

PROGRAMMABLE ILLUMINATION CONTROLLER

FIELD OF THE INVENTION

- 5 The present invention relates generally to the field of illumination controllers, and in particular to a programmable illumination controller.

BACKGROUND OF THE INVENTION

- 10 A machine vision system is an integral part of any automated process in a factory or production facility. The machine vision system is used in the inspection for defects in parts or components, or for guidance or gauging purposes.

- 15 Reliability of such machine vision systems largely depend on the image quality of the inspected part or the target. The machine vision system would first acquire the image of the target. Then carry out an analysis of the acquired image to determine whether the target passes or fails the inspection.

- 20 In order for the machine vision system to acquire a good and clean image of the target, there must first be sufficient and adequate illumination. Too little illumination and the image will be not have sufficient contrast for analysis. Too much illumination and the reflection of light off the target
25 surface would hide the features for analysis.

Many of such machine vision systems require several illumination devices at different locations for inspecting several targets with different features. Furthermore, certain features to be inspected require a variety of



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different illumination devices with different intensities. Examples of such combinations are : a ring light and a bar light or a plurality of ring lights in a predetermined arrangement covering different angles or a LED array and a Halogen Lamp.

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As such, it is necessary for machine vision systems to have control over the intensities of such a plurality of illumination devices. There may further be additional control requirements such as the strobing of the illumination devices. This usually concerns inspection of targets on an inspection on demand basis only. Such an illumination system would likely be controlled by a dedicated computer-based illumination controller. An example of such a system is Adaptive Light System from Semiconductor Technologies & Instruments, Inc (U.S. Patent No. 6,207,946). This system utilizes a suitable input/output interface to control its dedicated standalone intensity control circuit to drive a LED array.

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Current illumination systems that are provided for machine vision systems with such diverse requirements are frequently custom made. That is to say, that the specifications are determined by a user who approaches a vendor to supply the illumination system. The illumination system provided would then be designed specifically to the user's specifications. The illumination controller provided would also be specific to the provided illumination system. The different intensities and the strobing requirements of the illumination devices would likely be carried out by providing a set of programmed control parameters to a dedicated illumination controller. Furthermore, the electrical power needed to power such an illumination system would be provided by separate stand-alone power supply modules. With a wide variety of different illumination devices, there would also be a

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variety of different power supply modules. This not only incurs cost, the power supply modules also take up a lot more space.

5 Such an arrangement results in an automated inspection system that is not integrated with its illumination system. That is to say that the machine vision system and the illumination system each have their own controllers and interfaces working independently of each other. Furthermore, the power supply modules provided with the illumination system would cater only to the specifications as laid down by the user.

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When the need to expand or modify the machine vision system arises, settings to both the machine vision system controller and the illumination system controller would have to be affected separately. Both the controllers of the machine vision system and the lighting system would thus have to be re-programmed separately. Furthermore, the customized illumination system may not have catered for further expansion or modification. This is also a concern for the power supply modules. Eventually, this may result in additional illumination systems to complement the existing one or a completely new illumination system as well as additional power supply modules to cater for the expansion.

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Current illumination systems simply do not have the flexibility to adapt to such requirements for expansion and modification. They have not been sufficiently exploited to integrate the machine vision system, the illumination system and their power supply needs adequately.

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SUMMARY OF THE INVENTION

The present invention seeks to provide a programmable illumination controller, a method of configuring and a method of operating thereof.

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Accordingly, in one aspect, the present invention provides a programmable illumination controller comprising:

a card controller for receiving a plurality of predetermined illumination settings, and for providing a plurality of illumination control signals;

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a plurality of output power channels coupled to the card controller, and the plurality of output power channels for receiving at least one of the plurality of illumination control signals, and the plurality of output power channels for coupling to a variety of illumination devices, and the plurality of output power channels for providing power to the variety of illumination devices in accordance with the plurality of illumination control signals.

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Accordingly, in another aspect, the present invention provides a method for configuring a programmable illumination controller for illuminating a target with an illumination device, the method comprising:

20 arranging the target to view a particular feature of the target by an imaging device;

switching on the illumination device to illuminate the target;

varying intensity level of the illumination device through an interface program running on a computer;

25 viewing an image of the target to determine an optimum intensity level of the illumination device to best view the particular feature of the target;

saving the optimum intensity level into the computer.

Accordingly, in a further aspect, the present invention provides a method for operating a programmable illumination controller for illuminating a target with a plurality of predetermined illumination settings, steps comprising:

- 5 receiving the predetermined illumination settings of the plurality of output power channels coupled to the variety of illumination devices;
- providing the plurality of illumination control signals to the plurality of output power channels;
- providing power to the variety of illumination devices in accordance with the plurality of illumination control signals.

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BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a general block diagram of a machine vision system having an illumination controller in accordance with the present invention.

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Fig. 2 shows a block diagram of the present invention.

Fig. 3 shows a flowchart of a method for configuring the intensity levels of Fig. 2 in accordance with the present invention.

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Fig. 4 shows a flowchart of Fig. 2 in operation.

25 DETAILED DESCRIPTION OF THE DRAWINGS

Referring to Fig. 1, a machine vision system comprising a computer 5, an imaging system 15, and an illumination system 25. The computer further comprises a computer processor 12, a storage device 14 and a computer

bus 10. The imaging system 15 comprises at least one imaging device 17 and a frame grabber 16. The illumination system 25 comprises at least one illumination device 20 and an illumination controller 30. The frame grabber 16 and the illumination controller 30 both reside in the computer 5.

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The imaging device 17 acquires an image of a target (not shown) to be viewed and the image grabber 16 sends the image to the computer processor 12 for analysis. Illumination of the target is provided by the illumination device 20. The illumination device 20 is powered up to a
 10 predetermined intensity level controlled by the illumination controller 30. The illumination device 20 can further be strobed according to receipt of an external trigger signal 40. The strobing has a predetermined duration controlled by the illumination controller 30. The predetermined intensity level and predetermined duration is entered into the computer 5 by user input 18
 15 via a interface program running on the computer 5. The computer 5 then sends the predetermined intensity level and predetermined duration to the illumination controller 30. The illumination controller 30 can be a PCB card with an interface for communication with the computer bus 10.

20 Referring to Fig. 2, the illumination controller 30 comprises a card controller 210, a plurality of output power channels 230 and a plurality of input trigger channels 250. An output power channel 230 comprises in series a Digital Controlled Potentiometer (DCP) 232, a switch 234, and a Field Effect transistor (FET) 236. An input trigger channel 250 comprises in series an AC
 25 optocoupler 252 and a comparator 254. The card controller 210 can comprise at least one Complex Programmable Logic Device such as a Lattice-1032e.

A wide variety of illumination devices 20 may be connected to the plurality of output power channels 230 of the illumination controller 30. These illumination devices 20 are Direct Current (DC) devices. It should be noted that power requirements of the illumination devices 20 are supplied directly from the computer 5 via the computer bus 10 and the card controller 30, and separate power supply modules are generally not required. Some examples of the illumination devices 20 are LEDs 20a, Halogen Lamps 20b and Flash Lamps 20d. LEDs 20a are used in situations whereby rapid response of the illumination device 20 is required. Halogen Lamps 20b on the other hand have slower time response, but brighter illumination for sustained illumination. Flash lamps 20c are also used in situations where rapid strobing of the illumination device 20 are desired. If a Hi-Power illumination device 20d is required, i.e. the power consumption required is higher than can be supplied by a single output power channel 230, multiple output power channels 230 can be combined to provide the necessary power to the Hi-Power illumination device 20d. Furthermore, there are certain special illumination devices 20e that have may have peculiar power requirements. A separate power supply 50 can be connected to and controlled by the illumination controller 30 to power the special illumination device 20e. Other types of illumination devices 20 like Ultra Violet lamps and Infra-Red lamps may also be controlled by the illumination controller 30.

A plurality of external trigger signals 40 may be connected to the plurality of input trigger channels 250 of the illumination controller 30. The input trigger channels 250 serve to receive the external trigger signals 40 to send them to the card controller 210 for the controlling of the strobing of the illumination devices 20.

Referring to Fig. 3, the steps to configuring 300 the illumination controller 30 for illuminating a particular feature of a particular target starts 305 with arranging the target to view its particular feature 305. Next, switching 315 on the desired illumination device 20 to illuminate the target.

5 The intensity level of the illumination device 20 is then varied 320 using the interface program running on the computer 5. The image of the target acquired by the frame grabber 16 is viewed 325 to determine the optimum intensity level of the illumination device 20 to best view the particular feature of the target. This optimum intensity level is then saved 330 in the storage

10 device 14 of the computer 5. If the illumination device 20 has a strobe requirement 335, the desired strobe settings are entered 340 into the computer through the interface program and saved 345 into the storage device 14 of the computer 5. If there are no other 350 illumination devices 20, the steps of configuring 300 the illumination controller 30 ends 360, else the

15 next illumination device 20 is configured as per the above steps. The strobe settings comprises: the assignment of fan input trigger channel 254 corresponding to an external trigger signal to switch ON the illumination device 20 corresponding to a output power channel 232 and a duration of time after which the illumination device 20 is switched OFF. If there is no

20 strobe requirement 335 for the illumination device 20, the next illumination device 20 is configured as per the above steps else the steps of configuring 300 the illumination controller 30 ends 360. The strobe settings can also be further varied such that one external trigger signal is assigned to a plurality of illumination devices. Each of the illumination devices assigned to this one

25 external trigger signal may also have different intensity levels.

Referring to Fig. 3 and Fig. 4, the steps in the operation 400 of the illumination controller 30 for illuminating a target with a predetermined intensity level and a predetermined strobe setting starts with the receiving

410 of the predetermined intensity level and the predetermined strobe setting for each output power channel corresponding to each of the illumination devices. A reference voltage is formulated 415 by the card controller from the received predetermined intensity level. A voltage reference signal 212 is then
5 sent to set the DCP 232 of each channel 230 to set the DCP to register 420 the reference voltage. If the output power channel 230 has an illumination device 20 that does not have a strobing requirement 425, the switch 234 is switched ON 430. The voltage reference at the DCP 232 is applied to the FET 236 which controls 435 the current flowing through the FET 236 and to
10 the illumination device 20. The current flow from the FET 236 is based on the voltage reference which is based on the predetermined intensity level. The source of the current flow is generally not dependent on separate power supply modules and is drawn directly from the computer 5 via the computer bus 10 and the card controller 210. The illumination device 20
15 corresponding to the output power channel 230 is thus illuminated at the predetermined intensity setting. If there is another 440 illumination device 20, the steps in the operation 400 of the illumination controller begins again, else it ends 480.

20 If there is a strobing requirement 425, an external trigger signal 40 is received 445 by an input trigger channel 250. The external trigger signal is then further conditioned 450. The external trigger 40 signal is converted by the AC optocoupler 252 into a DC signal which is further converted by the comparator 254 into a logic level signal 216. The card controller 210 upon
25 receiving the logic level signal 216 switches ON 455 the switch 234 of the output power channel 230 corresponding to the assigned illumination device 20. At the same time, a countdown for the duration of time is started based on the predetermined strobe setting. The voltage reference at the DCP 232 is again applied to the FET and controls 435 the current flowing through the FET

236 to the illumination device 20 based on the predetermined intensity setting. When the countdown of the duration of time is completed 465, the switch 234 is switched OFF 470. The illumination device 20 corresponding to the assigned external trigger signal 40 is thus illuminated at the
5 predetermined intensity setting for the duration of time according to the predetermined strobe setting. If there is another 440 illumination device 20, the steps in the operation 400 of the illumination controller begins again, else it ends 480.

10 The above description does not in any way limit the scope of the invention. It would be apparent to one skilled in the art that the present invention may be modified without departing from the scope of the invention.

CLAIMS

1. A programmable illumination controller comprising:
a card controller for receiving a plurality of predetermined illumination
5 settings, and for providing a plurality of illumination control signals;
a plurality of output power channels coupled to said card controller,
and said plurality of output power channels for receiving at least one of said
plurality of illumination control signals, and said plurality of output power
channels for coupling to a variety of illumination devices, and said plurality of
10 output power channels for providing power to said variety of illumination
devices in accordance with said plurality of illumination control signals.
2. A programmable illumination controller in accordance with claim 1
further comprising a plurality of input trigger channels coupled to said card
15 controller, and said plurality of input trigger channels for receiving a plurality
of external trigger signals, and said card controller for receiving a plurality of
input trigger signals from said plurality of input trigger channels, and for
providing said plurality of illumination control signals to said plurality of output
power channels associated with said plurality of input trigger channels.
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3. A programmable illumination controller in accordance with claim 2
wherein said plurality of input trigger channels comprises in series a
comparator and an AC optocoupler.
- 25 4. A programmable illumination controller in accordance with claim 1
wherein said predetermined illumination settings comprises of intensity level
and strobe settings.

5. A programmable illumination controller in accordance with claim 4 wherein said strobe settings comprises an assignment of an input trigger channel to an external trigger signal to switch ON at least one of said variety of illumination devices and a duration of time after which said at least one of
5 said variety of said illumination devices is switched OFF.

6. A programmable illumination controller in accordance with claim 1 wherein said plurality of output channels each comprises in series a digital controlled potentiometer, a switch and a field effect transistor.
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7. A programmable illumination controller in accordance with claim 1 wherein said card controller comprises at least one complex programmable logic device.

15 8. A programmable illumination controller in accordance with claim 1 wherein said variety of illumination devices comprises: Light Emitting Diodes, Halogen Lamps and Flash Lamps.

9. A method for configuring a programmable illumination controller for
20 illuminating a target with an illumination device, said method comprising:
providing a programmable illumination controller comprising:

25 a card controller for receiving a plurality of predetermined illumination settings, and for providing a plurality of illumination control signals, and said plurality of predetermined illumination settings comprises intensity levels and strobe settings;

a plurality of output power channels coupled to said card controller, and said plurality of output power channels for receiving at least one of said plurality of illumination control signals, and said plurality of output power channels for coupling to a variety of

illumination devices, and said plurality of output power channels for providing power to said variety of illumination devices in accordance with said plurality of illumination control signals;

arranging said target to view a particular feature of said target by an imaging device;

switching on said illumination device to illuminate said target;

varying intensity level of said illumination device through an interface program running on a computer;

viewing an image of said target to determine an optimum intensity level of said illumination device to best view said particular feature of said target;

saving said optimum intensity level into said computer.

10. A method in accordance to Claim 9, wherein said programmable illumination controller further comprising a plurality of input trigger channels coupled to said card controller, and said plurality of input trigger channels for receiving a plurality of external trigger signals, and said card controller for receiving a plurality of input trigger signals from said plurality of input trigger channels, and for providing said plurality of illumination control signals to said plurality of output power channels associated with said plurality of input trigger channels and wherein said illumination device further having strobing requirements, said method further comprises:

entering said strobe settings through said interface program running on said computer; and

saving said strobe settings into said computer.

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11. A method in accordance to Claim 9 wherein said strobe settings comprises:

assigning an input trigger channel corresponding to an external trigger signal to switch ON said illumination device corresponding to said output power channel; and
a duration of time after which said illumination device is switched OFF.

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12. A method for operating a programmable illumination controller for illuminating a target with a plurality of predetermined illumination settings, steps comprising:

providing a programmable illumination controller comprising:

10 a card controller for receiving said plurality of predetermined illumination settings, and for providing a plurality of illumination control signals;

a plurality of output power channels coupled to said card controller, and said plurality of output power channels for receiving at least one of
15 said plurality of illumination control signals, and said plurality of output power channels for coupling to a variety of illumination devices, and said plurality of output power channels for providing power to said variety of illumination devices in accordance with said plurality of illumination control signals;

20 receiving said predetermined illumination settings of said plurality of output power channels coupled to said variety of illumination devices;

providing said plurality of illumination control signals to said plurality of output power channels;

25 providing power to said variety of illumination devices in accordance with said plurality of illumination control signals.

13. A method for said operating a programmable illumination controller in accordance to claim 12, wherein said plurality of illumination control signals each comprises a voltage reference signal.

14. A method for operating a programmable illumination controller in accordance to claim 12, wherein said predetermined illumination settings each comprises of an intensity level and a strobe setting.

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15. A method for said operating a programmable illumination controller in accordance to claim 14, wherein said plurality of output channels each comprises in series a digital controlled potentiometer(DCP), a switch and a field effect transistor(FET).

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16. A method for operating a programmable illumination controller in accordance to claim 15, wherein said step of providing power to said variety of illumination devices further comprises:

formulating a voltage reference in accordance to said intensity level for each

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of said plurality of output power channels;

setting said DCP for each of said plurality of output power channels to register said reference voltage;

switching said switch for each of said plurality of output power channels to ON;

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controlling current flow through said FET for each of said plurality of output power channels coupled to said variety of illumination devices.

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17. A method for operating a programmable illumination controller in accordance to claim 15, wherein said programmable illumination controller further comprising a plurality of input trigger channels coupled to said card controller, and said plurality of input trigger channels for receiving a plurality of external trigger signals, and said card controller for receiving a plurality of input trigger signals from said plurality of input trigger channels, and for

providing said plurality of illumination control signals to said plurality of output power channels associated with said plurality of input trigger channels and wherein said illumination device further having strobing requirements, said method further comprises:

- 5 receiving an external trigger signal for each of said plurality of input trigger channels;
- conditioning said external trigger signal;
- switching said switch for each of said plurality of output power channels to ON and starting a countdown based on said strobe
- 10 setting;
- controlling current flow through said FET for each of said plurality of output power channels;
- switching said switch for each of said plurality of output power channels to OFF when said countdown based on said predetermined
- 15 strobe setting is completed.

18. A method for said operating a programmable illumination controller in accordance to claim 17, wherein said plurality of input trigger channels comprises in series a comparator and an AC optocoupler.