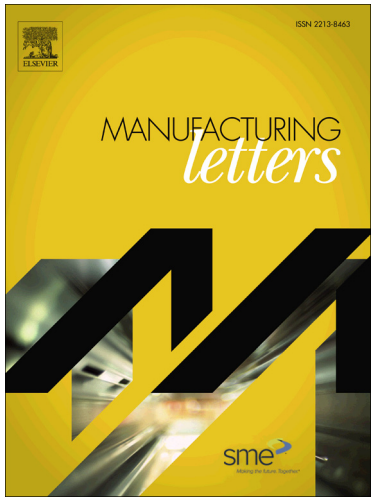

Letters

Surface defect identification and measurement for metal castings by vision system

Ulises Galan, Pedro Orta, Thomas Kurfess, Horacio Ahuett-Garza

PII: S2213-8463(17)30074-3
DOI: https://doi.org/10.1016/j.mfglet.2017.12.001
Reference: MFGLET 104

To appear in: *Manufacturing Letters*

Received Date: 18 October 2017
Revised Date: 30 November 2017
Accepted Date: 5 December 2017

Please cite this article as: U. Galan, P. Orta, T. Kurfess, H. Ahuett-Garza, Surface defect identification and measurement for metal castings by vision system, *Manufacturing Letters* (2017), doi: https://doi.org/10.1016/j.mfglet.2017.12.001

Surface defect identification and measurement for metal castings by vision system

Ulises Galan[1]*, Pedro Orta[1], Thomas Kurfess[2,3], Horacio Ahuett-Garza[1,]

(1) Tecnologico de Monterrey, Escuela de Ingeniería y Ciencias. Monterrey, N.L., México.
(2) Tecnologico de Monterrey, Escuela de Ingeniería y Ciencias, Distinguished Professor with the Automotive Consortium. Monterrey, N.L., México.
(3) George W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology, Atlanta, GA, USA

*Corresponding author at: Ave. Eugenio Garza Sada 2501, Monterrey, N.L., México, 64849.

E-mail address: ulisesg@itesm.mx (Ulises Galan)

Abstract

An inspection system based on vision technology was developed to identify defects on the surface of a metal part produced by a casting process. In the proposed methodology, binary images of the bright and dark regions of the surface are first obtained. Connected components of these images are processed to find the shadows originated from defects. The algorithm to process the binary images was implemented on a Jetson TK1 board, and programmed in CUDA. The setup performs the computation in 900 ms for images of 5 megapixels, and the connected components algorithm is three times faster compared to commercial software running on a CPU. The parameters to find the shadows are independent of the field of view and resolution, i.e., the quantities that relate the two binary images can be expressed in pixels.

Keywords: Vision system, metal surface, defects, shadow

1. Introduction

The quality of the surface of castings is important for many applications. Manufacturers routinely check for surface defects. Vision systems have been used for the characterization of metallic parts [1–4]. Images are processed with a variety of analytical techniques to recognize features of the surface, or the geometry of a part [5–7]. These systems have been used to identify color variations, or the presence/absence of geometry. The measurement of height of defects has not been addressed.

The work presented in this article relies on a vision system technology to detect defects on a metal part produced by die casting. In the proposed set up, light is directed to the metal surface and a grayscale image is obtained by a camera. The information is sent via USB to a Jetson TK1 GPU board with 192 cores running Ubuntu Linux. In the current configuration, a 1.3 megapixels camera and 0.1X lens are used to obtain images with a 48 mm x 36 mm field of view, and a 36 µm/pixel resolution. Another camera with 5 megapixels and 0.5X lens has also been used to obtain images with a 17.6 mm x 13.2 mm field of view, and 6.9 µm/pixel resolution. The Jetson board was connected to a PC running Nvidia nsight to allow cross compilation. OpenCV [8] for Tegra was installed to access computer vision functions, and flycapture SDK was used to control the cameras.

2. Method for image analysis

Grayscale images are obtained with the setup and the data is stored in a matrix. Binary images of the dark and bright areas are obtained by applying a threshold operation. The binary images have connected components that provide useful information [9–11]. There are several