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Adaptive Display Intensity Control Using Digital Signal Processor

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***Abstract*—** One of the major cause of eye strain and other problems caused while watching video displays is the relative illumination between screen and its surrounding. This can be overcome by adjusting the brightness of screen with respect to surrounding light. The display systems with the human eye features like automatic intensity control under varying background luminance conditions add more challenge to design of display systems. The Adaptive Intensity Control can be achieved by varying the display intensity according to the background intensity level taking into account the comfort level of the user. In this paper, various parameters important for automatic intensity control design have been discussed and a new methodology based on look up table generated using experimental values has been devised by which the display intensity can be adaptively varied maintaining an adequate contrast ratio in real time mode. In this paper, Signal Processor based adaptive display intensity control of display intensity has been proposed.

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I. INTRODUCTION

People look into different types of display screen either for work or entertainment. On an average, a person sits in front of them for a minimum of two hours. The display systems with the human eye features like automatic display intensity control under varying background luminance conditions add more challenge to design of display systems. The Adaptive Intensity Control can be achieved by varying the display intensity according to the background intensity level taking into account the comfort level of the user. In this paper, various parameters important for automatic intensity control design have been discussed and a new methodology based on look up table generated using experimental values has been devised by which the display intensity can be adaptively varied maintaining an adequate contrast ratio in real time mode. The use of automatic change in display intensity with the change of background intensity enhances the comfort level of the viewer by maintaining an appropriate contrast ratio. The main challenge is to make the system response in real time mode and provide good contrast ratio of the scene, image or symbology against wide dynamic range of background light condition [1].

The use of automatic change in display intensity with the change of background intensity enhances the comfort level of the viewer by maintaining an appropriate contrast ratio. The main challenge is to make the system response in real time mode and provide good contrast ratio of the scene, image or symbology against wide dynamic range of background light condition [2].

A display device used as an output terminal device of a personal computer, a word-processor or an engineering work station can be found not only in houses, but also in offices. This type of display device makes use of a display unit such as, for example, a cathode ray tube, a liquid crystal display panel, a plasma display panel or an electro-luminescent display panel. The display unit includes a multiplicity of pixels arranged in a matrix to provide a display screen [3].

The preselected and regulated video signal level at an input electrode of the picture tube is varied by changing the cathode voltage and therefore the bias on an amplifying device in the automatic gain control circuit of the receiver. The light responsive element is sequentially subjected to relatively high power dissipation which tends to vary the characteristics of the element and to shorten its useful life [4].

Most of the currently available devices is provided with either an adjustment switch having a plurality of switch positions for intermittently changing the luminance of the display screen or an adjustment knob for progressively changing the luminance of the display screen, so that the operator or user can adjust the luminance of the display screen to render it consistent with the ambient brightness, that is, the intensity of ambient light falling on the display. In either case, in changing ambient brightness, the adjustment of screen luminance is indeed cumbersome and is often sunk into oblivion. Also, depending on the position of the operator or user, the luminance adjustment may often be time-consuming and good for nothing [5].

A luminous data display is used to improve readability depending on the fluctuations in the light environment. It has automatic means to adjust the luminance of the image produced on the screen. These means use a first sensor close to the screen to obtain an indication of the ambient luminance, and a second sensor, preferably placed on the helmet, to appreciate the distribution of luminance perceived in the observer's field of vision. [5].Circuits process the detected signal and a manual adjustment signal to produce a correction signal applied to the image video signal. The luminous display is subjected to illumination which varies because of the light environment which itself varies. This can because difficulties related to the readability of the display. This is especially so when the local illumination is too great to display an image on a display [6].

In most television receivers, the display device is a cathode ray tube whose high voltage power is provided from the horizontal deflection system. Power drawn from the supply is a function of picture content, customer setting of black level; video gain (or contrast or picture controls); and automatic black level control may be implemented [7].

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Excessive beam current may cause a receiver to be damaged. Excessive beam current may adversely affect performance of receiver's deflection system; may cause electron beam spot defocusing. Accordingly, receivers are usually provided with an automatic beam limiter. Such, a circuit senses beams current and automatically reduces contrast or brightness levels or both when beam current increases beyond a predetermined value [8].

A voltage proportional to beam current is developed across a resistor connected from the lower end of a secondary winding of flyback transformer to a source of reference potential. This voltage is compared to a reference voltage in a controlled circuit when a desired maximum beam current is reach; action is taken to reduce video gain or contrast, so as to limit the current. The video controlled circuit comprises a video source, luma/chroma processing circuit, a beam current limiter circuit, a beam current sensing circuit, an automatic contrast controlled circuit and a manual brightness controlled circuit. The outputs of comb filter are inputs to luma/chroma processing circuit. Such circuits may be embodied as integrated circuits [9].

The screen used in these equipments produce images and videos by providing sufficient voltage to grid point of CRT. Intensity of display can be controlled by adjusting the control signal given at grid point of CRT. People surfing through channels get affected due to the huge contrast between atmospheric light and television brightness. When the contrast difference increases, additional stress is applied causing strains, headache and many visual disorders [10].

The reduction of power in an electronic device reduces cost of operation and potential environmental impact. Reducing power consumption is particularly important in the case of portable electronic devices. At truly portable electronic device normally operates using only the power obtained from an internal electric battery. The batteries used in portable electronic devices tend to be very small, in order to minimize overall weight and size of the device, enhancing portability [11].

II. ADIC REALIZATION

Signal Processor is a programmable logic device that has reconfigurable hardware i.e. we can get desired output by connecting the logic elements according to program. A programmable logic device may perform specific functions such as data communication; signal processing, device interfacing and timing control functions etc.

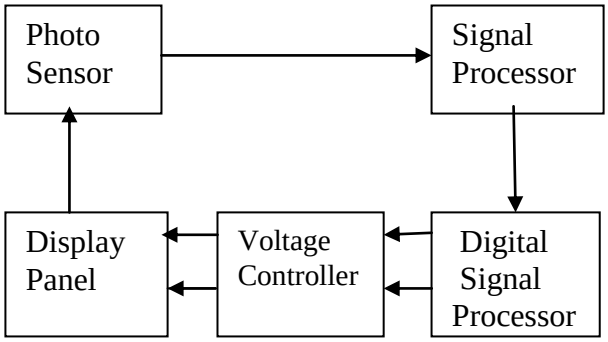

Figure 1: Block Diagram of ADIC

In this study, two photo sensors measure, both placed on front of display screen measures ambient and display screen intensity. Signal processor; depending on two intensities selects one control value from brightness correction table and this control value is input to potentiometer (or voltage controller). Based on contrast ratio formula display screen intensity is adjusted according to ambient intensity so as to render consistency with the operator or user.

Contrast Ratio (CR) = (Ambient Intensity + Display Intensity) / (Display Intensity)

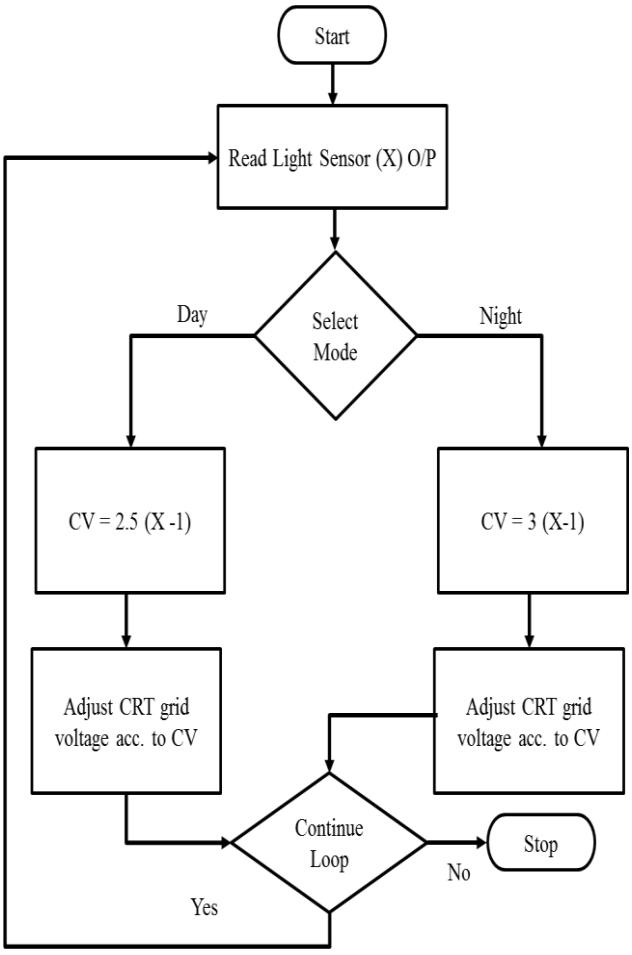

Figure 2: Flow Chart for ADIC

III. SIMULATIONS & RESULTS

The simulation results show that the output intensity is adjusted by a signal processor if the input ambient intensity is not equal to the display intensity or the contrast ratio between the two is less than 2.0.

The graphs in figure no. 3 and figure no 4 shows variation of adjusted screen intensity with respect to ambient intensity with varying contrast ratio is between 1.5 to 2.0. The red line graph represents contrast ratio of 1.5 and yellow corresponds to 1.75 whereas green lines show variation according to contrast ratio of 2.0.

Table 1: Parameters for Adaptive display Intensity Control

Ambient Intensity (Lux)	Ambient Voltage (Volt)	Display Intensity (Lux	Observed Screen Intensity	Contrast Ratio
100	1 V	90	95	2.05
400	2 V	300	270	2.48
800	3 V	600	527	2.13
1000	4 V	800	700	2.43

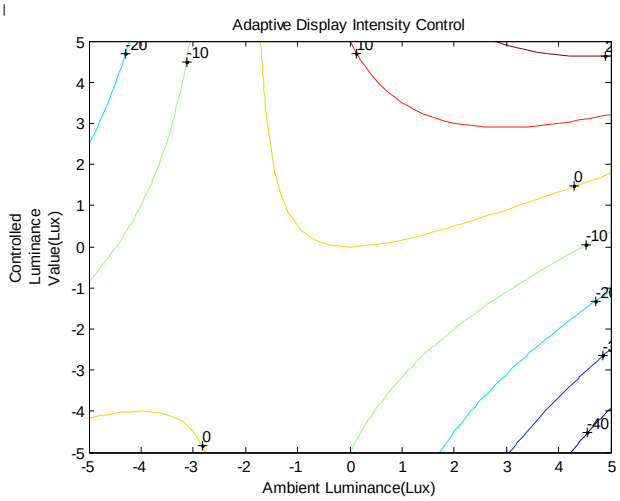

Figure 3: Graph of Ambient Luminance Vs Controlled Luminance for AIDC

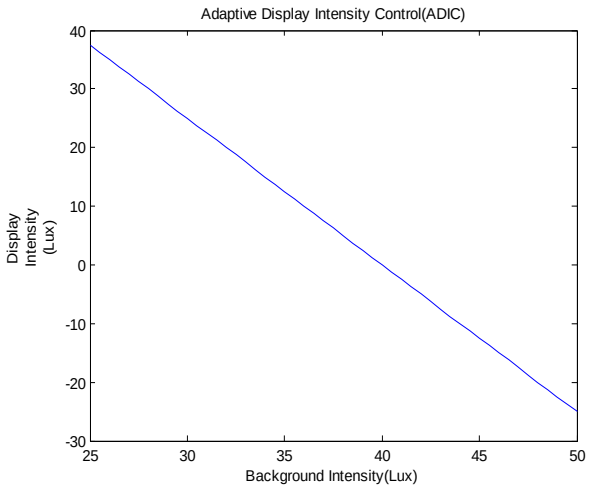

Figure 4: Graph of Background Intensity Vs Display Intensity for AIDC

IV: CONCLUSIONS

According to the changing environment brightness, the back level of the screen needs to be appropriately adjusted or corrected. The back level of screen is adjusted according to contrast ratio between display screen and ambient intensity. The varying levels are adjusted by signal processor under varying ambient intensities e.g. if ambient intensity increases from 100 to 400 LUX, observed screen intensity is 90 LUX so as to maintain contrast ratio 2.05, the processor adjusted to near about 92.5.

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