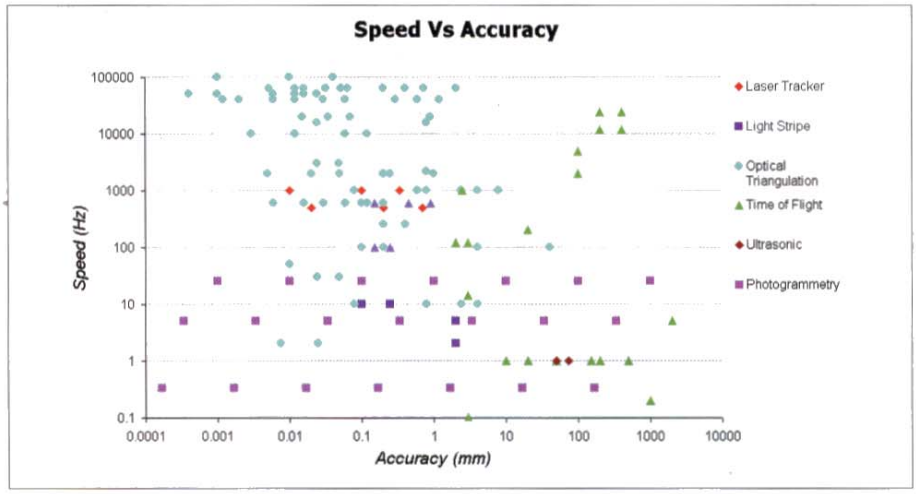
Non-contact measurement provides six of the best

The non-contact sector of the inspection market is expanding. Dr Tim Clarke of the City University reviews six systems



It is clear from this graph that some of the fastest devices are the optical triangulation devices which also have good accuracy. However, these devices also have relatively small ranges. Time of Flight systems can measure relatively quickly but with poor accuracy. Light stripe system appear to be relatively slow by the each stripe may contain several hundred measured points. another way of analysing these devices is to look a the range versus accuracy characteristics.

It is becoming increasingly important to measure the distance to surfaces to control manufacturing processes or for quality control. It is often a requirement that the surface is not physically touched. There are a number of techniques that can be used for non-contact measurement. The main principles are triangulation (e.g. single point triangulation, light-stripe, or photogrammetry, time-of-flight (e.g. ultrasound or laser), or interference (e.g. inteferometers, MoirÈ, electronic speckle pattern interferometry).

Six measurement techniques have been chosen to illustrate how information about surfaces can be acquired in one, two or three dimensions. Single point optical triangulation, ultrasound, time-of-flight, are inherently one dimensional and either the instrument or the object must be scanned in two dimensions to produce 3-D information. The light stripe method is a 2-D method which requires either the object to be scanned or for the instrument to be moved with respect to the object. Photogrammetry and the laser-tracker are full 3-D methods. The table below illustrates some typical applications.

In each application different information may be required, for instance: size; thickness; depth; opaque or clear liquid levels; vibration amplitude and frequency; length; gauging pass-fail; robotic tool stand-off distances; number of manufactured goods; surface roughness and flatness; alignment; radius measurement; 2-D shape; 3-D surface; deformation; and CAD models. The benefits of using non-contact measurement systems should be: lower inspection costs; better quality control; faster production; smaller tolerances; fewer defects; the ability to reverse engineer.

Survey information

There are many measurement systems available in each category. A survey of more than 200 different products have been

Typical objects measured by each measuring system

Single point optical triangulation	Laser stripe	Photogrammetry
Tyre treads	Logs	Aerospace metrology
Archaeological artefacts	Road surfaces	Automobile manufacture
Printed circuit boards	Human body	Shipbuilding
Road surfaces	Industrial components	Mapping
Paper roughness	Rare objects	Architectural models
Solder paste thickness	Joint tracking	Building facades,
Connector pin warp	Seam tracking	Archaeology
Silicone wafer thickness	Welding	Human body scans back problem
CD pickup travel	Object presence	Gait analysis
Industrial plant scanning	Part positioning	Missile or plane tracking
Turbine blades	Web presentations	Antenna measurement
Building facades	Virtual reality environments	Virtual reality
	Steel production inspection	Entertainment
Ultrasound	**Time of Flight**	**Laser trackers**
Liquid level measurement	Civil Engineering surveying	Robot tracking, calibration, and testing
Counting objects on a production line	Profiling rock faces in quarries	Shipbuilding
Thread or wire break detection	Tunnel profiling	Aircraft manufacturing
Robotic sensing for navigation	Hydrographic surveys of buoys, barges and oil rigs	Verification of the jig design
Vehicle obstacle detection	Range and bearing information	Reverse engineering
Wall-to-wall distance measurement	Aerial surveys	Inspection and alignment
Camera focussing		Surfaces

The Newport ATOS system

An example of the matching of an appropriate system to a particular task is the use of the Newport ATOS system which uses two photogrammetric techniques to produce a high density surface information

conducted to assess the capabilities of each method. The speed of these devices varies with the measurement accuracy as illustrated in the graph.

It is clear that some of the fastest systems are the optical triangulation devices that also have good accuracy. However, these devices also have relatively small ranges. Time-of-flight systems can measure relatively quickly but with poor accuracy. Light stripe systems appear to be relatively slow but each stripe may contain several hundred measured points. Another way of analysing these devices is to look at their range versus accuracy characteristics.

This graph illustrates the general trends of these measurement systems, for instance, photogrammetry is scaleable to many tasks with approximately the same measurement range/accuracy characteristic depending on how it is used.

Each measurement technique has advantages and disadvantages making it better suited for some tasks than others. The application requirements will often dictate which measurement system is used together with such factors as: cost, convenience, or reliability. It is likely that whether you wish to measure objects with micron accuracy over a range of a few millimetres, or large-scale objects of many metres in dimension with sub millimetre accuracy a measurement technique is available to suit your task. □

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The graph is able to clearly illustrate the general trends with these measurement systems, for instance, illustrating that photogrammetry is scaleable to many tasks with approximately the same measurement range/accuracy characteristics depending on how it is used.