OPTIMIZATION OF THE CONTROL OF A CCD IMAGE SCANNER TYPE L 110 C

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ABSTRACT. An optimal regime of a charge coupled device control is describes. It is shown that higher photosentivity of the L 110 C type CCD image receptor can be achievied in this way.

ОПТИМАЛЬНЫЙ РЕЖИМ УПРАВЛЕНИЯ ФОТОЧУВСТВИТЕЛЬНОЙ СХЕМЫ ПЗС ТИПА Л 110 Ц. В равоте описаный оптимальный режим управления фоточувствительной схемы с зарядовой связью, при которой повышается фоточувствительность светоприемника ПЗС типа Л 110 Ц.

OPTIMALIZÁCIA RIADENIA OBRAZOVÉHO SNÍMAČA CCD TYPU L 110 C. Článok popisuje optimálny režim riadenia snímača s nábojovo viazanou štruktúrou, pri ktorom sa zvyšuje fotocitlivosť obrazového snímača CCD typu L 110 C.

As regads opto-elektronic elements, image scanners based on charge-coupled devices (CCD) are being employed more and more in astronomy in recent years because of their advantageous properties. Their use appears to be very promising in positional astronomy, astrophysics, as well as in ground-based and space experiments. At present, attention in the field of CCDś is being concentrated mainly on improving the desing of the elements and on the technology of producing the devices themselves. Much less attention is being paid to the control of these scanner, although the image scanner on its own without control systems cannot be used. However, there is still much to be done in the field of CCD scanner control particularly with regard to increasing the effectiveness of obtaining and transmitting useful information in CCD's. One of the ways of increasing thesensitivity of the line image CCD

scanner of the L 110 C type,produced in the GDR, is described in this paper.

Designwise the L 110 C image scanner is a two-phase 1D MIS device based on P-type silicon substrate. It consists of four basic parts:

- the accumulation part formed by a series of 256 photosensitive PN-junctions where the image is optically charge - couple transformed;
- the storage part formed by parallel - in registers, which are controlled by U_{GXA} and U_{GXB} pulses and which relay the useful information from the accumulation part to the transmission part;
- the transmission part is formed by two CCD parallel-in registers whose gates are controlled by U_{G1AB} and U_{G2AB} pulses and which relay the information to the output circuit;
- the output circuit consists of a controlled CCD, a restoring and output tranzistor. It is part of the chip and carries out electric charge-coupled transformation. It is controlled by U_{GR} pulses.

The detailed design of the L 110 C scanner can be found in [1] . The control pulses required for the separate operational cycles of the scanner are illustrated in Fig. 1.

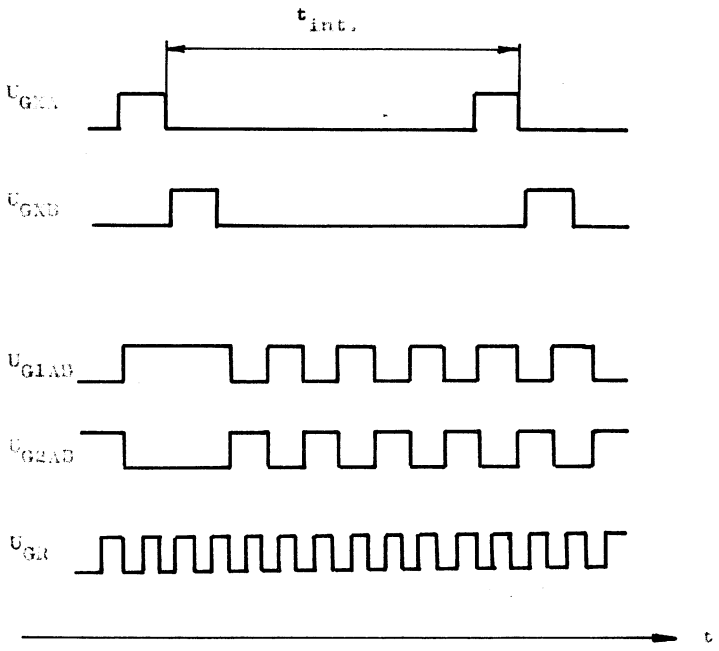

Fig. 1 The control pulses the CCD image scanner L 110 C

These pulse signals are generated in the control generator of the L 110C scanner, whose circuitry is described in [2] , and which froms part of the CCD line camera, constructed in our institute. Its block diagram is shown in Fig. 2.

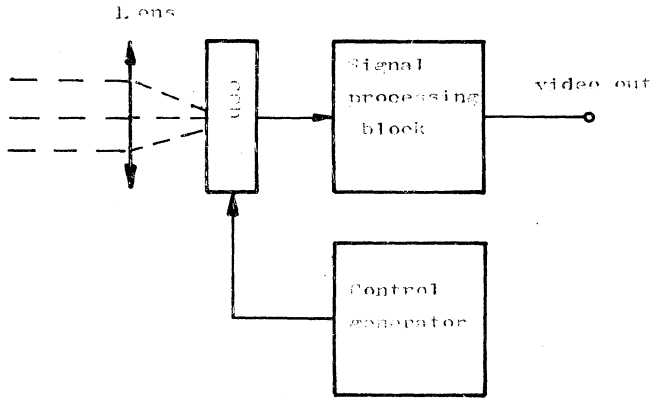

Fig. 2 Block diagram of the CCD line camera

We used this camera to achieve optimum efficiency of the image scanner i. e. to achieve maximum output signal under constant illumination of the scanned scene. Experiments were conducted with varying the parameters of the control pulses. Varying parameters U_{GXAB}, U_{G1AB} and U_{G2AB} yielded no results, because the size and time coincidence of these pulses is determined by the manufacturer on the basis of the technological design of the scanner, and any change of these parameters results in the scanner becoming unserviceable. In the experiments with varying the parameters of the U_{GR} pulse, an interesting effect, hitherto unobserved, appeared in the output signal.

A change in the size of the pulse, controlling the flip - flop of the restoring tranzistor of the controlled charge detector of the output circuit of the CCD scanner\ generates a change in the elevl of the output video signal. As the size of the U_{GR} pulse is decreased, output signal begins to grow under constant illumination. At a certain optimum value of U_{GRopt} , it reaches its maximum level which is 60 to 70% higher than the level of the output signal under the operating mode of the scanner, determined by the size of U_{GR} perscribed by the manufacturer. It is importand to note that the signal preserves all the properties of the useful signal. If U_{GR} is decreased further, the level of the output signal continues to decrease until it is below the value of the normal operating mode of the scanner, and any further change in U_{GR} in order to affect the output signal is practically useless. The whole phenomenon is clearly depicted in Fig. 3.

By the useful interval we understand the values of U_{GR} at which the photosensivity of the scanner is increased. This effect is reproducible. It appeared, under the given wiring of the camera, on all terminals and types of line scanners which were available. The properties of the phenomenon described were determined by measurements in which the wavelength and intensity of the incident radiation were varied.

The output signal of the scanner increases linearly with spectral sensitivity. This means the signal increment is the largest in the region of the

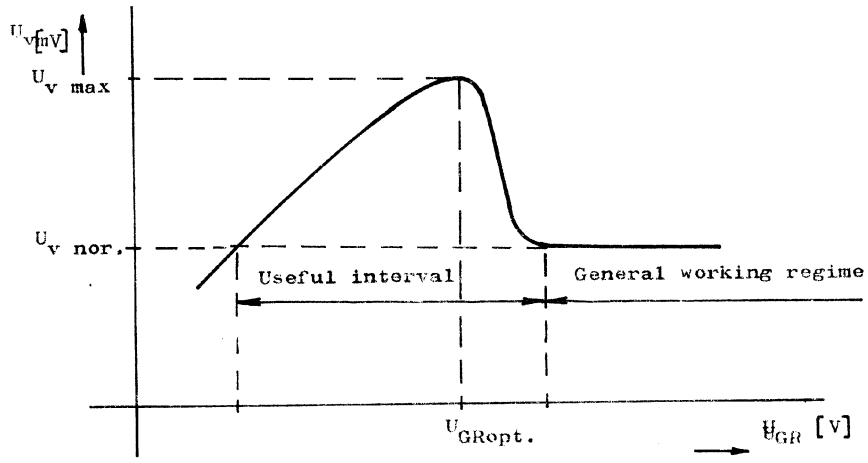

Fig. 3 Plot of the CCD output signal vs. the value of the control pulse U_{GR}

spectrum of the incident radiation where the sensor is most sensitive. Much more important was the finding that the increment of the output signal decreases with increasing intensity of the incident radiation, as shown in Fig. 4.

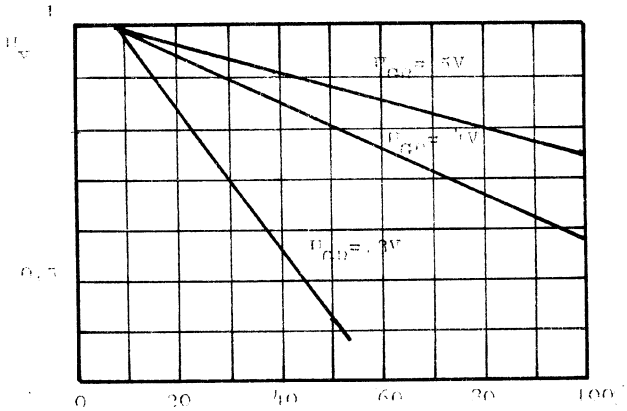

Fig. 4 The dependence of the output signal inevement on increasing intensity of illumination for different values of the control pulse U_{GR}

The intensity of the illumination was varied with the aid of the permeability of the individual fields of a photometric wedge. The curves indicate that increased photo sensitivity is more marked under weaker intensities of the incident radiation. This fact is important in astronomical applications of the scanner. For completeness, it is necessary to mention that the change in the spectral composition and intensity of illumination has not effect on the optimal operating mode of the scanner, i. e. when these parameters change, the sensitivity is increased at the same values of U_{GR}.

Work with the CCD camera and the line image CCD scanner, type L 110 C, has demonstrated its wide applicability in astronomical experiments, due to its suitable design and optimized control of the scanner. By utilizing the effect of increased photosensitivity, it can be employed in experiments with low illumination, wich are frequently conducted in astronomy.

REFERENCES

[1] Ladungsgekopette Senzorzite CCD L 110 C. Informations blatt, RFT Berlin.
[2] Minarovjech, M. , Klocok, Ľ. : TTL control generator of the CCD image scanner, type L 110 C. In Slovak Sdělovací technika 2, 1985.