Measurement 49 (2014) 138–147

Contents lists available at ScienceDirect

Measurement

journal homepage: www.elsevier.com/locate/measurement

Camera based precision measurement in improving measurement accuracy

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ARTICLE INFO

Article history:
Received 5 September 2013
Received in revised form 14 October 2013
Accepted 28 November 2013
Available online 4 December 2013

Keywords:
Measurement
Stylus
Probe
Camera
Tracking
Machine vision

ABSTRACT

This paper presents a vision based software system which is developed in order to improve the precision measurement in machining technology. Precision measurement, monitoring and control are very important in manufacturing technology. In order to increase the accuracy of the measurement system; application of camera or vision is very useful. Automatic control is also vital for the measurement performance to be improved. During measurement of the gear profile; human monitoring sometimes may face danger as this is a stylus contact scanning system and the stylus is very small and thin as well as the probe moves with a maximum speed of 10 mm/s. The existing methods for gear measurement are either time consuming or expensive. This paper presents the successful implementation of the vision system in precision engineering which saves times and increases safety of the measurement system with the increment of the measurement performance. Color based stylus tracking algorithm is implemented in order to acquire better performance of the developed system. Stylus tracking based measurement is the key issue of the present research.

1. Introduction

The measurement of images is often a principal method for acquiring scientific data and generally requires that features or structure be well defined, either by edges or unique color, texture, or some combination of these factors. In our previous research, a vision based measurement system is presented [1]. To investigate mechanical damage of the apple, a vision based detection system is discussed and elaborated. Based on image processing application, the apple's skin damage checking was accomplished here [2].

RGB is often considered as the standard in many programming languages, and it is used in many important color image data formats, such as JPEG and TIFF. True color consists of 24 bits of RGB color, 1 byte per color channel for 24 bits. In order to enhance performance, a 32-bit or 4-byte representation is often used because various commands are optimized for groups of 4 bytes or more [3]. Another important issue described is the impact of measurement performance in automatic mode on the quality of performance in case of the numerical image of scanned surface, from the standpoint of accuracy and number of collected data points within the shortest time. The discussion includes an analysis of conditions related to the measurement works, such as the process of preparing the model and measurement equipment as well as the data processing capacity [4].

Analysis of the accuracy of gears at different stages of technological process requires control of geometrical surface parameters with the use of coordinate measuring methods [5–7]. In another case, a low-quality frame grabber results in poor performance and instability of the entire system. For this reason, one commercial frame grabber called myVision USB is used to perform the desire activities in [8]. In 2009, Fukuda and others have presented a cost-effective (a term previously introduced by Lee and Shinozuka [10]) vision based displacement measurement system applied to large-size civil engineering structures,

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http://dx.doi.org/10.1016/j.measurement.2013.11.057

such as bridges and buildings [9]. They also implemented a TCP/IP (transmission control protocol/Internet protocol) for communications and carried out time synchronization for the time synchronization of the system. More recently, in 2011, Choi and others have introduced a vision based structural dynamic displacement system using an economical hand-held digital camera. In this case, a recorded video containing dynamic information of target panel attached directly to the civil structure was processed with image resizing method, and mm/pixel coefficient updating process, then the structure displacement was successfully determined by calculating the target position in each frame [11].

A technique of "Machine Vision Based Identification and Dimensional Measurement of Electronic Components" which is based on color pattern matching approach, that enables identification of an electronic component present in a group and its gauging gives the dimensional measurement of the electronic component [12]. A method for the precise and accurate measurement of part features such as edges require collimated light, careful placement of the part, a telecentric lens, calibration and perhaps optical distortion correction, and computation by the vision system's computer is proposed [13]. A geometric analysis of laser beam for underwater vehicle in measuring distance is discussed [14]. In this case, the moving object's distance is calculated by comparing it to a reference object.

Another evaluation based on minimum zone circle (MZC) method as to comply with the definition of roundness error given by Y14.5 M-1994 and ISO 1001 is discussed and highlighted the advantage of applying machine vision in the non contact nature of the measurement process which can be implemented in-process of making the cylindrical part [15]. A bore scope measurement system based on machine vision, which was composed of a bore scope, a CCD camera, an industrial computer, and a precision linear stage mounted with an optical linear encoder, was developed. The image processing algorithm was developed based on IMAQ Vision. This system is used to measure the space of circular rings, and comparison with the results measured by universal tool microscope shows the maximum absolute measurement error of this system is below 8 μm [16]. The types of measurements that can be performed on entire scenes or on individual features are important in determining the appropriate processing steps [17]. A computer vision algorithm for measurement and inspection of spur gears using multiple available software is proposed in order to increase the accuracy only limited to a maximum outer gear diameter of 156 mm [20].

2. Background study

Fig. 1 shows a photograph of a vision based gear profile measurement system. It consists of two main parts, hardware and developed software. The hardware consists of three items. The first item is the backlighting Table 1, which is a lighting box with diffusing surface at its front, and it is used to produce a back lighting for the gear to be measured (2). The second item is a CCD color video camera (3) and a set of lenses with different focal lengths. The camera is carried by a camera holder (4). The third item is a 24 bit per pixel (ELF VGA) frame grabber video card (5), which is installed inside the PC computer (6) and connected to the CCD camera. Capturing software (7) is provided with the frame grabber to acquire images and save it to files with various types of file formats [20].

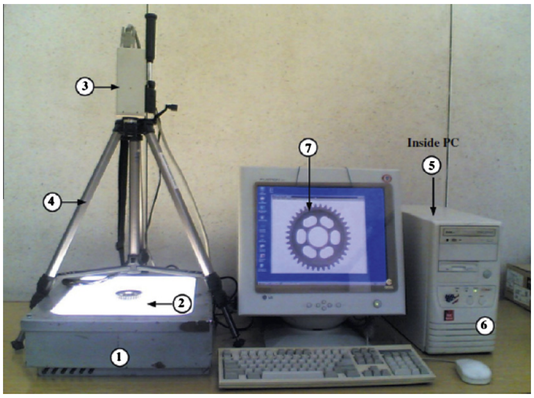

Fig. 1. Gear measurement system with vision [20].

Table 1
Threshold results.

Threshold values (TV)	Resulting image
0	Not visible (full blank)
10	Edge detected
25	Under dilation
112	Visible image
156	Slightly dark
212	Very dark
250	Not visible (full dark)

Fig. 2 shows single camera version of PhotoCalc technology, however, it can calculate 3D position by one camera, so it is affordable and nothing special is required except target for certain cases. SingleView3D can be used for 3D inspection of object and for tracking object by this [18].

Fig. 3 shows a developed system that uses multiple cameras to detect multiple points on a plane. Camera

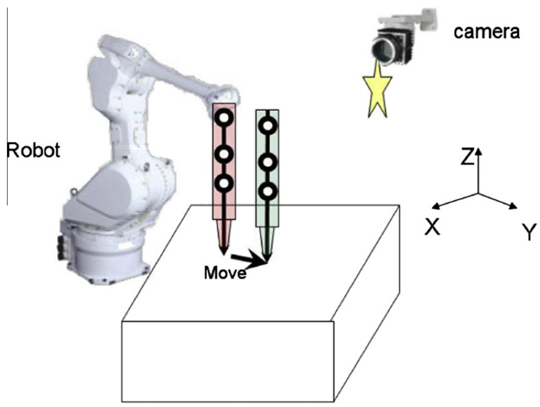

Fig. 2. Robot and detect the position of particular point [18].