OMC Project Description – Pipe Bending Angle System

This project developed a system to measure pipe-bending angles using a stereo camera module and coded targets mounted onto pipe clips. The system was successfully demonstrated to a government funding body for a CMM manufacturer in the UK.

Overview

Measurement of pipe bending angles is a recurrent task in the manufacturing industry. Every new batch of material may have slightly different properties that will result in a different amount of spring back. As a consequence, it is necessary to regularly check the shape of tubes as they are manufactured.

It is often time-consuming, inconvenient, or difficult to measure every type of object feature using a CMM probe stylus. As a consequence other techniques have been developed such as those that use multiple camera views of a pipe against a white background.

The scheme developed in this project uses a stereo camera head and coded targets mounted on lightweight pipe clips to estimate the pipe centres and hence the bending angles. Such a scheme can be extended to very long pipes and requires low operator experience. The use of just two cameras keeps the overall cost of the system down.

Industrial partners

ITP Group/ Department of Trade and Industry (DTI) SMART Award funding

Project duration

18 months

Project value to OMC

£30k

Intended beneficiaries

CMM manufacturer, pipe manufacturing industry

Current status

Demonstrator system, ongoing discussions with manufacturers

Project Highlights

- Highly commended in the 2000 Metrology for World Class Manufacturing Awards
- Successfully demonstrated to DTI in May 2001 to conclude SMART award project

Background

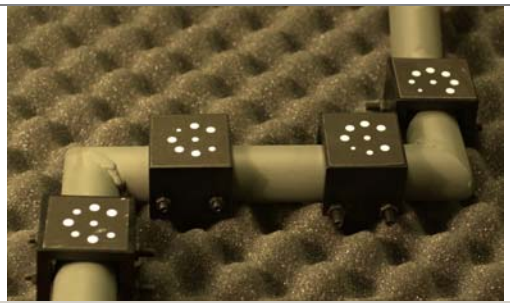
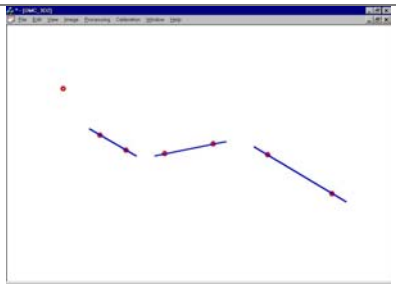
OMC were sub-contracted by ITP Group on their DTI Smart award development project to produce an optical method of estimating pipe bending angles. ITP had experience of selling systems for this purpose that used a conventional CMM and a probe. This scheme relies upon the pipe not moving and being rigidly held during measurement. Also a reasonable level of operator skill is required.

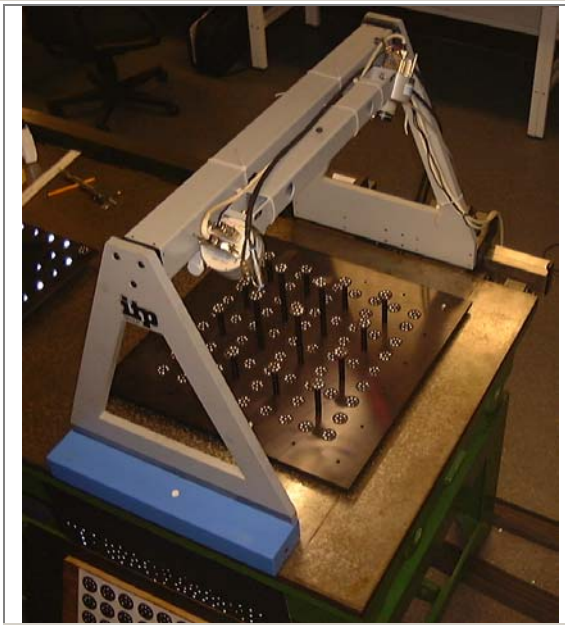
The OMC solution was to use a stereo system to measure the 3-D location of groups of targets (white spots). Each group of targets has a known geometric relationship to each other which allows the extraction of 6-D information e.g. position and orientation. Because of the geometry each group of targets has a unique ID and can be fixed to a structure such as a lightweight pipe clip. It is then possible to estimate hidden features such as the pipe centres.

The stereo system range was extended by use of a moving gantry system that allowed the measurement of very long pipes to be achieved with the same system by stitching together the measurements taken at each location as the gantry was moved along the length of the measurement table.

Pictorial highlights

Conventional measurement of pipe bending angles using a manual CMM with an experienced operator.

 	The pipe clip consisted of a lightweight U shaped structure with spring retractable contacts that allowed the clip to be rigidly fixed to the pipe. Each clip has an unique ID. The pipe centre location is estimated for each clip using a calibration procedure. Adjustment of the spring mounted contact allowed for various sizes of pipe to be measured
	By mounting one or two clips per straight section of the pipe the pipe centres can be determined. As the six degrees of freedom of the pipe clip are estimated it is possible to use just one clip for short sections.
	Estimation of the 3-D locations of the targets allowed the 6-D parameters of the hidden pipe centre to be computed and visualised on the screen of the computer.
	By attaching the coded target adapters in a known sequence the connection between pairs of adapters is known. At this point the bending angles can be computed. The resulting data can then be exported to pipe bending angle software program where the pipe can be visualised and checked against the CAD design.
	The stereo head system has a finite field of measurement volume. To extend this the head can be mounted on a CMM or a gantry arrangement with a linear scale in order to stitch together each set of measurements.

	Calibration of the stereo head is achieved by using a calibration artefact. This procedure is only required on an irregular basis if the system tests show that a new calibration is required.
	Bill Crofts, ITP's Project Development Manager operating the system at ITP's Rugby site.
	Members of the development team (Bill Crofts, ITP, Tim Clarke, OMC and Frank Wang, OMC) receiving a "Highly Commended" award for the system at the Metrology for World Class Manufacturing Awards 2000.