

VIDEO MEASURING SYSTEM

The present invention relates to a video measuring system and, more particularly, to a fast, efficient, user-friendly video measuring system.

It is known to employ a solid state TV camera for industrial process control. For example, U.S. Patent No. 4,135,204 to Ray E. Davis, Jr. et al, which is entitled "Automatic Glass Blowing Apparatus and Method" and is assigned to the assignee of the present application, discloses the use of an analog video signal to control the growth of a thermometer end opening blister in a heated hollow glass rod by monitoring and iteratively controlling the growth of the edges of the blister using analog edge detection techniques. It is also known to employ a solid state TV camera in a video inspection system. For example, U.S. Patent No 4,344,146 to Ray E. Davis, Jr. et al, which is entitled "Video Inspection System" and is assigned to the assignee of the present application, discloses the use of such a TV camera in a high speed, real time video inspection system wherein the TV camera has at least sixteen levels of grey scale resolution.

The present invention represents an improvement over both of these prior art systems and complements the video inspection system of U.S. Patent No. 4,344,146. In addition to being user-friendly, the present invention is highly efficient because it can effectively perform measurements using only a small part of the information obtained by the system. It is extremely fast while, at the same time, being relatively inexpensive and very reliable.

In a preferred embodiment, the present invention employs a pair of solid state TV cameras, a pair of interface/memory circuits (also known as "frame grabbers"), a pair of TV monitors, a computer, a keyboard, a joystick and strobe lights. In the system are stored a series of "menus" which guide the operator in defining those features of the object which are to be measured. These menus and the manner in which they are presented render the system very user-friendly.

Initially, the operator takes a picture of an object such as a package using the TV camera. The picture is stored in memory and displayed on the monitor. The operator then uses the joystick to manipulate a cursor on the monitor and specifies those features of the object to be measured. The operator designates points where the system is to start searching for the features and also specifies intensity gradient thresholds for the features. The intensity gradient is the rate of change of light intensity at a particular point on the monitor and has both a magnitude and a direction. It may be defined as the difference in intensity between neighboring picture elements.

If the object is a package having a closure and a label, the operator defines the package, defines the closure and defines the label. In addition, the operator specifies tolerances for these measurements. All of this is done with the assistance of various menus which are presented to the operator and provide step-by-step guidance for the operation of the system.

After this information has been entered and stored, the

the system is ready to operate. A picture is now taken of each package as it moves past the TV camera, for example along a high speed fill line. The picture is stored and the system measures the package, the closure and the label for each package. The system will indicate when these features are out of tolerance or missing altogether so that corrective action can be taken.

An important advantage of the present invention is that it permits accurate measurements but does not require large amounts of data to effect the measurements. Thus, to measure an object the system starts at specific points and searches along lines of picture elements or "pixels", looking for gradients which exceed the selected thresholds. It is not necessary for the system to examine more than a small percentage of the pixels in order to measure an object or a particular feature of the object. For example, if the TV camera comprises a two dimensional array containing over 50,000 photodetectors, it is possible to measure an object by examining fewer than 400 pixels, or less than one percent of the information captured and presented on the TV monitor. Similarly, it is possible to measure a series of features using less than five percent of the pixels.

Because the video measuring system is user-friendly, and because it is highly efficient in its use of information, it is an extremely valuable industrial tool. Thus, it can be used for process control in manufacturing operations, for the quality control of both raw materials and finished goods, and to provide sensory signals for robotics.

The present invention is described with reference to the following drawings which form a part of the specification and wherein:

Fig. 1 is a functional block diagram of a preferred embodiment of the video measuring system of the present invention;

Fig. 2, 3 and 4 are line drawings illustrating ways in which the system of Fig. 1 can be used to define various features of the package shown in Fig. 1; and

Figs. 5, 6, 7 and 8 are line drawings illustrating ways in which the system of Fig. 1 can be used to measure and analyze various features of the package shown in Fig. 1.

The basic system architecture of a preferred embodiment is shown in Fig. 1. The system employs two TV cameras 10 and 12, designated "A" and "B". Connected to TV cameras 10 and 12 are two interface/memory units 16 and 18, also designated "A" and "B". Associated with TV cameras 10 and 12 is a TV monitor 14 which is connected to either interface/memory 16 or interface/memory 18, depending on the position of switch 15. TV camera 10 and interface/memory 16 form channel "A", while TV camera 12 and interface/memory 18 form channel "B". Two channels are employed because when the system is used, for example, to inspect packages on a high speed fill line, these packages frequently have both front and rear labels and it is desirable to inspect both labels.

Interface/memory units 16 and 18 are connected to computer 22 via a conventional multibus arrangement. Also connected to computer 22 are joystick 26, strobe lights 28, keyboard 23



and monitor 24. The operator uses keyboard 23 to communicate with computer 22 and uses joystick 26 to manipulate the cursor on monitor 24. Strobe lights 28 illuminate package 30, which comprises a top closure 32 and a label 34 containing the letter "V." The strobe lights are synchronized with the TV camera and the movement of package 30.

Monitor 14 and monitor 24 may, for example, be a Panasonic TR-932 dual monitor made by Matsushita Electric, Osaka, Japan. Joystick 26 may be a 91 MOB-6 joystick made by Machine Components Corp., 70 New Tower Road, Plainview, NY 11803. Strobe lights 28 may be a model 834 dual stroboscope control unit by Power Instruments, Inc., 7352 North Lawndale, Skokie, IL 60076. Keyboard 23 may be a VP-3301 keyboard data terminal made by RCA Microcomputer Marketing, New Holland Avenue, Lancaster, PA 17604. Computer 22 may be an Am 97/8605-1 8086 16 bit Monoboard Computer made by Advanced Micro Devices, 901 Thompson Place, P.O. Box 453, Sunnyvale, CA 94086. This computer is software transparent to code written for the SBC-86/05 and SBC-86.12A computers. Interface/memory units 16 and 18 may be "frame grabber" boards Model VG-120B made by Datacube, Inc., 4 Dearborn Road, Peabody, MA 01960. These units acquire a full screen of video information from any EIA-standard video source. The information is stored in an on-board memory for access by any MULTIBUS-based computer. The model VG-120B frame grabber also generates EIA-standard video from the on-board memory for a TV monitor. Finally, TV cameras 10 and 12 may be Model KP-120 solid state TV cameras made by Hitachi Denshi America, Ltd., 175 Crossways

Park West, Woodbury, NY 11797. This is a solid state black and white TV camera employing solid state imaging. It has a two-dimensional photosensor array with 320 horizontal and 244 vertical picture elements or 78,080 pixels. The frame grabbers capture information from an array by 320 by 240 photosensors or 76,800 pixels.

The system operation will now be explained with reference to a preferred embodiment of the invention using an illustrative object, in this case package 30 shown in Fig. 1. In the preferred embodiment, the invention employs a "Master Menu" from which the operator makes selections. The Master Menu includes the following operating routines.

1. Select Product
2. Teach Product
3. Measure
4. Run
5. Stop Run
6. Tally

Assuming the operator wishes to select a product and then teach that product to the system, the operator turns the power on, initiates the "Select Product" routine and enters the product number. Next the operator initiates the "Teach Product" routine, which has its own menu, and includes the following sub-routines.

1. Get Image
2. Teach Product Name
3. Define Package
4. Define Closure

5. Define Label
6. Define Feature 1
7. Define Feature 2
8. Teach Tolerances

The operator initiates the "Get Image" routine and then decides whether a continuous image or a single image is desired. A continuous image is used, for example, when the system is being set up, to adjust lighting levels. A single image is employed, for example, to capture the image of the package as it moves along a high speed fill line. Taking the image is synchronized with the physical location of the package on the fill line and the TV camera and involves the use of strobe lights 28 shown in Fig. 1. Once a satisfactory image is obtained, the operator so indicates and the image is stored in memory. The system then returns to the Teach Menu.

The operator now initiates the "Teach Product Name" routine and teaches the product name, either by selecting an existing name or by entering a new name. In the preferred embodiment up to ten product names may be stored in memory. The operator now decides whether to enable label A and/or label B. Label A may be the front label while label B may be the rear label. Enabling label A involves enabling TV camera A, interface/memory A and the associates strobe light and tells the system that label A should be taught. Enabling label B involves enabling TV camera B, interface/memory B and the associates strobe light and tells the system that label B should be taught. Once images of one or both labels are taken and stored, the system returns to the Teach Menu.

The operator now initiates the "Define Package" routine. This can more easily be understood by referring to Fig. 2, which shows package 30 drawn in outline on TV monitor 24. The first step is to designate the starting point 2A for locating the left edge of package 30. This is accomplished by using joystick 26 to move a cursor until the cursor has reached point 2A, which is then stored. It is necessary to designate a starting point to the left of the actual left package edge because, when the image of the package is obtained as the package is moving, the image will not always appear in the centre of TV monitor 24. The cursor is now moved to point 2B, which is the left edge of package 30, which is temporarily held. Next the cursor is moved to point 2C, which is the starting point for locating the right edge of package 30, which is also stored. Thereafter, the cursor is moved to point 2D, which is the right edge of package 30, which is also temporarily held. The system then stores the difference between points 2B and 2D, which is the measure of the package width. Points 2B and 2D need not be stored. In a similar manner, joystick 26 is used to locate starting points 2E and 2G for determining the left and right top package edge points 2F and 2H. Note that points 2E and 2F are spaced to the right of the left package edge, while points 2G and 2H are spaced to the left of the right package edge. This ensures that the top edge of the package can be detected even if the image of package 30 is not centered on TV monitor 24 because of less than perfect synchronization. Only points 2E and 2G need be stored.

At points 2B, 2D, 2F and 2H there exist gradients in light intensity corresponding to the transitions at the edges of the package. In addition to locating the points 2B, 2D, 2F and 2H, the operator also selects gradient thresholds for those points, e.g., by selecting a value between minus 63 and plus 63 for each point. To assist the operator in choosing an appropriate gradient threshold, the system will, on request, visually display the gradient which exists at any given point on the TV monitor. By selecting appropriate gradient thresholds for points 2B, 2D, 2F and 2H and storing them in memory, the operator ensures that the edge of the package can be accurately located.

Points 2A, 2C, 2E and 2G, together with gradient thresholds for points 2B, 2D, 2F and 2H, are stored in a package offsets table. Also stored in that package offsets table are the package width and the package elevation, which is the average of points 2F and 2H. The package elevation, which forms a horizontal reference, is also stored in a work table for later use. ~~See step 247 of the program.~~ Also stored in the work table is the package center, which is the average of points 2B and 2D, and forms a vertical reference. After these various values have been stored, the system returns to the Teach Menu.

Having completed the "Define Package" routine, the operator now initiates the "Define Closure" routine, since package 30 has a closure 32. If there were no closure, this routine would be bypassed. Referring to Fig. 3, the operator uses joystick 26 to position the cursor at point 3A, which is then stored. This is the starting point for locating the top closure. Next the

operator moves the cursor to point 3B, selects an appropriate gradient threshold (magnitude and sign), which is then stored. This process is repeated for the remaining points 3C through 3H, which together define top closure 32. Points 3A, 3C 3E and 3G are stored. The difference between points 3B and 3F and the difference between points 3D and 3H are also stored, together with the gradient thresholds for points 3B, 3D, 3F and 3H. If, as package 30 travels down a high speed fill line, top closure 32 is either misaligned or absent altogether, this defect can be readily detected by the system and appropriate corrective action taken.

In the preferred embodiment, the absolute locations of points 3A, 3C, 3E and 3G are not stored. Rather, these points are stored relative to the horizontal and vertical package references previously computed and stored in the work table. This permits the closure to be located and measured irrespective of where the image of the package appears in the picture. The relative locations of points 3A, 3C, 3E and 3G, as well as gradient thresholds for points 3B, 3D, 3F and 3H, are stored in a closure offsets table. It should be noted that points 3A, 3C and points 3E, 3G need not be located on opposite sides of the closure. All may be located below the closure. All may be located above the closure. All may be located within the closure. The system will operate properly in each case.

Now the operator initiates the "Define Label" routine. Referring to Fig. 4, package 30 and label 34 are shown on TV monitor 24. Using joystick 26, the operator positions the

cursor at point 4A, which is then stored. Next the cursor is moved to point 4B, which defines one edge of the label. An appropriate gradient threshold is now stored for point 4B. This procedure is repeated for points 4C through 4L, all of which define the label and permit the label to be located when an image of the label is obtained as the package moves along a high speed fill line. As a result of the foregoing there are now stored in the system: (1) points 4A, 4C, 4E, 4G, 4I and 4K; (2) gradient thresholds for points 4B, 4D, 4F, 4H, 4K and 4L; (3) the difference between points 4B and 4F and/or the difference between points 4D and 4H; and (4) the difference between points 4J and 4L.

The various points and gradient thresholds for the "Define Label" routine are stored in a label offsets table. As with the "Define Closure" routine, the start search points for the "Define Label" routine are stored relative to the horizontal and vertical package references. Again, this permits locating the label irrespective of the location of the package in the picture. Note also that the label need not be defined using the label. It may be defined using information appearing on the label itself. Referring to Fig. 5, the operator uses joystick 26 to position the cursor at point 5A, which is then stored. Next the operator selects the horizontal and vertical distances from point 5A, which are also stored. These distances are 5B and 5C and define an area which will be searched. The operator now determines (1) whether the search will be from right to left or from left to right and (2) whether the search will be from top to bottom or from

bottom to top. This information is also stored. In Fig. 5, for point 5A, the search pattern is from left to right and from top to bottom. Finally, the operator selects and stores a gradient threshold. A similar procedure is employed for point 5D. The search area is defined by points 5E and 5F and the search pattern is from right to left and from top to bottom. This information is stored in the feature offsets table.

In addition to defining the label, the operator may define various features of the label and, in this way, determine not only that the label has been correctly applied to the package, but that the correct label has been applied. In the present illustrative embodiment, the label contains the letter "V". Features of this letter may be defined by the operator by initiating the "Define Feature 1" and "Define Feature 2" routines of the Teach Menu.

Fig. 6 illustrates how the present invention can accurately measure distances. Joystick 26 is used to position the cursor at point 6A, which is the starting point for locating the first edge of the feature to be measured. After point 6A is stored, the cursor is moved to point 6B, at which time the operator selects and stores a gradient threshold. Point 6B is temporarily held. A similar procedure is followed for points 6C and 6D. The difference between points 6B and 6D is also stored. The system can now measure the distance between points 6B and 6D of the letter "V" of label 34 on package 30 as it speeds down a fill line. The unit of measure in the system is a "Pixel," i.e., a picture element. The system measures distance by counting the number of pixels between,

e.g., points 6B and 6D in Fig. 6.

It will be appreciated that, while the measurement of distances were illustrated in a rudimentary fashion using the letter "V", the ability to accurately measure objects or features of objects "on-the-fly" is extremely valuable and has numerous and wide-ranging applications. For example, one can use the present system to perform a 100% quality control check on the dimensions of parts, either as they are received from suppliers or as they are being used in an automated assembly operation. Also, one can use the present invention to do a 100% quality control check on the dimensions of goods as they are being manufactured and thus correct defects before the goods are shipped to customers. In addition to quality control applications, the present invention is also useful in the on-line control of manufacturing operations, for example, to measure increases or decreases in the size of features as well as increases or decreases in the distance between features.

In addition to accurately measuring distances, the present invention can also examine for line signatures. Referring to Fig. 7, the joystick is used to locate points 7A and 7B, which are the beginning and end of the line signature, and are stored. Next a gradient threshold is selected and stored. The line signature routine may be used to examine a label for positive and negative transitions which exceed the gradient thresholds. For example, positive (dark-to-light) transitions which exceed the gradient thresholds may be assigned a binary one while negative (light-to-dark)

transitions which exceed the gradient threshold may be assigned a binary zero. The result of the line signature operation is then a series of one and zeros, which may be accumulated in a shift register. This binary signature may be used, for example, to differentiate between a front label having a line signature of "1010" and a rear label having a line signature of "0101".

The present invention can also be employed to measure area gradients. Referring to Fig. 8, the center of the search area is designated by moving the cursor to point 8A, which is then stored. Next the horizontal and vertical distances from point 8a are selected and stored. These are Points 8B and 8C and define the search area. Finally, a gradient threshold is selected and stored. In determining the area gradient, the system sums and stores the number of transitions (light/dark) and/or dark/light) which occur within the area to be searched and which exceed the gradient thresholds. If, for example, the area to be searched is a solid color, then essentially no transitions should be observed. If a number of transitions are observed, this indicates that the area being searched is not a solid color and may signify that an incorrect label has been applied or that the correct label has been applied upside down.

Having completed the foregoing, the system again returns to the Teach Menu where the operator initiates the "Teach Tolerances" routine. At this point the operator selects the tolerances for labels A and/or B. To set the tolerances the operator employs the "Measure" routine in the Master Menu.

Using the joystick, the operator manipulates the cursor and designates two points, for example the points 2B and 2D in Fig. 2. The system counts the number of pixels between the two points, each pixel corresponding to, for example, 1/32 of an inch. The tolerance selected for the width of package 30 may, for example, be plus or minus two pixels. After the appropriate tolerances have been entered in the tolerance table, the system returns to the Master Menu and is now ready to run.

It should be noted that once the various values have been determined and stored in the package offsets table, the closure offsets table, the label offsets table, the feature offsets table and the tolerance table, this data may be used so long as the package does not change. Also, in the preferred embodiment, the system has the capability of storing such data for ten different packages. Thus, so long as these packages do not change, they need be taught to the system only once, even if the packages are used only infrequently.

In operation, the system captures and stores an image of the package as it speeds along the fill line. The system then searches along lines 2A-2B, 2C-2D, 2E-2F and 2G-2H until the appropriate gradient thresholds are detected so as to locate the package and measure its width (see Fig. 2). The system also determines the horizontal and vertical package references and stores them in the work table. Next the system verifies that the top closure is present and properly positioned. This is done by searching along lines 3A-3B, 3C-3D, 3E-3F and 3G-3H until the appropriate gradient

thresholds are detected (see Fig. 3). Next the system locates the label by searching along lines 4A-4B, 4C-4D, 4E-4F, 4G-4H, 4I-4J and 4K-4L until the appropriate gradient thresholds are detected (see Fig. 4). The horizontal and vertical package references are taken from the work table and combined with the data from the label offsets table and used to analyze the image of the label. The skew, label references and label width are now stored in the work table. Finally, the label is analyzed in a similar manner to see if the label contains the proper information (see Figs. 5-8). Note that in all of this searching, relatively few pixels are examined. Thus, in searching along lines 2A-2B through 4K-4L, less than about five percent and preferably less than about one percent of the pixels are actually utilized.

When it is desired for any reason to stop, the operator enters the stop run code via keyboard 23. In the interim, the system has kept a count of, e.g., the number of defective labels. These totals can be requested by the operator. If an unusually large number of defective labels has been detected, it may indicate the existence of a bad batch of labels, or it may indicate that the tolerances have been set too tight. Finally, upon request the system will display the error codes for the defects detected so that the operator knows precisely what is causing the defects.

The invention disclosed and claimed herein is not limited to the preferred embodiment shown or to the exemplary application of that embodiment to the inspection of packages on high speed fill lines since modifications will undoubtedly

occur to persons skilled in the art to whom this description is addressed. Therefore, departures may be made from the form of the present invention without departing from the principles thereof. For example, the sequence in which various steps are performed is ultimately a matter of choice. Thus, while the preferred sequence is define package, define closure, define label, define feature and define tolerances, these steps may be performed in a wide variety of sequences. Also, while it is preferred to define, for example, points 2A and 2C before choosing gradient thresholds for points 2B and 2D, that sequence may be reversed if desired without affecting system operation.



CLAIMS:

1. A video measuring system comprising:
 - (a) a TV camera for taking a picture, said camera having a two-axis array of photosensors;
 - (b) interface/memory circuitry connected to said TV camera for digitizing and storing said picture;
 - (c) a digital computer connected to said interface/memory circuitry;
 - (d) a monitor connected to said computer for displaying the stored picture;
 - (e) a keyboard connected to said computer to permit an operator to communicate with said computer;
 - (f) means connected to said computer for controlling the position of a cursor on said monitor to locate a plurality of start search points for the picture being displayed; and
 - (g) means for storing the start search points.
2. A system according to Claim 1 wherein the means for controlling the position of said cursor comprises a joystick.
3. A system according to Claims 1 or 2 further including means for selecting and storing gradient thresholds for a plurality of points for the picture on the monitor.
4. A system according to Claim 3 further including means for storing the difference between a pair of points for the picture on the monitor.
5. A video measuring system comprising:
 - (a) a TV camera for taking a picture, said



(3V)

camera having a two-axis array of photosensors;

(b) interface/memory circuitry connected to said TV camera for digitizing and storing said picture;

(c) a digital computer connected to said interface/memory circuitry;

(d) a monitor connected to said computer for displaying the stored picture;

(e) a keyboard connected to said computer to permit an operator to communicate with said computer;

(f) a joystick connected to said computer for controlling the position of a cursor on the monitor to locate a plurality of start search point for the picture on the monitor;

(g) means for storing the start search points;

(h) means for selecting and storing gradient thresholds for a plurality of points for the picture on the monitor; and

(i) means for storing the difference between a pair of points for the picture on the monitor.

6. A system according to Claim 5 further comprising means for selecting and storing a tolerance for said difference.

7. A system according to Claim 6 further comprising means for determining and storing horizontal and vertical references for the picture on the monitor and means for selecting and storing additional start points for said picture, said additional start search points being located relative to said references.



8. A video measuring method comprising the steps of:

- (a) taking picture using a TV camera having a two-axis array of photosensors;
- (b) digitizing and storing the picture;
- (c) displaying the stored picture;
- (d) locating a plurality of start search points for the picture;
- (e) storing the start search points; and
- (f) selecting and storing gradient thresholds for a plurality of points for the picture.

9. A method according to Claim 8 further including the step of storing the difference between a pair of points for the picture.

10. A method according to Claim 9 further including the step of selecting and storing a tolerance for the difference between the pair of points.

11. A method according to Claim 10 further including the steps of determining and storing references for the picture; and selecting and storing additional start search points for said picture, said additional start points being located relative to said references.

12. A method according to Claim 8 further including the step of determining and storing the line signature for a line in the picture.

13. A method according to Claim 8 further including the step of selecting and storing an area to be searched.



14. A method according to Claim 13 further including the step of selecting and storing a search direction for the search area.

15. A method according to Claim 13 further including the step of selecting and storing a gradient threshold for the search area.

16. A method according to any of Claims 8 through 15 further including the steps of presenting an operator with a series of menus from which to make selections.

17. A method according to any of Claims 8 through 15 further including the additional steps of:

(a) taking a second picture using a TV camera having a two-axis array of photosensors;

(b) digitizing and storing the second picture;
and

(c) searching the second picture commencing with the start search points previously stored.

18. A method according to Claim 17 further including the step of determining whether the gradient for the second picture exceeds the gradient thresholds.

19. A method according to Claim 17 including the further step of determining and storing references for the second picture.

20. A method according to Claim 19 wherein the search of the second picture utilizes less than about five percent of the picture elements.

21. A method according to Claim 20 wherein the search of the second picture utilizes less than about one percent of



the picture elements.

22. A method according to Claim 17 wherein the step of locating a plurality of start search points for the first picture includes the step of moving a cursor on the monitor using a joystick.

23. A video measuring method comprising the steps of:

- (a) taking a first picture using a TV camera having a two-axis array of photosensors;
- (b) digitizing and storing the first picture;
- (c) displaying the first picture;
- (d) locating and storing a plurality of start search points for the first picture;
- (e) selecting and storing gradient thresholds for a plurality of points for the first picture;
- (f) taking a second picture using a TV camera having a two-axis array of photosensors;
- (g) digitizing and storing the second picture;
- (h) searching the second picture commencing with the start search points previously stored; and
- (i) determining whether the gradient for the second picture exceeds the gradient thresholds.

24. A method according to Claim 23 further including the step of storing the difference between a pair of points for the first picture.

25. A method according to Claim 24 further including the step of selecting a tolerance for the difference between the pair of points.



26. A method according to any of Claims 23, 24 or 25 further including the steps of determining and storing horizontal and vertical references for the first picture; and selecting and storing additional start search points for said first picture, said additional start search points being located relative to said references.

27. A method according to any of Claims 23, 24 or 25 wherein the gradient threshold stored has both a sign and a magnitude.

28. A method according to Claim 27 further including the steps of determining and storing horizontal and vertical references for the first picture; selecting and storing additional start search points for said first picture, said additional start search points being located relative to said references; and determining and storing horizontal and vertical references for the second picture.

29. A method according to claim 27 wherein said first and second pictures are pictures of packages and the second picture is taken while the package is moving.

30. A method according to any of Claims 23, 24 or 25 further including the step of displaying the gradient for a point for the first picture.

31. A method according to any of Claims 23, 24 or 25 wherein less than about five percent of the picture elements of the picture are searched.

32. A method according to Claim 31 wherein less than about one percent of the picture elements of the second picture are searched.



33. A method according to any of Claims 23, 24 or 25 further including the steps of presenting an operator with a series of menus from which to make selections.

34. A method according to any of Claims 23, 24 or 25 further including the steps of determining and storing the line signature for a line in the first picture; and searching the second picture to determine whether that line signature is present.

35. A method according to Claim 34 wherein said line signature is stored as a binary number.

36. A method according to any of Claims 23, 24 or 25 further including the step of selecting and storing an area of the first picture to be searched.

37. A method according to Claim 36 further including the step of selecting and storing a search direction for the search area.

38. A method according to Claim 36 further including the step of selecting and storing a gradient threshold for the search area.

39. A method according to any of Claims 23, 24 or 25 wherein the step of designating a plurality of start search points for the first picture includes the step of moving a cursor on the monitor.

40. A method according to Claim 39 wherein the step of moving the cursor includes the step of manipulating a joystick.

41. A video measuring method comprising the steps of:

(a) taking a first picture using a TV camera having



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- a two-axis array of photosensors;
 - (b) digitizing and storing the first picture;
 - (c) displaying the first picture;
 - (d) locating a plurality of start search points for the first picture;
 - (e) storing the start search points;
 - (f) selecting a feature of the first picture to be measured by designating a pair of points;
 - (g) selecting and storing gradient thresholds for the pair of points;
 - (h) storing the difference between the pair of points;
 - (i) selecting and storing a tolerance for the difference between the pair of points;
 - (j) taking a second picture using a TV camera having a two-axis array of photosensors;
 - (k) digitizing and storing the second picture;
 - (l) searching the second picture commencing with the the stored start search points;
 - (m) determining whether the gradient for the second picture exceeds the gradient thresholds;
 - (n) measuring the selected feature; and
 - (o) determining whether or not the measured feature is within tolerance.

42. A video measuring method according to Claim 41 wherein less than one percent of the picture elements of the second picture are searched to make the measurement.

43. A method according to Claim 41 wherein the step of



locating a plurality of start search points includes the step of moving a cursor on the monitor.

44. A method according to Claim 43 wherein the step of moving the cursor on the monitor includes the step of manipulating a joystick.

45. A method according to any of Claims 41, 42 or 43 wherein the stored gradient threshold has both a magnitude and a sign.

46. A method according to any of Claims 41, 42 or 43 further including the steps of presenting a series of menus to an operator.

47. A method according to any of Claims 41, 42 or 44 further including the steps of: determining and storing horizontal and vertical references for the first picture; and selecting and storing additional start search points for said first picture, said additional start search points being located relative to said references.

48. A method according to Claim 47 further including the step of determining and storing horizontal and vertical references for the second picture.

49. A video measuring system or method substantially as hereinbefore described with reference to the accompanying drawings.
