Visual Inspection System for Bearing Balls and related Objects

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STATEMENT OF WORK AND PROBLEM ANALYSIS:

The proposed "computer vision" system prototype is to be installed on-line to inspect bearing balls for the 3 types of defects that follow:

A) "dark" defect - pit/rust
B) "light" defect - scratch
C) grey ball - unpolished

These bearings have a variety of sizes with timings through the field of view as follows:

	SIZE (in diameter)	RATE
A)	1/8 inch ball	32 per second
B)	1/4 inch ball	16 per second
C)	1/2 inch ball	8 per second
D)	3/4 inch ball	5 per second
E)	one inch ball	4 per second
F)	1 1/2 inch ball	2.66 per second
G)	2 inch ball	2 per second

SPECIFICATIONS:

The inspection system that you require must have the following capabilities to our understanding: (NOTE: We will use the 1/2 inch size ball bearing for all calculations. The assumption is that all other balls will be scanned at the same resolution, therefore the timings will be the same).

1. To inspect a number of varied sized ball that are moving underneath two 256 pixel line scan cameras.

2. The 1/2 inch ball will be moving at 8 inches per second.

3. They will make 1 complete rotation within 1/4 inch.

4. The resolution of the camera system will be 128 pixels over .25 inches or 1 pixel every .001953

inches.
NOTE: This ignores the curvature of the ball.

5. To maintain the same resolution along the axis that is perpendicular to the axis of rotation, 512 scan lines will have to be taken.

6. At 8 inches per second, the 512 scans have to be accomplished in 1/32 of a second, or .03125 seconds. The maximum time allowed per scan will be 61 micro seconds.

7. A rejection signal will be provided to activate the rejection mechanism.

IMPLEMENTATION:

Digital Image Systems Corporation proposes the building of a PC/AT bus backplane computer, using off the shelf available parts provided by Texas Microsystems, Inc (TMI). This computer would be of a "passive" backplane nature (no computational capabilities in the backplane), installed into a 14-slot enclosure (figure 1), in which the backplane will be broken up into two independent 7-slot channels. An N286-16 MHz CPU board with 1 Megabyte of on-board memory and serial/parallel communication ports will be added to each 7-slot channel. This combination with Western Digitals" hard disk/floppy disk controller, Seagate Technologies 20 Megabyte hard disk and TEAC 3 1/2 inch floppy disk as well as Goldstar Monochrome Graphics Controller, now gives us 2 identical computer systems "living" in the same physical enclosure.

The enclosure is a hardened steel chassis that is rack mountable in a 19 inch rack. The passive backplane approach is preferred by the fact that it is a more "ruggedized" environment less suspect to vibration and other stress fracture conditions. Also having one enclosure makes cabling and power requirements an easier issue for on-floor or on-line installation.

The heart of the hardware system will be the OEBSYS II Line Scan Camera interface boards. Originally designed to work with the Fairchild line scan cameras, these boards will be redesigned to work with the LC1902 sensors, specified for the application because of speed issues associated with the timings. Also the resolution requirements do not need 3456 pixel elements to make the necessary readings.

Both 7-slot channels of the computer will be equipped with the OEBSYS II controller digitizer board. One board set will be used to look for the bright errors while the second board set will be scanning for dark and grey ball errors. Because both 7-slot panels of the enclosure will behave as separate computers, the signal from the cameras will be split into the separate board systems. Either system channel may reject a ball and both will keep statistics that can be merged for off-line analysis.

The proposed camera that we would use for this application would be the E G & G Reticon LC1902-DAN011 or LC1902-DKN011. Both will be evaluated and the most acceptable will be installed on-line after the qualification process. Camera optics are not being quoted with this proposal at this time. Various optics will be evaluated in the real-world environment and the one giving the best results will be selected. It has been our experience that optics are one of the most important components in a computer vision system. However, many people take them for granted, quoting any "old lense" that fits. We feel a little differently about this issue; "garbage in" yields "garbage out". If the image quality coming into the digitizer and computer is poor, then the analysis of this imagery offers results that are suspect.