of pediatric renal masses may be differentiated from Wilms tumor on the basis of their clinical and imaging features. Wilms tumor is distinguished by vascular invasion and displacement of structures and is bilateral in approximately 10% of cases. Nephroblastomatosis occurs most often in neonates and is characterized by multiple bilateral subcapsular masses, often associated with Wilms tumors. Renal cell carcinoma is unusual in children except in association with von Hippel–Lindau syndrome and typically occurs in the 2nd decade. Mesoblastic nephroma is the primary consideration in a neonate with a solid renal mass. Multilocular cystic renal tumor is suggested by a large mass with multiple cysts and little solid tissue. Clear cell sarcoma is distinguished by frequent skeletal metastases, and rhabdoid tumor is distinguished by its association with brain neoplasms. Angiomyolipoma frequently contains fat and is associated with tuberous sclerosis. Renal medullary carcinoma occurs in patients with sickle cell trait or hemoglobin SC disease and manifests as an infiltrative mass with metastases. Ossifying renal tumor of infancy is differentiated from mesoblastic nephroma by the presence of ossified elements. Metanephric adenoma lacks specific features but is always well defined.

Inspection in Semiconductor Manufacturing is another interesting subject I came across while I was reading about computer vision material. Microscopy techniques for semiconductor wafer analysis fall into three main categories: in-line microscopic for rapid, whole wafer defect detection, off-line microscopic for defect review and failure, and microscopy techniques for critical dimension (CD) and overlay metrology. State-of-the-art in-line imaging systems require from two to twenty minutes to scan an 8-inch wafer. At a defect sensitivity of 0.25μm, a throughput is required of approximately 2GHz, i.e., $2x10^9$ image pixels must be captured, moved through the image processing system, and reduced to a small set of descriptive features, e.g., defect location and size, every second. Finding a 0.25μm defect on an 8-inch diameter wafer is equivalent to searching for an object the size of a baseball on 58000 acres of land! To maintain a throughput of 8-inch wafers at three wafers per hour requires a pixel processing speed of 2GHz. A series of images must be captured, processed, and reported at this sampling rate. This is accomplished by scanning the wafer across the rows of die and subtracting one die from its neighbor to locate subtle differences. The following generic algorithm describes the following steps for defect detection: an image is captured from the test region of a die, the wafer stepper scans to the same location on a neighboring die, and a second image is captured, the two images are aligned and subtracted, small alignment residuals and texture anomalies are filtered and removed, the defect location and size features from the resulting mask are extracted, defect information is logged in the electronic wafermap file for later reference, the stepper moves to the next die and the process is repeated. To maintain the suggested throughput it is important that several of these steps are completed in parallel. Pipeline image processing allows for a serial stream of functions to be processed in parallel, and therefore pipeline image processing is a leading technology in this area.