International Journal of Modern Engineering Research (IJMER)
www.ijmer.com Vol.2, Issue.3, May-June 2012 pp-639-643 ISSN: 2249-6645

Online Image Capturing and Processing Using Vision Box Hardware: Apple Grading

C. Velappan Gnana Arivu[1], G. Prakash[2], A. Sada Siva Sarma[3]

[1]*PG Student, Department of Electronics and Communication Engineering, K.S.R College of Technology, Tiruchengode, Namakkal-637 215, Tamilnadu, India.*

[2] *Assistant Professor, Department of Electronics and Communication Engineering, K.S.R College of Technology, Tiruchengode, Namakkal-637 215, Tamilnadu, India.*

[3] *Principal Scientist, CEERI- CSIR Madras Complex, Chennai-600 113, Tamilnadu, India.*

***Abstract* - The early detection of damages in fruits is especially important in agriculture products processing because a very small number of injured fruits can cause rottenness infected by microbes and spread the infection to the whole batch and thus causing great economic loss and it also affects further storage and sale. At present manual sorting of fruits and vegetables is carried out at many places. The most important post-harvest damage in fruit picking, transport and storage is mechanical bruise caused by external forces which causes physical changes in texture. The detection accuracies are also greatly affected by many factors such as time, bruise type, bruise severity, fruit variety, and fruit pre- and post harvest conditions.**

Manual sorting has many disadvantages as it requires plenty of labours to investigate it results in low productivity and grading standard is difficult to carry out. Hence the manual sorting is replaced by Machine Vision (MV) system using Vision Box hardware with the advantages of high precision and high automatization.

Key words: Machine vision (MV), Vision Box, processing, grading

I. INTRODUCTION

Inspection of fruits and vegetables is an important procedure for marketing, storing and processing as their appearance affects the consumer acceptance. Colour provides valuable information in estimating the maturity and examining the freshness of fruits and vegetables. Uniformity in size and shape of fruits and vegetables are some of the other important factors in deciding overall quality for buyer's acceptance and value addition.

The early detection of damages in fruits is especially important in agriculture products processing because a very small number of injured fruits can cause rottenness infected by microbes and spread the infection to the whole batch and thus causing great economic loss and it also affects further storage and sale. At present manual sorting of fruits and vegetables is carried out at many places. The manual sorting of fruits has the following disadvantages

- Great labour intensity
- Low productivity
- Grading standard difficult to carry out
- Grading precision instable
- Plenty of labours

The fruit quality can be improved through lots of methods, among which quality detection and sorting operations are the most important ones to increase fruit quality and the profits. Many high quality fruits intermixed with low quality ones are exported or on sale at low price due to the laggard means of quality detection and sorting operations. With the development of computer technology, machine vision grows rapidly. The manual sorting replaced by machine vision with the advantages of high precision, high automatization and belonging to non-contact detection is an inevitable trend of the development of automatic sorting.

1.1 MACHINE VISION SYSTEM

Machine vision (MV) is the application of computer vision to industry and manufacturing. Machine vision, being an engineering discipline, is interested in digital input/output devices and computer networks to control other manufacturing equipment such as robotic arms and equipment to eject defective products. Machine Vision is a subfield of engineering that is related to computer science, optics and industrial automation. One of the most common applications of Machine Vision is the inspection of manufactured goods such as semiconductor chips, automobiles, food and pharmaceuticals. Machine vision systems use digital cameras, smart cameras and image processing software to perform similar inspections.

Machine vision systems are programmed to perform narrowly defined tasks such as counting objects on a conveyor, reading serial numbers, and searching for surface defects. Manufacturers favour machine vision systems for visual inspections that require high-speed, high-magnification, 24-hour operation, and/or repeatability of measurements. Cameras are not equivalent to human optics and while people can rely on inference systems and assumptions, computing devices must 'see' by examining individual pixels of images, processing them and attempting to develop conclusions with the assistance of knowledge bases and features such as pattern recognition engines. Although some machine vision algorithms have been developed to mimic human visual perception, a number of unique processing methods have been developed to process images and identify relevant image features in an effective and consistent manner.

Machine vision and computer vision systems are capable of processing images consistently, but computer-based image processing systems are typically designed to perform single, repetitive tasks, and despite significant improvements in the field, no machine vision or computer vision system can yet match some capabilities of human vision in terms of image comprehension, tolerance to

lighting variations and image degradation, parts' variability etc.

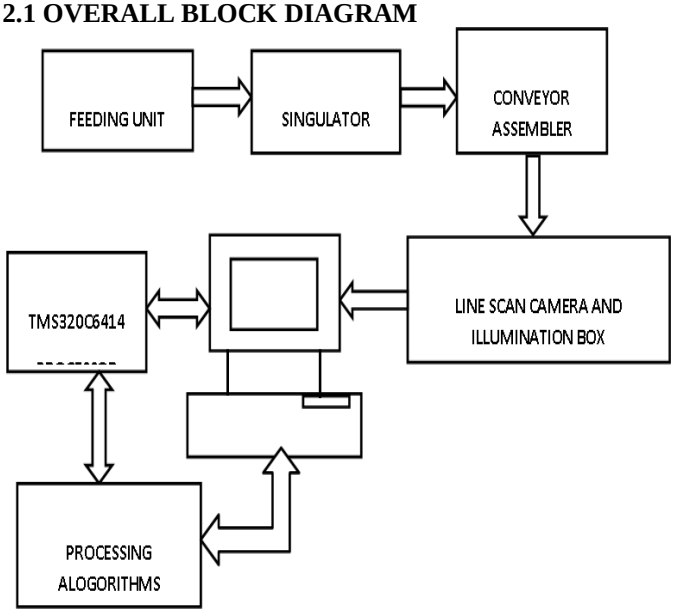
II PROPOSED METHODOLOGY

In the proposed methodology the processing of apples leading to a sorting and grading is done using machine vision system which includes the Vision Box hardware. Now using dsp processor and with image processing algorithms, the apple images can be analysed and the defects can be studied and classified according to the quality.

This method uses a machine vision technology the apples are passed in a linear fashion on a conveyer assembly and when the system is triggered the image of an apple is acquired with the aid of a line scan camera. A flash card receives the image data and then with the help of File Transfer Protocol the digital image is stored in the host computer's buffer. The image captured in the computer's buffer is fed to the TMS320C6414 DSP processor, which is a 32 bit floating point VLIW processor and algorithms for determination of size, shape and colour are applied by using appropriate machine vision techniques. These feature extraction methods are implemented using the Code Composer Studio (CCS) software that serves as an Integrated Development Environment (IDE), comprising tools for highly optimized code generation, a C compiler, an assembler and a linker.

Digital Image Processing forms the fundamental methodology adopted in this project. Digital Image Processing is defined as subjecting the numerical representation of an object to a series of image processing routines to obtain the desired results. This field combines the techniques of image processing with the power of DSP to enable the achievement of Real Time Processing, which requires the computation to be kept in pace with the reception of input signals. It is achieved with the help of highly efficient Digital Signal Processors designed specifically to cater the computationally intensive problems.

2.1 OVERALL BLOCK DIAGRAM



One of the components of the machine vision system for the apple sorting and grading system is the PC platform which acts as the host and a software which is used for inspection. The overall working of this application which would interact with the user and which has been simulated in this project is given below.

- Initially the image of the apple is captured using line scan camera
- A frame grabber (National Instruments IMAQ 1428 hardware) card or the flash card receives the digital data from the line scan camera and stores it in a buffer in the PC
- Digital data is transferred from the host computer to the DSP memory for processing through the Host Port Interface (HPI) with the help of PCI
- In the front end VC++ application interacts with the user and it does the function of grabbing the image and transferring the data to the DSP through HPI
- For accomplishing the transfer of data between the host computer and the EVM through HPI
- Certain host software components are provided along the EVM board. These host support software components consist of an operating system specific low level driver and a user mode Win32 DLL. These components are used to create and execute user mode applications for the EVM board.
- C code built with the help of CCS runs at the backend on the Digital Signal Processor to process the digital image and the result is stored in a memory location
- The result is accessed at the front end and displayed to the use.

The line scan cameras field of view covers three apples. In a real time system a total of 4 views would be captured for an apple (for each 90 degree rotation). So all 4 views are processed for a single and the final result is displayed. Given below is the sequence of steps followed for the determination of colour, size and shape for each view of the apple by using digital image processing algorithms.

2.2 PROCESSING METHODS

Commercial and open source machine vision software packages typically include a number of different image processing techniques such as the following:

- Pixel counting: counts the number of light or dark pixels
- Thresholding: converts an image with gray tones to simply black and white
- Segmentation: used to locate and/or count parts
- Edge detection: finding object edges
- Template matching: finding, matching, and/or counting specific patterns

III VISION BOX HARDWARE

The Vision Box MPS2 is equipment introduced by the STRAMPE GERMAN COMPANY. STRAMPE develops image processing and machine vision on its own line of

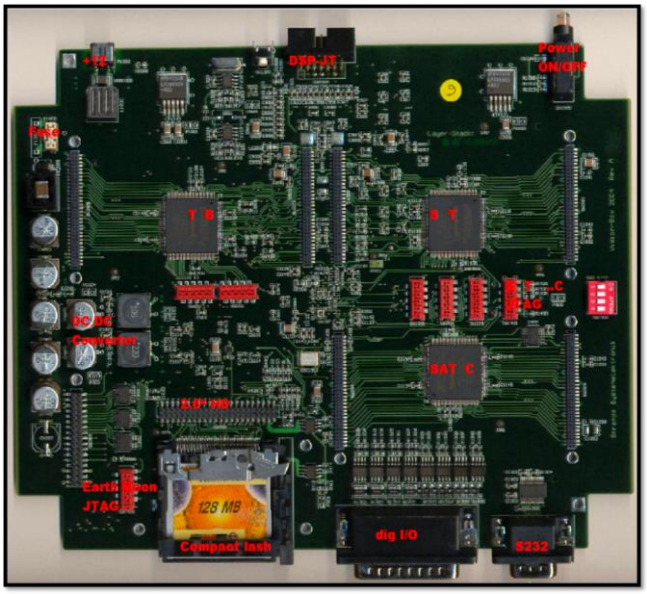
DSPC6000 Vision Box systems. Vision Box MPS2 is a stand-alone image processing computer based on Digital Signal Processing (DSP) TMS320C6414 from Texas Instrument.

3.1 VISION BOX SPECIFICATIONS:

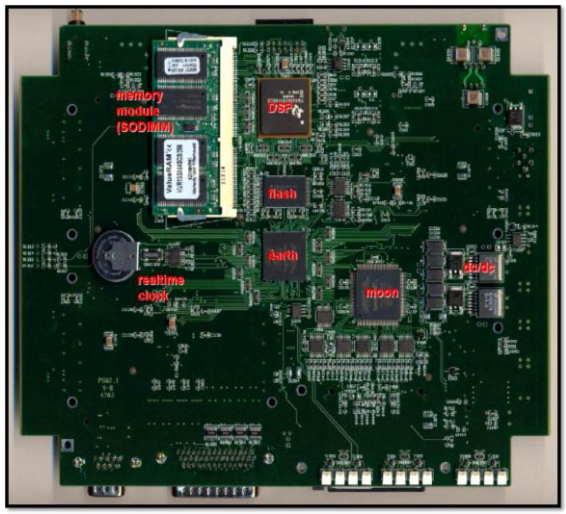
- Processor Frequency - 1000 MHz
- Calculation Power of the Processor - 8000 MIPS
- Processor Manufacture Type - Texas Instrument TMSC320C6414
- SDRAM – 256 MB (option 512 MB)
- Flash EPROM – 4MB
- Compact Flash Card - >1GB
- Compact Flash Card Option – SanDisk Extreme III 4GB
- Digital I/P / O/P , optocoupled – 8/8
- Delay b/w I/p & Trigger star of camera - Typ. 20 µs
- Ethernet, TCP/IP, FTP – 1000 [MBits/s]
- Power consumption – 10 watts
- Ethernet, Monitor, Keyboard and mouse using a web browser - yes
- Serial Interface Max. 115 k Baud - 3
- Camera Interface Camera Link - 2
- PS/2 Keyboard input - 1
- Power Supply - 12v/ one Amp

Vision Box is equipment which hosts a DSP with 1000 MHz processor with a calculation speed of 8000 MPS, This box has a TI DSP of the family TMS320C6416 with a RAM of 256 MB and there is also a separate Flash card to hold some static images.

3.2 VISION BOXMPS2 TOP SIDE



3.3 VISION BOX MPS2 BOTTOM SIDE



IV SOFTWARE DESCRIPTION

4.1 CCS

Code Composer Studio (CCStudio) is an integrated development environment (IDE) for Texas Instruments' (TI) embedded processor families. CCStudio comprises a suite of tools used to develop and debug embedded applications. It includes compilers for each of TI's device families, source code editor, project build environment, debugger, profiler, simulators, real-time operating system and many other features. The intuitive IDE provides a single user interface taking you through each step of the application development flow. Familiar tools and interfaces allow users to get started faster than ever before and add functionality to their application thanks to sophisticated productivity tools. Here the online capturing of images is done in ccs environment.

4.2 HALCON

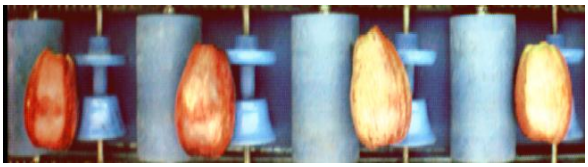
HALCON is the comprehensive standard software library with an integrated development environment (IDE) for machine vision that is used worldwide. It leads to cost savings and improved rime to market. HALCON's flexible architecture facilitates rapid development or machine vision, medical imaging, and image analysis applications. It provides on extensive library of more than 1 300 operators with outstanding performance for blob analysis, morphology, pattern matching, measuring, 3D object recognition, and binocular stereo vision**.** It secures your investment by supporting the operating systems Windows, Linux, and Solaris. The full library can be accessed from common programming languages like C, C++, C#.

IV SIMULATION RESULTS

RESULT OF IMAGE ENHANCEMENT

Image enhancement is the process of manipulating an image so that the result is more suitable than the original image for a specific application. Histogram Equalization can be used for image enhancement.

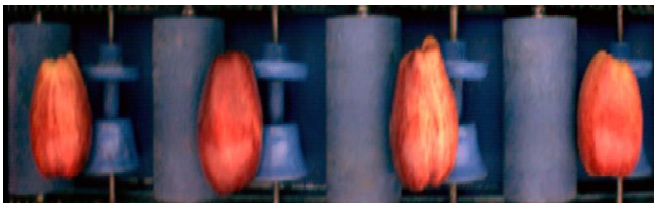
Original image



Processed image

4.1 RESULT AFTER NOISE SMOOTHING

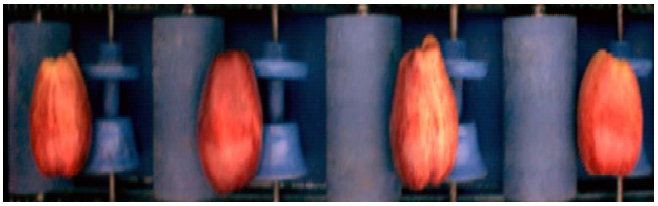
Mean filtering is simple and easy method used for smoothing the image and hence removing the noise. Here each pixel value is replaced with average value of its neighbours. There are two main problems with mean filtering. Single pixel with a very unrepresentative value can affect the mean value of all the pixels in the neighbour. when the filter neighbourhood straddles an edge the filter will interpolate new pixels on edge and will blur that edge. Median filter overcomes the above problem.



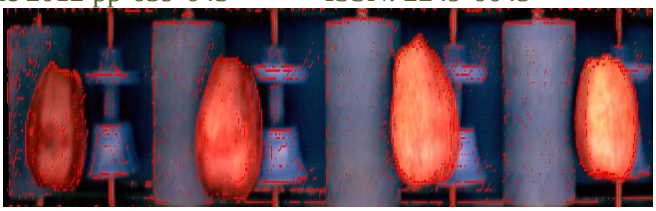
Original image

Processed image after median filtering

4. 3 RESUT OF THRESHOLDING

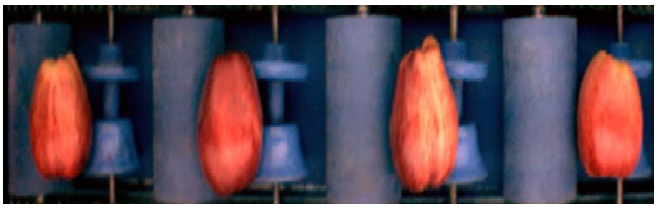


Original image

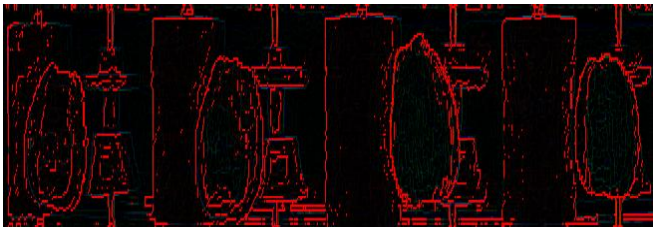


Processed image

4. 4 RESULT OF EDGE DETECTION



Original image



Processed image

V. CONCLUSION

It is testified that machine vision is an alternative to unreliable manual sorting of fruits. The system can be used for fruit grading by the external qualities of size, shape, colour and surface defects. The machine vision system can be developed to quantify quality attributes of various fruits and vegetables such as mangoes, cucumbers, tomatoes, potatoes, peaches and mushrooms. The exploration and development of some fundamental theories and methods of machine vision for pear quality detection and sorting operations would accelerate the application of new techniques to the estimation of agricultural products quality.

The work in the project has resulted in a clear-cut and systematic sequence of operations to be performed in order to obtain the end result of an apple image with the defects clearly segmented followed by categorizing them as good or bad fruit. The proposed steps are based on the assumption that the images were taken under proper illumination, due to which some regions with improper illumination are considered defects. future work might include a small modification in the presented algorithm in order to adapt to this irregularity. This algorithm was tested with several images and the results were encouraging.

REFERENCES

[1] Anil K. Jain, Robert P.W. Duin, and Jianchang Mao, "Statistical Pattern Recognition: A Review"IEEE Transactions On Pattern Analysis And Machine Intelligence, Vol. 22, No. 1, January 2010

[2] King-Sun Fu, Azriel Rosenfeld, "Pattern Recognition and Image Processing", IEEE transactions on computers, vol. c-25, no. 12, december 1996

[3] Mohan.V, Shanmugapriya.P, Dr.Y.Venkataramani, "Object Recognition Using Image Descriptors", Proceedings of the 2008 International Conference on Computing, Communication and Networking (ICCCN 2008)

[4] AnangHudayaMuhamad Amin, Asad I. Khan, "A Divide-and-Distribute Approach to Single-Cycle Learning HGN Network for Pattern Recognition" Intl. Conf. Control, Automation, Robotics and Vision, Singapore, 2010

[5] Minoru Fukumi, SigeruOmatu, Fumiaki Takeda, and ToshihisaKosaka, "Rotation-Invariant Neural Pattern Recognition System with Application to Coin Recognition", IEEE TransaciionsOn Neural Networks, Vol. 3, No. 2, March 1992

[6] H. K. Kwan and L. Y. Cai, "Supervised Fuzzy Inference Network for Invariant Pattern Recognition", IEEE, 2010

[7] Sung-Jung Hsiao, Shih-ChingOu, Kuo-Chin Fan, Wen-Tsai Sung, "Using the RNN to Develop a Web-Based Pattern Recognition System for the Pattern Search of Components Database" IEEE, Proceedings of the First International Symposium on Cyber Worlds (CW.02) 2007

[8] Kuo-Chin Fan, Sung-Jung Hsiao, Wen-Tsai Sung, "Developing a Web-Based Pattern Recognition System for the Pattern Search of Components Database by a Parallel Computing"IEEE, 2008

[9] Wang Shou-jue' Chen Xu, "Biomimetic (Topological) Pattern Recognition-A new Model of Pattern Recognition Theory and Its Application" IEEE 2003

[10] G. Z. Gondal, "On the use of PDL, for Domain Independent", Second IEEE International Conference on Intelligent Systems, 2004