A High Resolution Imaging System for Simultaneous Acquisition of Two High Aspect Ratio Object Fields

Field of Invention:

The present invention is related to an imaging and method for the simultaneous acquisition of a pair of images with high aspect ratio with extended resolution.

Description of Prior Art:

Classical techniques of image capturing systems consists of optical elements arranged to collect light signals from an object. The light signals are processed and focused to form a single image of the entire object at the focal plane where a detector system is placed. The detector system are generally pixelated Charge Coupled Device (CCD) cameras. The detector signals are transmitted electronically to a display system in direct synchronization with the detector system.

The operation of this classical imaging system works to capture the entire scene of an object field, generally with an aspect ratio near 1.0:1 to 1.5:1. Standard television aspect ratio is 4:3 or 1.33:1. The limitation on the implementation of such a classical imaging capture system on a large object field with high aspect ratio leads to a loss of descriptive image signal details on the object. Traditionally, to overcome the loss of image signal detail, a reduced object field is compromised.

In addition, the classical imaging system captures one entire object field in a single image field and displays as a single image frame. To capture two object fields, the process is repeated in a sequential manner, with the two object fields being displayed sequentially or overlapped or stored separately.

The prior art is distinctive in its resolution limits and sequential capture of multiple object fields. The approach to increase resolution is to increase pixelation densities. However, there are practical limits in fabrication and production of very high pixel density CCD cameras. There is presently an urgent need for an imaging system with higher resolution than what is currently available. The capability to acquire more than one object fields in a single frame will reduce data storage requirements and time required to process and enhance the acquired images.

Hence it is the object of the present invention to produce an imaging and processing system which is capable of capturing simultaneously two high finesse object fields with high aspect ratios to processing them in a single image frame.

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The following are further objects of the invention:

(I) To produce an imaging and processing system using two currently readily available CCD image detectors with pixel densities such as MxN matrix in the device resulting in resolution performance increased two fold for an elongated object field (2MxN).

(ii) To produce an imaging acquisition system that is modular in essence, and versatile to be assembled in regular modules for various applications and object fields.

(iii) To produce a system capable of acquiring high aspect ratio object fields in contrast to currently available systems

(iv) To produce the imaging and processing system described herein to perform under lighting condition available for imaging processing and machine applications.

Summary of the Invention:

These and other objects are accomplished readily by the present invention in which there is an innovative assembly of image acquisition optics, critical detector system arrangements and display methods.

The image acquisition optics consists of a front twin optical system and prisms arranged for the relay and folding of light beams into a common beam reception group. The front twin optical group allows for acquiring two object fields simultaneously. Each of the twin optical group will collect light signals from the object fields which it is directed at. The light beams from the two object fields are processed optically by an image parting technique to reach the detector system plane side by side. In this manner, two high aspect ratio object fields can be displayed side by side on a single frame. The axis of the front twin optical systems are constructed to be movable or hinged for flexible orientation of the viewing directions. Additional optical elements can be mounted to enhance these capabilities.

A separate optical technique is used for the critical arrangements of detector systems to generate increased resolution. This is achieved by the segmentation of individual object fields and directing the light beams into two detector arrays that are arranged in an ordered offset according to the segmentation. In this way, two ordinary detector systems with a given available pixelation density of say MxN can be so arranged to capture an object field. The resulting resolution is increased to about 2MxN for that object field.

An electronics processor interface for the system is used to merge the two detector data signals into one single image frame. The final resultant display of the image frame is in the form of elongated picture configuration.

The modular construction is achieved by optimizing and encapsulating the optics and reflecting elements in a mechanical system suitable for versatile interchangeability and connections such as slider mechanism described in the preferred embodiments. The system can be assembled for the acquisition of single object field at high finesse details when

constructed with a single front optical group. A separate system constructed with a twin front imager group can be used to view a pair of rows of leads from a Integrated Circuit (IC) package. The twin front imager group can be constructed to adjust to suit the distance between the rows of leads, or to view them at different orientations.

Brief description of the drawings:

The means by which the above objectives and other objects are accomplished, the method of achievement will be readily understood from the following illustrations and specifications:

Fig 1: is a side view of the imaging system.

Fig 2: is the front elevation of the device arranged to acquire 2 object fields.

Fig 3: is illustrates the image electronic integration system for 2 CCD image detector chips.

Fig 4: is an illustration of the object field segmentation and display.

Fig 5: is an illustration of various configurations of the device assembled for viewing of high finesse object.

Fig 6: illustrated arrangement for the inspection of IC package.

Detailed Description of the Invention:

In accordance with the invention, an imaging and display system for simultaneously capturing two high finesse, high aspect ratio objects and displayed in a single frame is disclosed. The imaging system comprises of three main image acquisition optical modules and an electronic module. The image acquisition optical modules are front twin optical module 1, image parting module 2, and the beam reception module 3. The modules are constructed with mechanical design interfaces that allow capability for modular reassembly.

Twin Imaging Mechanism

The front twin optical module 1 consists of optical elements 10&11 constructed to work with prisms 12&13 to relay light beams from the objects 14&15 respectively. These optics and/or other suitable optical components are so arranged for the relay of the elongated objects 14&15 positioned in the same orientation as the prisms 12&13. The size of the objects 14&15 are extended in shape stretching from 16 to 17. The optical components are housed in two separate cells 18&19.

The image parting module 2 consist of a mirror prism 20 and lenses 21 which are assembled in cell 22. The mirror prism 20 will part the images of

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14 and 15. The image parting module 2 and the front twin optical module 1 are assembled at the mirror prism 20 optical axis interface.

Cells 18&19 are interfaced to cell 22 on a sliding mechanism 23 for adjusting the object positional distances between 14&15. The relative positions of these two cells can be fixed with locking mechanism 24. This or other similar arrangement will allow the sliding mechanism to adjust the inter-axial distance to view objects positioned differently. This construction enables the simultaneous paired image acquisition of object fields 14&15. The objects 14&15 will be imaged side-by-side at the detector system placed at the focal imaging plane.

Extended Pixelation Resolution Mechanism

The beam reception module 3 consists of a beam splitter 30 and two CCD image detectors 31&32 assembled in a cell 33 to form a module. The beam splitter 30 is arranged to divide the light beam coming from the elongated object field, say 16 to 17 through the front twin optical module 1, and image parting module 2. The light beam is divided such that CCD detector 31 will capture the first image segment 16 of the object field and CCD detector 32 will capture the second segment of the 17 of the object field. In this manner, each object field length separated into two segments and the whole extended field is detected by the sum of number of pixels provided by the CCD image detectors 31 and 32.

Image Merging by Electronics Integration

The electronic module consists of three parts. the first part is the image integrator 40 will receive and digitize the electronic output signals from the two CCD image detectors 31&32 and then merge the two segments of object fields 16&17 to reconstruct an image of the extended objects again in a single frame displayed on monitor 41. The digital image processor 42 is used to further process the captured images to detect high finesse features of the object fields for further enhancements or calculations. A much higher final resolution can be achieved by the processor 41 by performing pixel interpolation calculations.

The final result executed by the imaging system is illustrated by viewing of two objects 45&46. The objects will be acquired by the front twin optical module 1 of the imager system and displayed on the monitor screen 41 as images 47&48 respectively. An elongated object say 45 comprising of rows of circles is segmented by the beam reception module 3 into segments tagged 49 to 50. These segments are directed by the beam reception module to two CCD image detectors 31&32 described previously. The images received by the detectors are processed by the electronic module and merged to form a single image frame for ease of data processing.

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Preferred Embodiments of the Invention

The following descriptions of the invention are for exemplary purposes only and are not intended to encompass all possible uses and applications of the invention.

Macro-Super Resolution Imager

The basic configuration for single object field is illustrated in FIG 5a, comprising of a single optical unit and the beam reception unit. The image is acquired at enhanced pixel resolution and large aspect ratio, as compared to a normal camera system.

In FIG 5b, by constructing the front twin optical units on a image parting module, the device can be used for viewing objects at very close range. This device configuration forms a dual view macro-imager application. The optical units can be adjusted for inter-axis shifts and directions suitable for acquiring the images of the target objects. A single ordinary camera can be attached. This is an improvement over conventional capture of the entire scene encompassing the two objects. In FIG 5c, another configuration is disclosed by the coupling of the two CCD detector beam reception module. In this configuration, the acquired pixel resolution is further enhanced and the object aspect ration can be vastly increased.

IC Inspection Head System

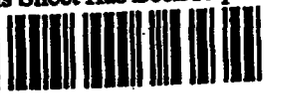
Modern electronic integrated circuit (IC) chip components are packaged with high pin-count and high density leads. It is a common requirement to inspect the leads before the IC packages are assembled onto Printed Circuit Boards (PCB). There are a few inspection process required to be performed, such as the component information printed on the IC package, the coplanarity of the leads, lead dimensions etc. The fabrication and manufacture of these packages follow a general trend of increased lead density and lead count.

Currently, for a large IC package, capturing the entire component in a single view frame using ordinary cameras is not able to generate the pixel resolution essential for advanced image processing work such as full dimensional extension of the component. Various partial and reduced object field techniques are used for the inspection of the IC

The device assembled in the single object field with CCD image detector beam reception module configuration can be used to view the entire package. The resulting image will generate enhanced acquired pixel resolution which is sufficient to measure the full lead extensions accurately.

To inspect the lead end for defects, the fully constructed imager comprising of front twin optical unit, image parting unit and CCD image detector beam reception unit can be used. The pair of front optical unit is directed at the rows of leads endwards or from the plan. The acquired pixel resolution is high and sufficient to detect defects such as coplanarity and lead tilts. The illustration for a fully equipped package inspection device is illustrated in FIG 6.

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Comparative Measurement devices.

Real time multiple object calibration or comparative viewing can be performed by the device. As an example, two objects may be studied for characteristic changes simultaneously, or a stable calibration tool or ruler can be placed in the second object field. The object to be studied is placed in the study partition and the measuring device or ruler is placed in a stable environment. According to the studies required, as the ambient condition at the first object field changes can be observed in real time.

Claims:

It is understood that the invention is not confined to the particular construction and arrangement described in this submission. For example, the optical elements may be constructed as magnifiers. It is also possible to construct image parting system for multiple object fields. Many variations of the invention are possible, and are embraced with the scope of the following claims:

1. The method of two or multiple object light beam acquisition and partition according to the optical technique described in this submission for two or multiple object fields to be acquired by a camera system.

2. The method of interruption of focusing beam reception, partition and direction into CCD detectors to generate very high pixel resolution from the image acquisition hardware device.

3. A method of image reconstruction and alignment display for multiple large-aspect ratio object fields.

4. A method of modular optical unit construction for device assemblies and image acquisitions.

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