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Polarization Image Processing with Scilab

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Polarization is an imaging modality that is not part of our everyday lives. However, in nature there are many examples of animals that utilize this modality for orientation and object recognition. Similarly, in industrial inspection, many materials have properties that exhibit a polarization effect. The major challenge lies in the non-visibility, which makes intuitive exploration and exploitation difficult. For establishing industrial usage of polarization imaging, new tools for polarization image processing are required.

We have developed a series of algorithms and imaging devices that enable experiments, measurements and evaluation of material properties. For obtaining polarization measurements, the raw sensor data needs to be processed for computing Stokes vectors for each pixel. From these values the computation continues depending on the application. For example in measuring glass stress, calibration and reference images need to be included for obtaining retardations and apparent temper numbers. These numbers indicate the correct cooling of the glass to the plant operators.

Although only few dozen operations per pixel are necessary, the involved trigonometric functions together with high frame rate and pixel count pose a challenge for interactive operation. We currently use Scilab 6.0.1 for algorithm development and debugging and are able to work at interactive speeds at reduced spatial resolution. For integration into an industrial inspection system, the algorithms are then ported to an optimized .dll implementation. These modules are installed at our customer's sites and will run 24/7 for inspection of products like container glass and tableware among other glass products.

Within the EU funded project ARGO we work on optimizing the transition from algorithm development in Scilab to the real-time capable implementation that is needed for continuous operation. The developed tools enable automatic multicore parallelization and are able to guarantee worst case execution time (WCET) on embedded platforms. In industrial inline inspection, each product has a fixed travel speed and in the limited time we need to decide if the product is good or bad – the conveyor belts will not stop when the algorithms would take slightly longer for processing. The Scilab workflow and automatic WCET -aware parallelization enable rapid prototyping for these constrained applications.