On the Optimal Choose of Architecture for a Low Cost Automated Visual Inspection Module in Industrial Applications

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ABSTRACT

Automatic visual inspection is one of the primary applications of computer vision. Machine vision inspection requires efficient processing time and accurate results. In order to achieve efficiency and accuracy with a reasonable cost , it is important to choose the right architecture of the system.The paper presents the choices and a concrete architecture of a module ,with some aspects regarding application development and possible applications.

Keywords: machine vision, visual inspection, industry automation,DSP

1. Introduction

Automated visual inspection systems are major components in the continuous improvement of manufacturing technologies.Visual inspection has broad applications in industry automation and covers the full range of technical difficulty in computer vision.

Most of the present solutions use PC technology to solve this task. The major advantages are the low development cost for a system ,and the possibility to use well known software tools.

Designing a dedicated system for automated video inspection offers the possibility to achieve a small cost for the final system (end user system), a compact solution, adapted to the manufacturing line. The use of DSP chips offers the possibility to have a large computational power at a relative small complexity of the system.

2. Possible architectures

Here we examine three possible architectures for the visual inspection system:

a. Simple system (fig.1)[2][3]

Main advantages:

-acquisition controlled directly by DSP chip
-minimum resources
-low speed communication with other components of the manufacturing line
-lowest cost
-suitable for small image processing tasks in simple applications

b. System with autonomous acquisition channel (fig.2.)[1][4]

Advantages:

-possibility of processing while acquiring images

-larger local control functions
-communication with a host unit
-synchronization with other components of the manufacturing line

c. Enhanced system (fig.3.)

-extended local interface (analog-digital input and output lines)
-high speed interface for integration in intelligent manufacturing lines
-punctual processing using LUT's
-highly paralleled architecture

The architecture of the described system (fig.4 [5]) ,first member of the family,is located between the first and the second class in this description.

The module is based on fixed-point DSP (TMS320C25 or 50),has a input resolution of 512x512 pixels ,in a gray scale of 256 shades.

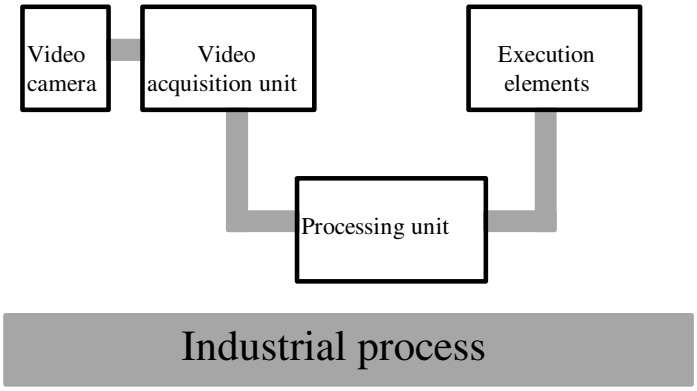

Fig.1 . Simple video inspection system

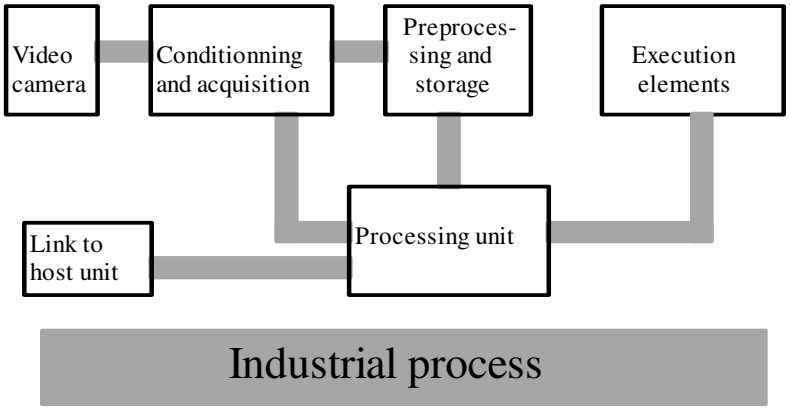

Fig.2.Video inspection system with separate acquisition channel

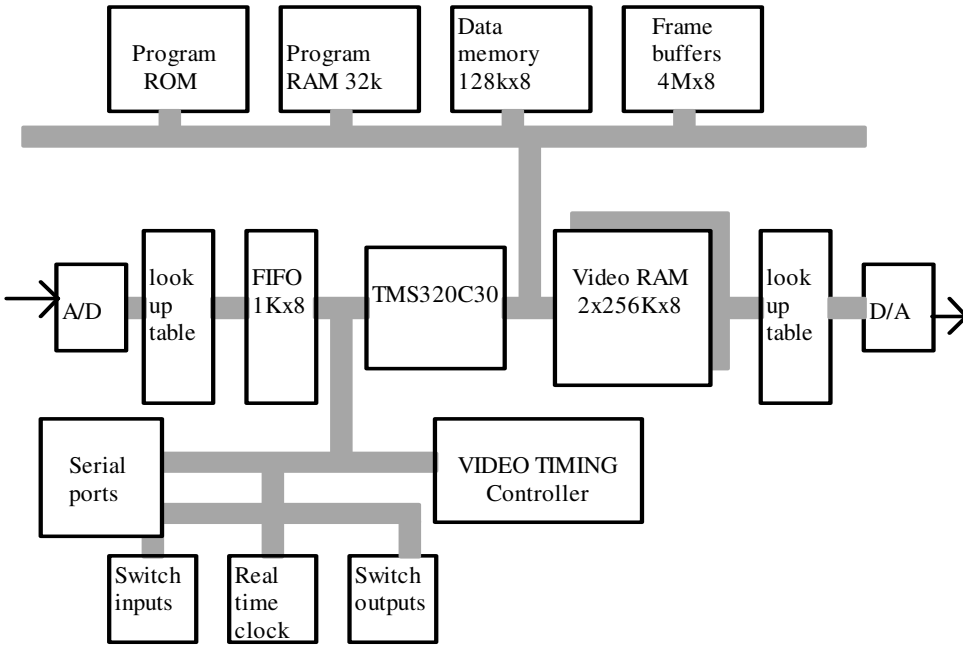

Fig.3.General diagram of an enhanced system

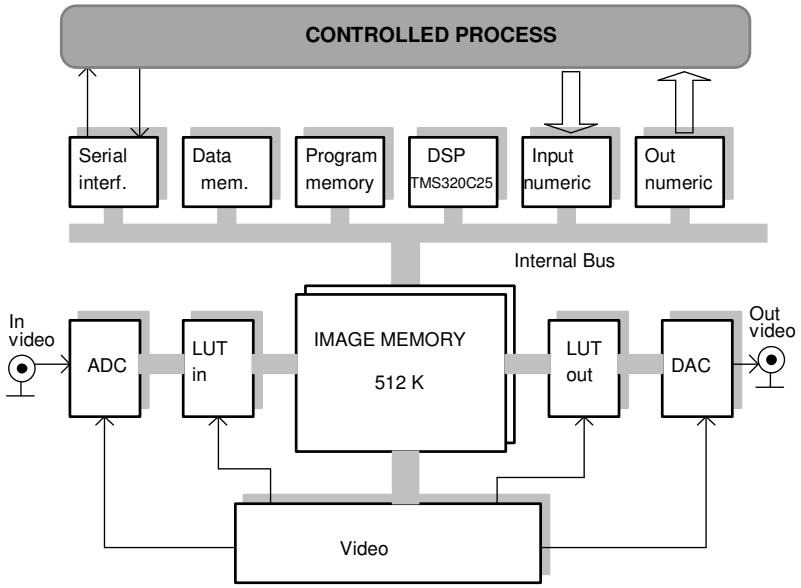

Fig.4.Architecture of the proposed module

3. Software support

For current applications software tools are the same as for common development environments (C compilers, assembly language).

A major improvement would be using visual development environments (LabView style) or in this case to build an environment.

For this phase of the project we use general software tools (C Compiler, Assembler,Debbuger) of the COFF environment [6] (fig.5).

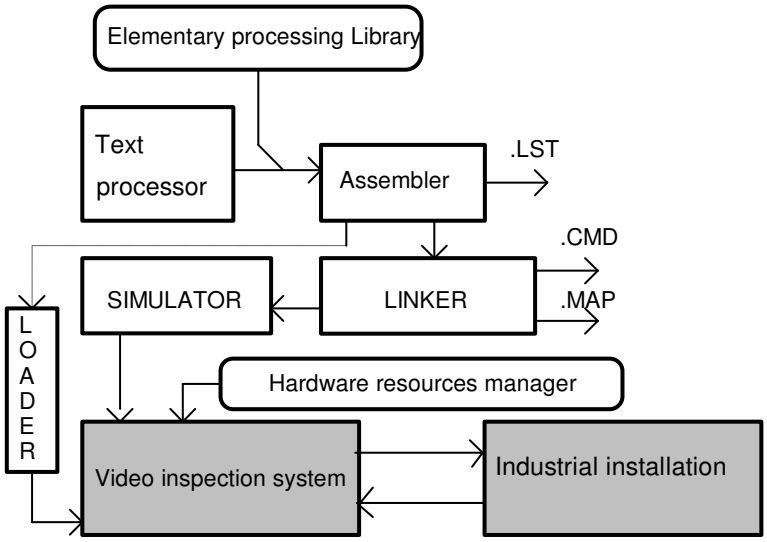

Fig.5.Flow diagram of an application development process

One of the major component is the Application Library containing main processing routines (filtering, thresholding, edge detection).

4.Experimental results

This section presents only the most significant elements to recommend DSP technology in image processing tasks.It contains execution times for DSP system at a general frequency of 20Mhz (half of the maximum speed for TMS320C25 -40Mhz).

Time(ms/pixel)	PC(40Mhz) TPASCAL	DSP system
Horizontal line drawing	-	1
Vertical line drawing	-	2,6
Diagonal line drawing	-	3,6
FFT 256 points(total)	2s	5ms
DCT(8x8 pixel)	-	1
Convolution 3x3	~45	~4
DPCM compression	~78	~4

Performances are comparable with the most performant computers (Pentium family) and considerable higher of most common industrial PC's.

As the computing power of DSP is extremelly high , in fig.6. we present the low memory requirements for various algorithms (DCT and unidimensional FFT).

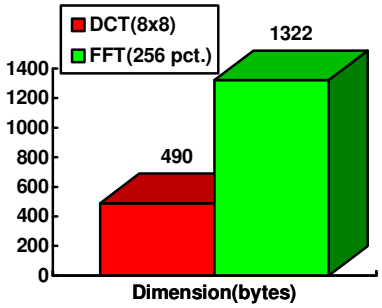

Fig.6.Memory use by different image processing algorithms

5. Applications

Visual inspection systems are useful in every application who needs continuous monitoring of quality using the visual ability of human operator. The main advantage is the fact that an automated system is capable to perform an inspection at a rate inaccessible to the human operator without strain.

Of the most useful applications of the system we can mention:

* the 100% checking of workpieces before and after assembly
* reliable recognition of parts for the purpose of production control and materials handling
* high-speed reading of codes and characters in material flow control
* high-precision measurement of products without physical contact
* inspection of surface finishes

6. Conclusion

This family of automated visual inspection systems seems to be the choice in the future for many manufacturing lines in various fields of activity.

The presented system is probably the first romanian system specially designed for this purpose, and based on DSP technology.The performances allows us to solve a large class of the machine vision problems in industrial applications.

The future improvements are related to the implementing of new families of high performance DSP's (TMS320C80 or TMS320C6xx), and to the building of user-friendly environments to facilitate application development.

7.References

[1]*** {1997}-SIMATIC-Videomat IV - Vision Systems for Inspection and Parts Identification-Siemens AG

[2]*** {1995} -i2S-Numevision-Product catalogue-

[3]*** {1994}-RMV-Rheinmetall E&S Machine Vision-Vision Box-

[4]*** {1995}-BarGold Electronics Ltd-Product Catalogue-

[5]Radu Arsinte {1997} Studii şi experimentări privind achiziția de date cu aplicații în realizarea senzorilor vizuali inteligenți -Teza de doctorat -UTCN

[5]*** - {1994} Digital Signal Processing Applications with the TMS320 Family-Volumes 2-3 Texas Instruments