IMAGE PROCESSING SYSTEM WITH TI DSP TMS320VC5407

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The image processing became more applicable and useful in different spheres. There applications, which don't need high resolution and fast interface to transfer the images in real time. Their purpose is to monitor any geometric measurements, or to perform so called "edge detecting", and to provide output reaction to an actor.

1. INTRODUCTION

The developed system for image processing is purposed for monitoring over object in industrial process lines, analyzing the received image and producing command to a actor system. The image is made by a CMOS sensor system. The general representation of the system is shown on fig. 1.0.

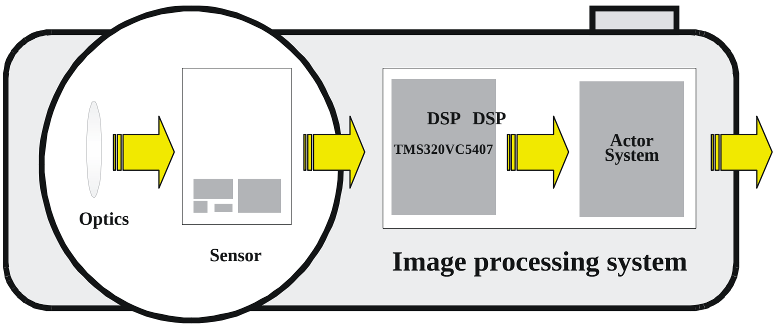

fig. 1.0

The separate elementary points in the image – so called pixels, are drag out by a digital signal processor. By appropriate filters the image is converted into a form suitable for analysis. The analysis represents in the measurement of distances between objects, the mutual location among the object, or just determination of some geometric dimensions. On the basis of the calculated information, the system generates a set of commands to executive mechanism.

? xpedient application for the system is for a astronomical monitoring with long exposition, where an automatic leading of telescope is necessary.

2. BUILDING OF THE SEPARATE MODULES OF THE SYSTEM

The block diagram is shown on fir. 1.1 The system is built by several blocks. The first is the CMOS sensor system. It is read by a digital signal processor. To reduce the processor overhead it is convenient to use channels with direct memory access – DMA for transfer the data stream from the CMOS sensor to external static RAM.

That's why it is necessary to use the serial interface of the DSP for reading the present image. For converting parallel data stream from CMOS sensor system to serial a programmable logic device is used.

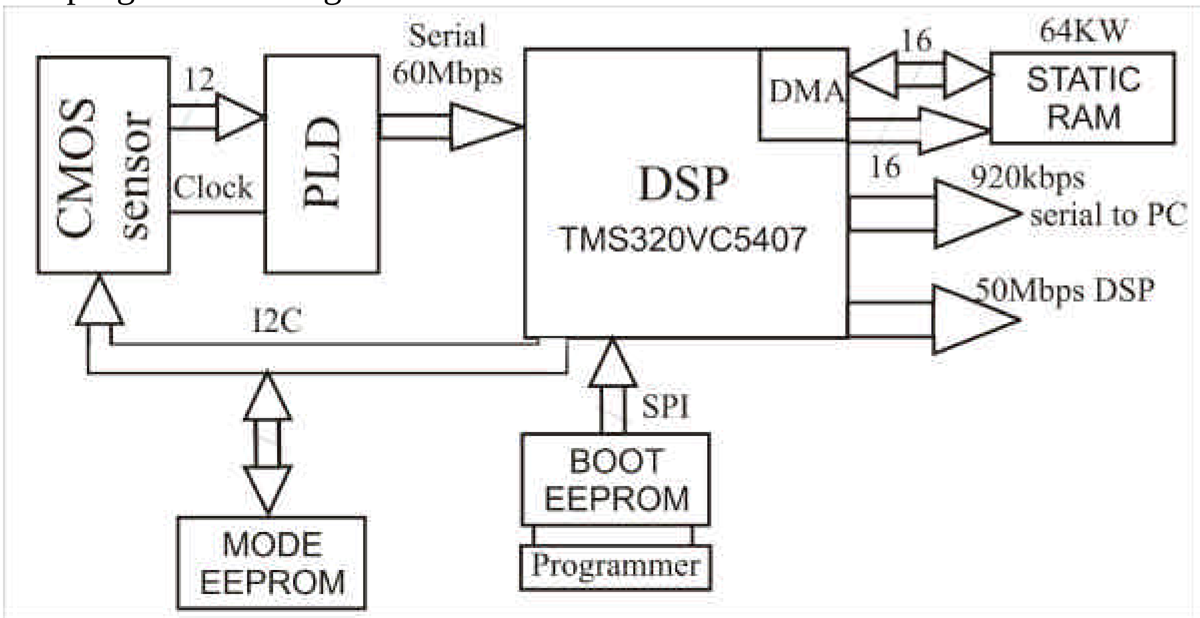

fig. 1.1

The configuration of the CMOS sensor is made via I²C from the signal processor. The sensors configuration parameters are stored in non-volatile memory on the same I²C bus.

The booting of the system software is configurable by jumpers. There are two possibilities – from serial channel or from EEPROM. The first possibility gives good possibility for software developing, with fast and easy to implement way.

2.1. CMOS sensor system.

The used CMOS sensor in the present system is LM9647 from National Semiconductors. It is built by a sensor matrix with 648 rows and 488 columns, or 316224 light-sensibly cells fig. 1.2. All the cells are covered with a mask of so called "Bayer pattern". This pattern is a chess situated filters of the basic three colors – red, green and blue. In the odd rows green and red cells alternate, in the even blue and green. Four cells from two neighbour rows form a elementary point – pixel.

In the beginning before taking any cadre, every pixel is make with value null. After the period of exposition, the accumulated in the cells charges are measured. After there is discrete values for the pixel are ready, they've been put in parallel from the sensor system. The synchronization is done by the two signals Hsync and Vsync.

2.2 Parallel to serial data stream converter.

The used programmable logic device for building the converter is XC9572XL with 72 macrocells. The CMOS sensor system transmits 10 information bits for the present pixel d[9:0], two synchronization bits "hsync" and "vsync" and one clock signal. The digital signal processor has two modes of serial synchronous interface – 12 data bits or 16 data bits. In the present system it is chosen the format with 12 bits consist of 10 data bits for the present pixel and two bits read for the synchronization signals "hsync" and "vsync". The time flowchart of the converter is presented on fig.1.3.

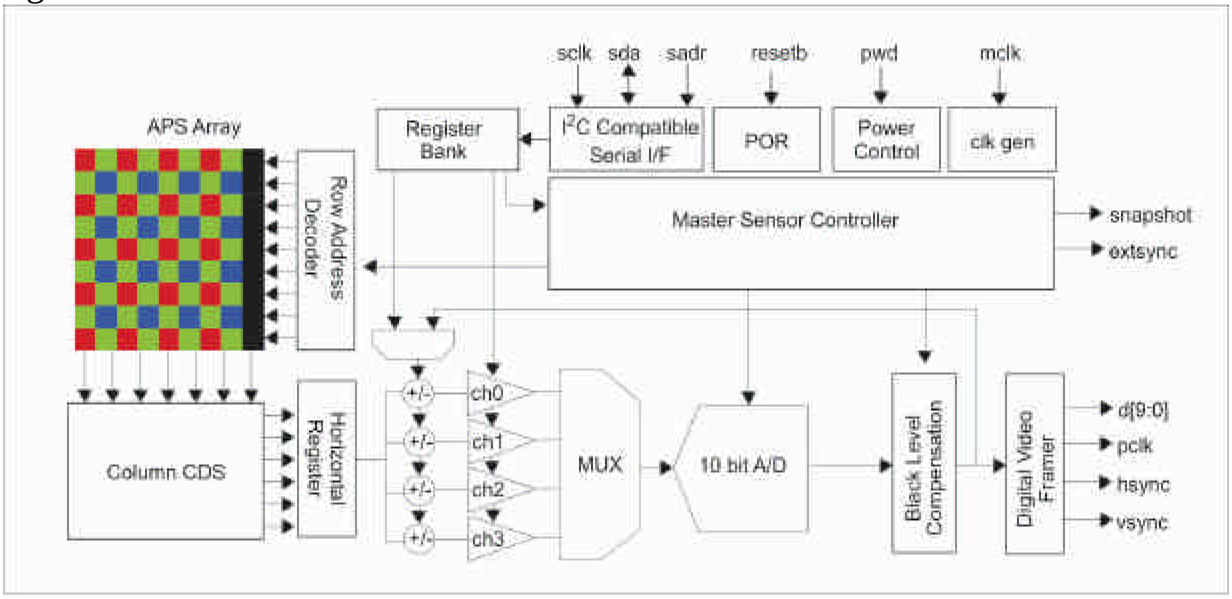

fig. 1.2

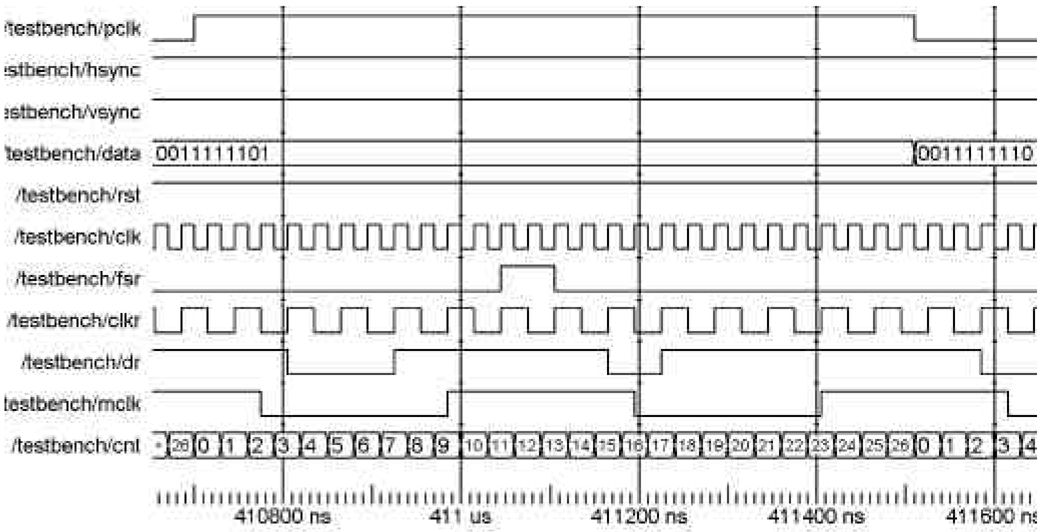

fig. 1.3

3. SOFTWARE REALIZATION

The fundamental part of image processing are filters implementation. After the raw image is read by the processor, it is turn for using the appropriate filter. Generally they are two types :

➢ For improving the quality of the image, by removing noise, while the importantdetails are not changed. The well-known in this group are mean filter; median filter local density optimization and etc.

➢ The second group are these for edge detecting. Their aim is to strengthen theharsh transition from one colour to another – transition found in the outline edge of the objects in the image.

3.1. Sobel filter

The first implemented filter is Sobel. It is from the "edge detecting" filters. It has the characteristic to make the outlint edge with brither, which is helpful during the analysis. It can be present by te follow mathematical equation:

$$G_{jk} = |G_x| + |G_y|$$

$$G_y = F_{j-1,k-1} + 2F_{j,k-1} + F_{j+1,k-1} - (F_{j-1,k+1} + 2F_{j,k+1} + F_{j+1,k+1})$$

$$G_x = F_{j+1,k+1} + 2F_{j+1,k} F_{j+1,k-1} - (F_{j-1,k+1} + 2F_{j-1,k} + F_{j-1,k-1}),$$

where (j,k) are the coordinates of each pixel $F_{j,k}$ in the image. It is equatl to convolution with masks:

$$\mathbf{X_{mask}} = \begin{bmatrix} \mathbf{-1} & \mathbf{0} & \mathbf{1} \\ \mathbf{-2} & \mathbf{0} & \mathbf{2} \\ \mathbf{-1} & \mathbf{0} & \mathbf{1} \end{bmatrix} \qquad \mathbf{Y_{mask}} = \begin{bmatrix} \mathbf{1} & \mathbf{2} & \mathbf{1} \\ \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \mathbf{-2} & \mathbf{-2} & \mathbf{-1} \end{bmatrix}$$

3.2. Roberts filter

Roberts filter is similar to Sobel, but just simpler and respectively with lower quality of processing. It equation is as follows:

$$G_{jk} = |F_{jk} - F_{j+1,k-1}| + |F_{j,k+1} - F_{j+1,k}|$$

or like a convolution

$$\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} + \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$$

3.3. Median filter.

The median filter is used to remove the noise in the image, simultaneously it keeps the important details. ? he basic moment in the median filter is filter window. It represents a a square field of elementary elements, in which allocation is the pixel, whose value will be changed. First the pixel in the window are ordered in ascending way of their values. The median pixel is this, which is in the middle of the order.

By widening of the filter window, the ratio signal to noise is increased. This is done for increasing the time for executing the filtering procedure over the imag?.

4. ? XPERIMENTAL AND RESULTS.

The made experiments characterize the time for executing of the three basic filters in the system – Roberts, Sobel, and Median filter. The system clock is 120MHz

As it can be seen from fig. 1.4, Roberts filter has lower noise resistance, also lower edge detecting possibilities.

Original

Median filter (9?9)
execution time3,929sec.

<u>*Roberts filter*</u>
execution time 0,038sec

<u>*Sobel filter*</u>
execution time0,045sec.

fig.1.4

5. CONCLUSION

The developer system grant good opportunities for scientific investigation and industrial application. Another appropriate is for the security system, on the basis of recognition differences of two consecutive cadres.

On the other hand we have enough simple system with low price in comparison with other similar systems built by relatively fast signal processors.

6. REFERENCES

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