**Automatic Defect Recognition in Industrial Inspection Applications**

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This project centers on developing analytic and computational mechanisms for detecting part defects in spite of imaging noise and allowed part-to-part variation. The analytic space for expressing and detecting part defects, as well as statistical models for dealing with noise and variation, are both of high interest, and solutions that couple these two areas are desired. While a large body of general work on this subject exists, the problem specific to this project is made challenging by aggressive constraints on processing time and by the overall size of the data to be processed. For example, images of a single part may contain hundreds of millions of samples, and a decision to pass or fail the part must be made within a few minutes. Hence, solutions must be lightweight and fast. Finally, while it may be possible to optimize a solution for a particular part, a general capability is needed to accommodate a large range of parts and defects.

A given manufacturing process will have associated failure modes that lead to classes of characteristic defects. Relative to the entire size of the part, these defects are usually quite small. In addition, some variation is tolerable in industrial processes, such that every “difference” is not necessarily a defect. However, because the parts being examined are manufactured, defects do present in typical manners, and the cause of each failure mode is often understood. Examples of real defects (as well as non-defective parts) will be provided to assist the development of new approaches to this problem.

Inspected parts are represented as arrays of intensities collected through a specific imaging process. Hence, the data carry physical significance beyond the spatial geometry and material distribution of the part. Defects, however, are typically characterized by changes in spatial geometry. Practically, this means that the acquired data contain information that contaminate and obscure the defects. Some of this information can be characterized as stationary noise, but much of it is correlated or non-linear or both. Because the defects are small relative to the imaging resolution, imaging noise plays an important role in the detection process.

**Open problems and objectives for MPI:**
- What are some lightweight and fast approaches to detecting defects?
- Can these approaches by generalized to a broad range of defects and parts, or can they be specialized to particular sub-problems within this range?
- Can these approaches be optimized to handle correlated and non-linear imaging noise while also driving down the size of detectable defects?

**References**