Work Piece Gauging using Image Processing

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Abstract— **The main objective of this paper is to explain the process of check the machining done on the three different jobs numbered 631, 632 and 633. The jobs are made of the same mould. First the number engraved on the job and the four sides of the job are captured using a web camera. The captured images are cropped and processed using MATLAB code.**

In case of large production units even a minute change in the dimension of the product would lead to serious errors. To prevent such errors image processing is used. An image of the correct dimensions of the job is obtained from a template of hundred images of the job. Every finished product is captured using a camera and the damaged products are detected by comparing both images.

Keywords – Work Piece Gauging, LPC 2148 Processor, Inspection system, Image Processing, Vision Processing

I. Introduction

The high demands on modern quality management result in the necessity for flexible tools to be made available for quality assurance in production companies. Image processing systems represent such a tool in quality testing areas as well as in automated measuring functions and in the area of technical visual inspection.

Important advantage of image processing systems are the high measuring rate which can be achieved and the high level of objectivity which particularly distinguishes the systems from human inspection[1]. For a human inspector, e.g. a high manufacturing cycle, concentration weaknesses or just features which are difficult to distinguish from one another can cause problems which, in principle, can be solved with an automatic image processing system[2].

A worker can detect simple errors quickly and independently with the aid of a camera image. Even for less qualified workers, suitable tools in control software can clarify how the optimum status of the system should look. Though the high abundance of information in the camera image, it is also possible to combine several characteristics, through which some functions only become possible.

A. Computer Vision

Computer vision is the science and technology of machines that see. As a scientific discipline, computer vision is concerned with the theory for building artificial systems that obtain information from images. The image data can take many forms, such as a video sequence, views from multiple cameras, or multi-dimensional data from a medical scanner.

As a technological discipline, computer vision seeks to apply the theories and models of computer vision to the construction of computer vision systems. Examples of applications of computer vision systems include systems for controlling processes, detecting events and organizing information.

II. Embedded System

We have used ARM7 processor (LPC 2148) for the embedded part of our project. The components used here LPC 2148 processor, Omni vision camera and Ethernet IC.

The processor communicates with the camera through serial communication. Commands to the camera like synchronizing the camera with the processor are given by the processor. Picture command for taking a snapshot is given by the user through Personal Computer(PC). Picture captured by the camera is encoded and sent to the PC via the processor.

A. LPC 2148 Processor

The LPC2148 microcontroller is based on a 32/16 bit Central Processing Unit (CPU) with real-time emulation and embedded trace support, that combines the microcontroller with embedded high speed flash memory of 512 Kb. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30% with minimal performance penalty.

The ARM7 is a general purpose 32-bit microprocessor, which offers high performance and very low power consumption. The ARM architecture is based on Reduced Instruction Set Computer (RISC) principles, and the instruction set and related decode mechanism are much simpler than those of micro-programmed Complex Instruction Set Computers. This simplicity results in a high instruction throughput and impressive real-time interrupt response from a small and cost-effective processor core.

Pipeline techniques are employed so that all parts of the processing and memory systems can operate continuously. Typically, while one instruction is being executed, its successor is being decoded, and a third instruction is being fetched from memory. The ARM7 processor also employs a unique architectural strategy known as THUMB, which makes it ideally suited to high-volume applications with memory restrictions, or applications where code density is an issue. The key idea behind THUMB is that of a super-reduced instruction set.

B. C328R Camera Sensor

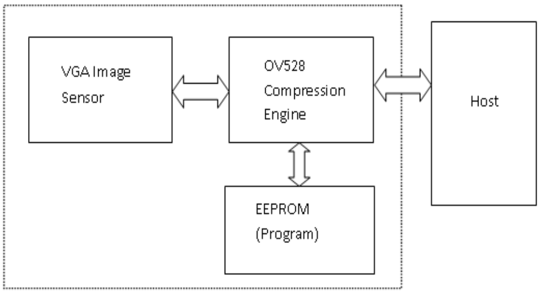

FIG.1 INTERNAL BLOCK DIAGRAM OF C328R CAMERA SENSOR

The C328R is Video Graphics Array (VGA) camera module performs as a JPEG compressed still camera and can be attached to a wireless or PDA host. Users can send out a snapshot command from the host in order to capture a full resolution single-frame still picture. The picture is then compressed by the JPEG engine and transferred to the host through serial port.Fig.1 shows the internal block diagram of c328 camera sensor.

The OV528 Serial Bridge is a JPEG CODEC embedded controller chip that can compress and transfer image data from Camera Chips to external device. The camera interface synchronizes with input video data and performs down sampling, clamping and windowing functions with desired resolution, as well as color conversion that is requested by the user through serial bus host commands.

The JPEG CODEC can achieve higher compression ratio and better image quality for various image resolutions. A serial type program memory is built-in for C328R to provide a set of user-friendly command interfacing to external host.

III. IMAGE SEGMENTATION

Edge detection is a well-developed field on its own within image processing. Region boundaries and edges are closely related, since there is often a sharp adjustment in intensity at the region boundaries. Edge detection techniques have therefore been used as the base of another segmentation technique [3-5].

The use of local segmentation is an effective way to achieve a variety of low level image processing tasks. The local segmentation principle states that the first step in processing a pixel should be to segment the local region encompassing that pixel. This provides a snapshot of the local structural features of the image, with the signal clearly separated from the noise. It is hoped that the identified structural information could be used to implement many image processing tasks including, but not limited to, image denoising, pixel classification, edge detection, and pixel interpolation. Local segmentation can be seen to belong to a continuum of approaches to image understanding. At the lowest level is local segmentation which operates in a purely local manner using only a small number of pixels. At a higher level is global segmentation which attempts to group together related pixels from throughout the image. The highest level is object recognition, whereby global segments are combined into logical units representing real world objects of interest.

The fundamental component of the local segmentation approach is the segmentation algorithm itself. Most segmentation algorithms are designed to operate upon a whole image, or a large portion thereof. Local segmentation can only utilise a small number of pixels belonging to fragments of larger segments.

Some image processing techniques can be seen or interpreted as exploiting the principle of local segmentation in some way. In most cases the local segmentation principle is not stated explicitly, nor used as a guiding principle for developing related algorithms. One example is the lossy image compression technique Block Truncation Coding (BTC) uses simple thresholding to segment blocks of pixels into two classes, but it was many years before alternative segmentation algorithms were considered.

Those image processing tasks suited to local segmentation are often the first to encounter the raw image data. This data is usually contaminated with one or more forms of noise. The fundamental attribute of a local segmentation based algorithm should be to preserve as much image structure (useful information) as possible, and to suppress or remove as much noise (useless information) as possible. These goals are complementary and inseparable. The ability to identify structure implies the ability to identify noise. Good image denoising algorithms specialize in extracting structure from noisy images. This application is probably the most appropriate low level technique for demonstrating local segmentation [6-8].

IV. WORK PIECE GAUGING

A typical application of industrial image processing is work piece gauging. Frequently the gauging procedure is used in combination with a transmitted light illumination. Before beginning, the actual measurement, a work piece for which the relevant dimensions are correct is placed under the camera, and the system is thereby calibrated. The calibration takes place in such a manner that a known dimension is measured and the result of the measurement in the pixel together with the target result in mm or inch is stored. Typically the scaling factors for u and v are determined in two measurements[9].

Then, on the basis of the template part, position and nominal value for one or more relevant dimensions are determined and stored. The gauging of parts from the production line then takes place. By means of a feed, the work piece comes under the camera. It is usually only ensured that the parts lie flat, the precise position and orientation is not known. Accordingly, the rotated position of the object must be determined by means of an alignment before the actual measurement can start[10].

A. Gauging And Implementation

The sub pixel-precise determination of the grayscale transitions, i.e. edges would have gone beyond the scope of the implementation, but the calculation for this is relatively straightforward and will briefly be introduced for the reader's own implementations. After alignment, a vertical edge of known height is to be measured. After comparison of the result with a given threshold value, the transition u0 is known with pixel-accuracy. A sub pixel-precise determination can now take place via a parabolic fit with the inclusion of two surrounding grayscale values on the line of the gradients. The implementation process is as described below: a) Conversion to grayscale, inversion, binarization. b) Moment calculation. c) Calculation of the center of area of the region and determination of the angle of the major axis. d) Determination of the orientation of the major axis e) Drawing the now determined coordinate system in the color image f) Rotating the binary image g) Gauging of an (arbitrarily) specified dimension near the center of area, parallel to the minor axis. h) Output of the image data and of the measured dimension in two windows[11-12].

V. RESULTS

The following results are obtained fir the three different machines pieces.

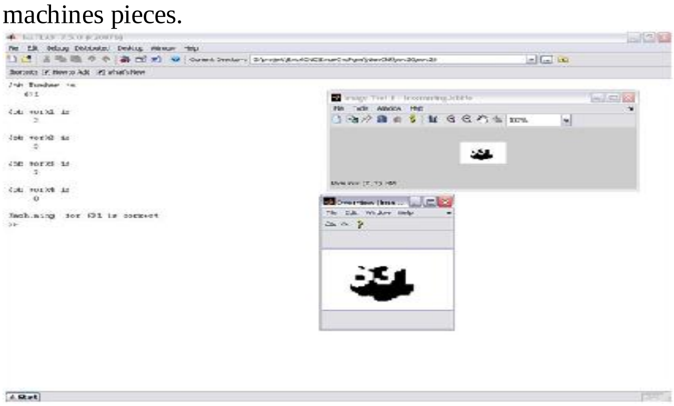

Fig.2 Output for machine piece 631

Fig.2.Shows the Key point descriptors for machine piece 631.

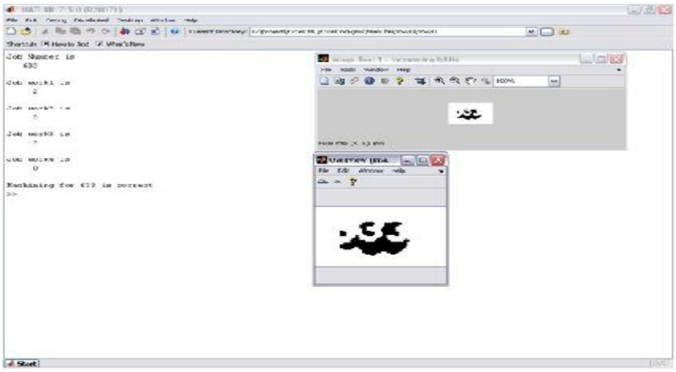

Fig.3 Output for machine piece 632

Fig.3 shows the Key point descriptors for machine piece 632.

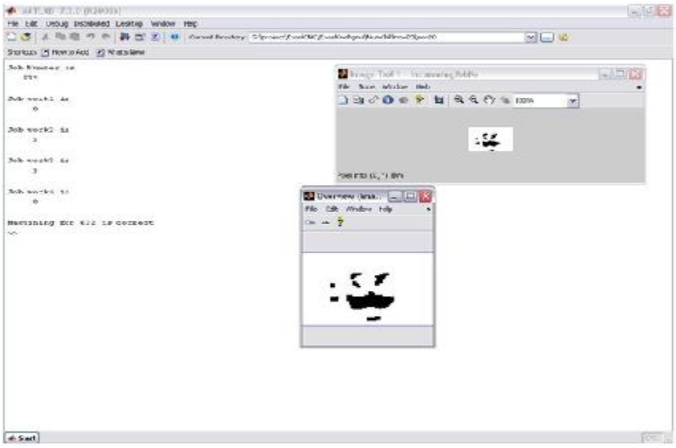

FIG.4 OUTPUT FOR MACHINE PIECE 633

Fig.4 Shows the Key point descriptors for machine piece 633.

VI. CONCLUSION

The image processing technique has seen a rapid growth in the last few decades. Automation is going to be the future of all industries. This work piece gauging can also be done using MATLAB software. In this paper, work is carried out by ARM7 processor to design the circuit and PCB using LPC2148 controller. We used CR328 UART (serial interface) camera to capture the image and store it in the computer. We were able to implement the image processing techniques in ARM7 processor also.

The initial costs may be a bit high, but considering all the factors it's worth the money while using ARM 7 microprocessors.

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