

OPTICAL ON-LINE MEASUREMENT SYSTEMS*

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Abstract

The need for dimensional measurement of products has always been there, now with the industry 4 push to further understand measure and to record process parameters is more important than ever. This applies to both flat and long products, camera systems have always provided the method to measure, stereo Linescan cameras for flat products and innovative applications using 2D and Linescan cameras for long products. Instrumentation will become more important to producers enabling processes to be better controlled and understood, that aim being to make the production process understandable more repeatable and less reliant on operator influence. Primetals Technologies Ltd offer solutions for all types of products.

Keywords: On-Line; Measurement; Dimensions, long products, Long & Flat products.

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1 INTRODUCTION

Optical measurement systems have provided the means to measure various product dimensions for many years, advances in technology has been dramatic over recent years providing solutions to more applications.

Since the development of the first rotating rod gauge by British Steel and the resulting relationship with Integrated Photomatrix Ltd (IPL) the Orbis has been constant feature of on-line measurement in long product mills.

Costs, product improvements and competitiveness in the market place are the driving force which results in a continuous steam of new products, and in this fast moving world obsolescence management has a huge impact, especially considering the life span of a gauge is in excess of 10years.

Cost benefit analysis shows that pay back on gauges can be measured in months rather than years, if the information gathered from the measurements data are utilized to improve process control and used to the full extent.

2 MATERIAL AND METHODS

The methods used for measurement will depend on application, for the flat products either product self-emission (Radiant system) or LED backlight (Backlit system) can be utilized. For the long product gauges for Rod & Bar mills use the shadow technique (backlit) or laser line illumination for more complex shapes.

Flat Product

Stereo Camera for hot strip mill (HSM) products the method chosen is the stereo camera, the camera is mounted above the line and can be either be configured as a radiant system or backlit system, the factor which decides this is the temperature of the product. The method of operation is the same for both types, each camera lens is selected to cover the complete field of view, therefore each camera detects the position of both edges Fig 1, this method allows for the strip to move upwards and tilt from the roll surface without effecting the measurement accuracy. The basic camera system measures width and centerline deviation, addition functions can be selected to include Camber measurement, Crop Shape and flatness by additional laser spots.

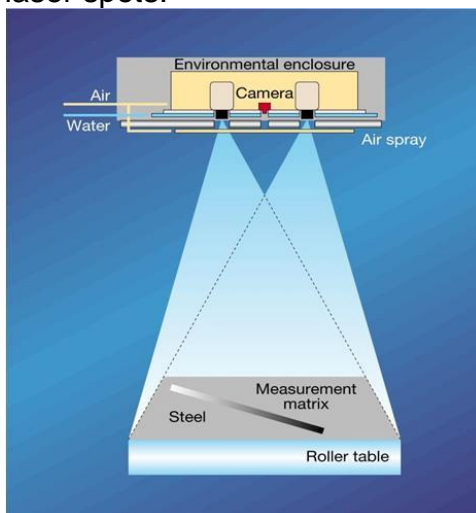


Fig1 Stereo Camera

Long Product.

Backlit, Full Profile – The traditional method of measuring solid shapes, e.g. Rounds, Squares, Hexagon, Flats and Rebar is achieved using a shadow technique, the Orbis gauge which has been in production since 1985 uses Linescan cameras which are rotated around the product to measure the complete profile, as the camera detects the complete diameter at each scan the gauge only has to rotate 180 degrees to obtain a full profile, the profile obtained is a helix scan along the length of the product. This technique enables the detection of underfill and overfill independent of product twist. The optical system is a telecentric system using collimating lens to provide a calibrated measurement area, this means that the size of the product is not affected by the position in the gauge.

Two models are available a single camera gauge for Rod Mill applications and for Bar mills a dual camera system Fig 2. The gauge requires mill water for cooling and instrument air for purging the windows. Fig 3 Shows the Operator HMI.

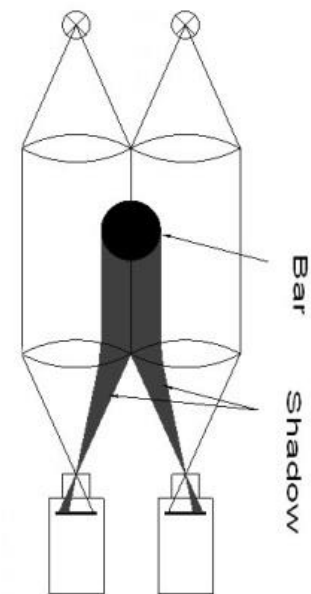
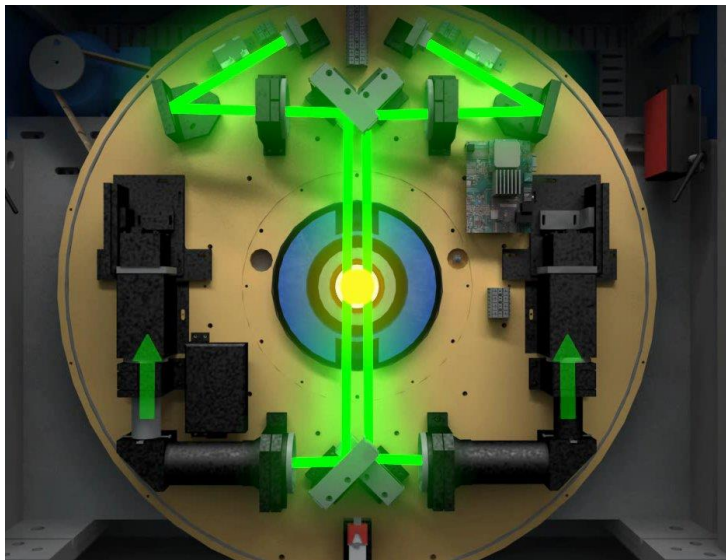


Fig2a Orbis OR2 Optical System showing light path. Fig2b Simplified Optical Layout



Fig3 Orbis Run Screen.

Backlit Static. The measurement of dimension can be also measured using a static gauge which will measure the diameter at a fixed point, this technique allows almost instantaneous measurement but is limited in detecting common rolling defects as it will only measure at a fixed point, to reduce this effect the gauge can have up to a 6 axis measurement points to provide more comprehensive coverage.

The technique used on the Statis Gauge axis measurement is a pair of backlit cameras working at right angles to each other Fig 4, one measures the position of the product while the other measures the diameter and visa versa, therefore each camera measures the true diameter corrected for distance by the other, this removes the need for costly telecentric optics.

The system does not require any services from the mill, water or compressed air is not required for cooling or purging, instead an air blower is provided to provide low pressure high volume air which pressurises the complete gauge which escapes through the viewing aperture providing a curtain of air which stops contamination from the environment entering the gauge.



Fig4a 4 Axis Statis Gauge

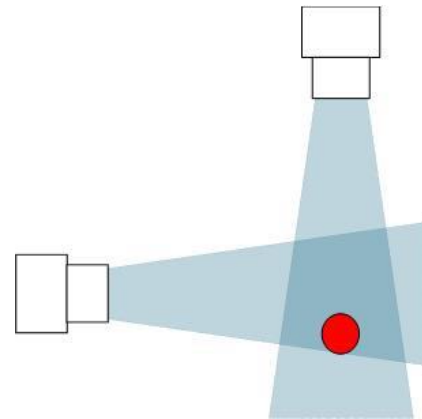


Fig4b Camera Layout

Complex Shape, Limitations of the shadow technique become apparent if the product has features that are hidden by other features such as Rail, H, I sections and Channels which requires dimensions such as leg thickness web thickness etc. to be measured. The technique used to image the complex profile is a projected laser line which raps around the complete profile, this is achieved by using 4 laser units perpendicular to the product and 4 cameras positioned at an oblique angle, two on the top side and 2 on the underside Fig 5. The technique used for dimensioning is the triangulation method; images obtained from the cameras are reassembled within the image processing engine, software tools then recreate the shape enabling dimensions to be provided.

The camera can be multiple cameras to increase the field of view and or accuracy, this system also uses two different frequency lasers to limit crosstalk.

The system can have a surface defect module added, in some applications additional cameras are not required, thus reducing the space required inline to both measure and inspect product.

Environmental conditions are controlled by a closed loop water chiller and a air blower supplied as part of the system.

Gauge manufactured by Mermec Italy sold under agreement by Primetals Technologies Ltd.

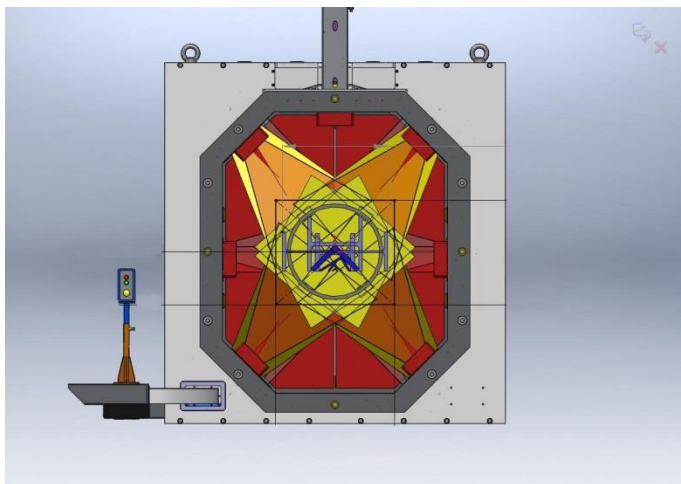


Fig 5a ProScan Optical Layout

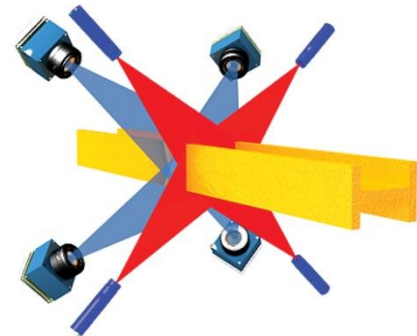


Fig5b Laser Camera schematic

3 RESULTS AND DISCUSSION

The gauges have different accuracy and performance figures based on application, and is summarized in the table 1 below.

The differing measurement techniques allow for a wide range of measurement application to take place from HSM through to complex section mills. As with all optical measurement systems the environment is the most difficult to manage, a clear field of view must be maintained to get accurate measurements..

HSM cameras tend to be mounted on a gantry above the line with the backlight positioned underneath with a water wash to prevent contamination of the light and in some instances air cooled to protect from the product radiation.

Maintenance of the rotating gauge is higher than the static gauges due to the mechanical items associated with a rotating machine, bearings, pinion, drive belt and brush tips but design has reduced this to a minimum, for full profile measurement of a finished Rod or Bar the rotating gauge offers the best solution.

Static systems by their very nature are less complicated mechanically with no moving parts but still require regular maintenance to ensure windows are keep clean.

Application	Type	Technique	Method	Accuracy Typical	Max Product Size
HSM	Width Gauge	Static	Radiant	+/_ 0.04	3000
	Width Gauge	Static	Shadow	+/_ 0.04	3000
Rod Mill	Orbis OR1+	Rotating	Shadow	+/-0.01	4 - 30
	Statis	Static	Shadow	+/-0.02	4 - 50
Bar Mill	Orbis OR2+	Rotating	Shadow	+/-0.02	4 - 100
	Statis	Static	Shadow	+/-0.04	4 - 120
	ProScan*	Staic	Triangulation	+/-0.01	270
Section Mill	ProScan*	Static	Triangulation	+/-0.02	460

Table 1

*ProScan is produced in several models the largest being able to measure product of 900mm width.

Exact specification depends on application.

All systems provide links to the L2 to enable automatic setup at size / shape change and enabling measurement data to be transmitted to allow rolling data to be analyzed and saved for future reference.

Dimensional information provided to the operator is cold corrected measurements.

4 CONCLUSION

Optical gauging methods have improved in accuracy and reliability mainly due to the processing speeds achievable in the latest range of PCs, the data processing speeds available today were only a dream a few years ago, as with all computing systems the drive to provide faster machines will continue to have an impact on what is possible in the future. Industry 4 is waiting.

Acknowledgments

- 1 ProfileCheck manufactured by Mermec sold under agreement.