Portable Handheld Optical Window Inspection Device

This device allows field measurement of defects such as commercial aircraft windows.

John F. Kennedy Space Center, Florida

The Portable Handheld Optical Window Inspection Device (PHOWID) is a measurement system for imaging small defects (scratches, pits, micrometeor impacts, and the like) in the field. Designed primarily for window inspection, PHOWID attaches to a smooth surface with suction cups, and raster scans a small area with an optical pen in order to provide a three-dimensional image of the defect. PHOWID consists of a graphical user interface, motor control subsystem, scanning head, and interface electronics, as well as an integrated camera and user display that allows a user to locate minute defects before scanning. Noise levels are on the order of 60 μin. (1.5 μm).

PHOWID allows field measurement of defects that are usually done in the lab. It is small, light, and attaches directly to the test article in any orientation up to vertical. An operator can scan a defect and get useful engineering data in a matter of minutes. There is no need to make a mold impression for later lab analysis.

The PHOWID system components consist of a scanning head, motor control board, graphical user interface, and supporting electronics, and weighs approximately 5 pounds (2.3 kg). The scanning head consists of an x–y positioner, optical distance sensor, carrier plate, and vacuum supplied suction cups. The head has an integrated camera and LCD (liquid-crystal-display) screen that allows a user to easily position it above the defect. Vacuum is supplied to suction cups through a dual circuit system, which includes check valves to hold the head against the window or other smooth surface up to 90° inclination in the event that the vacuum source is lost. The graphical user interface (GUI) displays the surface image and allows the user to describe an area of interest to be scanned at various speeds and resolutions. The GUI displays the scanning progress in real time. Once a scan is completed, software provides the automated measurement capability to determine defect length, width, and depth and will store this information in a file.

The GUI also communicates with the motion control electronics. These electronics control the x–y positioning motors that move the optical sensor in the sensor head. These electronics also combine the depth and position data in real time and stream the data to the GUI. The associated electronics box contains the vacuum pumps, optical-sensor conditioning electronics, and power supplies.

Functionally, the user places PHOWID over the defect using the integrated camera. The user selects the desired area, resolution, and scan speed at the laptop GUI and initiates scanning. PHOWID has a depth range of 0.01 in. (0.25 mm). It has a noise floor better than 60 μin. (1.5 μm). Usable scan area is on the order of an inch square. Smallest resolution of the scan in the x–y direction is on the order of 300 μin. (7.6 μm).

This work was done by Curtis Ihlefeld and Adam Dokos of Kennedy Space Center and Bradley Burns of ASRC Aerospace Corporation. Further information is contained in a TSP (see page 1). KSC-13218

Salience Assignment for Multiple-Instance Data and Its Application to Crop Yield Prediction

Automated mapping of crops saves on survey time and improves map accuracy.

NASA's Jet Propulsion Laboratory, Pasadena, California

An algorithm was developed to generate crop yield predictions from orbital remote sensing observations, by analyzing thousands of pixels per county and the associated historical crop yield data for those counties. The algorithm determines which pixels contain which crop. Since each known yield value is associated with thousands of individual pixels, this is a "multiple instance" learning problem.

Because individual crop growth is related to the resulting yield, this relationship has been leveraged to identify pixels that are individually related to corn, wheat, cotton, and soybean yield. Those

that have the strongest relationship to a given crop's yield values are most likely to contain fields with that crop. Remote sensing time series data (a new observation every 8 days) was examined for each pixel, which contains information for that pixel's growth curve, peak greenness, and other relevant features.

An alternating-projection (AP) technique was used to first estimate the "salience" of each pixel, with respect to the given target (crop yield), and then those estimates were used to build a regression model that relates input data (remote sensing observations) to the target. This is achieved by constructing

an exemplar for each crop in each county that is a weighted average of all the pixels within the county; the pixels are weighted according to the salience values. The new regression model estimate then informs the next estimate of the salience values. By iterating between these two steps, the algorithm converges to a stable estimate of both the salience of each pixel and the regression model. The salience values indicate which pixels are most relevant to each crop under consideration.

This approach produces better estimates than an existing "primary instance" (PI) approach does. The PI ap-