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MIDAS, the Mobile Intrusion Detection and Assessment System

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ABSTRACT

MIDAS is a semiautomated passive detection and assessment security system that can be quickly deployed to provide wide-area coverage for a mobile military asset. Designed to be mounted on top of an unguyed telescoping mast, its specially packaged set of 32 infrared sensors spin 360 degrees every two seconds. The unit produces a low resolution infrared image by sampling each sensor more than 16,000 times in a single 360-degree rotation. Drawing from image processing techniques, MIDAS detects vehicular and pedestrian intruders and produces an alarm when an intrusion is detected. Multiple intruders are tracked. MIDAS automatically directs either an assessment camera or a FLIR to one of the tracks. The alerted operator assesses the intruder and initiates a response. Once the operator assesses an intruder, the system continues to track it without generating new alarms. Because the system will track multiple targets and because the assessment system is a separate pan and tilt unit, the detection and tracking system cannot be blind-sided while the operator is assessing a diversionary intrusion.

INTRODUCTION

The MIDAS project was conceived by Sandia National Laboratories and sponsored by the Defense Nuclear Agency specifically as a security system for the small ICBM missile system. As the program has evolved, it is apparent that it will be useful for a number of applications ranging from fixed-site security of large areas to quickly deployed temporary security for low-intensity conflict encampments. Other possibilities are dock-side water security and detection of airborne threats.

The system consists of three major parts, each of which is controlled by a separate microprocessor. The first two are the detection sensor and the assessment sensor. The third major part integrates the two sensor platforms with a user interface and display called the Monitor, Control, and Display system, or the MCD. The following section describes the three MIDAS subsystems. First, the MCD is discussed. Following that is a discussion of each of the two sensor platforms. Figure 1 shows the complete MIDAS block diagram.

MIDAS DESCRIPTION

Using information provided by the detection sensor, the MCD determines that a valid intrusion has occurred. When this happens, the MCD sounds a beep, shows a flashing icon on a color situation display, and directs the assessment cameras to the location of one of the intruders. The MCD displays the flashing icon in the estimated location of the intruder (see Figure 2). The operator views the assessment camera's images on video monitors that are located close to the MCD color display. While viewing the video monitor, the operator controls the pan and tilt using a joystick.

The color display also incorporates a touch panel controlled, menu-driven, graphical user interface. Once an assessment is made, the operator touches a selection from the menu-driven touch panel interface to identify the intruder as a nuisance or a threat. Whether it is an animal, person, vehicle, or unknown cause is also selected from a menu. Once an assessment is made, it is reflected in the graphics by changing the flashing icon to a solid color. The detection sensor provides subsequent observations of the intruders to the MCD. The MCD continues tracking with no further attention from the operator.

The intrusion detection sensor is the Linear Infrared Scanning Array called LISA. LISA produces a 360-degree infrared image by sweeping its motor-driven optics table around once each 2 seconds. On flat terrain, or water, the sensor covers a circular area with a 2.2 km maximum range. The image is transmitted to the memory of LISA's controlling microprocessor. Figure 3 shows the geometry of LISA's area of coverage.

Intruders are detected using image processing techniques. Repeatable image registration is important to the success of this approach. The spinning LISA sensor unit is stabilized about all three rotation axes using torque motors, tilt meters, resolvers, and rate gyros in an analog servo loop. Timing and multiplexing is synchronized to table position using an optical incremental encoder and an index pulse. This system has proved stable in winds above 50 mph.

For assessment, MIDAS normally uses the DNA/Sandia developed VISDTA (Video Imaging System for Detection, Tracking, and Assessment). A typical assessment suite includes an infrared imager, a low light level TV camera, and an eye-safe laser range finder. Video monitors located with the MCD console show the scene. The MIDAS operator has full control of the VISDTA functions on the MCD touch screen. The operator can use the VISDTA laser range finder to determine distance, or as proposed for future work, to prestore range data for each part of the coverage area.

VISDTA pan and tilt can be controlled in two ways. The operator may choose to control the pan and tilt unit using a joystick, or the MCD can control VISDTA when an intrusion is detected. While the operator controls the assessment suite to observe the intruder, the LISA sensor continues scanning the detection area to look for other intruders. Thus, the detection sensor and the assessment devices operate fairly independently. In this way, the detection system cannot be delayed or blind-sided by diversionary tactics, and the assessment system will not be interrupted by sharing the detection responsibility. Figure 4 shows a block diagram of VISDTA.

VISDTA also serves as a backup to the LISA sensor. When used alone, or in a back-up mode in the MIDAS system, it can be used to scan a preset pattern of 135 positions to cover 360 degrees in about 3 minutes at 2.7 degrees per position. Commercial hardware is used to detect differences in the images and provide visual and audible cues to the operator. In a second, single scene detect mode, the image processor can be used to detect motion after a few seconds in any single fixed-camera position.

Two physically separate sensor platforms were envisioned for the proposed mobile missile security application. As shown in Figure 3, one hydraulic mast supports the intrusion detection sensor, and the second mast supports the assessment sensor suite. Work has started on colocating the two sensors on the same mast.

AUTOMATIC INITIAL TARGET ASSESSMENT

The use of target blob size limits and aspect ratio are under consideration for an automatic initial target assessment. A preliminary assessment of intruder as a man, small animal, or a vehicle would provide information for alarm priorities. Greater threats may be more likely to receive the first attention if the alarm priorities were queued for the operator. The option to override the initial target assessment as well as the option to override the order of assessment for multiple targets would still be available to the operator.

OTHER MIDAS APPLICATIONS

The MIDAS concept can obviously be applied to fixed-site as well as mobile applications over both flat terrain and water and can detect slow airborne threats such as parachutists, hang gliders, ultralites, and helicopters with an appropriate change in vertical scan angle. A second phase of the MIDAS program has been proposed in which the equipment would be greatly miniaturized so that the LISA area sensor could be integrated with point sensors and trip wires for small force security.

With this flexibility in application, the MIDAS concept has been considered for the Army Underground Storage Facility, Sierra Army Depot, military mobile assets, dual capability aircraft dispersal, low-intensity conflict, remote airstrip security, swimmer, as well as small craft detection for dock-side security, airborne threats at DOE weapon storage sites, and finally, protestor intrusion detection at the Nevada Test Site.

OPERATIONAL OBSERVATIONS

In development tests so far, we have observed that vehicle and personnel detection and tracking is straightforward from dusk to several hours after daybreak and under cloudy conditions, or with a live grass, low brush, or water background. Our experience in Albuquerque so far has been mostly with a dry desert background where sun heating and random thermal cooling events become significant, resulting in degraded detection. In other climes, rain and high humidity can cause a loss of contrast, especially at the longer ranges.

To meet the challenge of high thermal background activity during the day, or low contrast targets in rain or fog, there will be additional development of the algorithms using image processing.

CONCLUSION

The MIDAS system brings advantages to a number of security applications. While providing large area coverage, it is quickly deployable. It allows simultaneous, independent assessment of intruders and detection. The choice of infrared sensors produces a low signature thus allowing surveillance of an area with a low probability of being discovered when that is desirable. The work is approaching the end of the development cycle, and promising results have been achieved at the prototype stage.

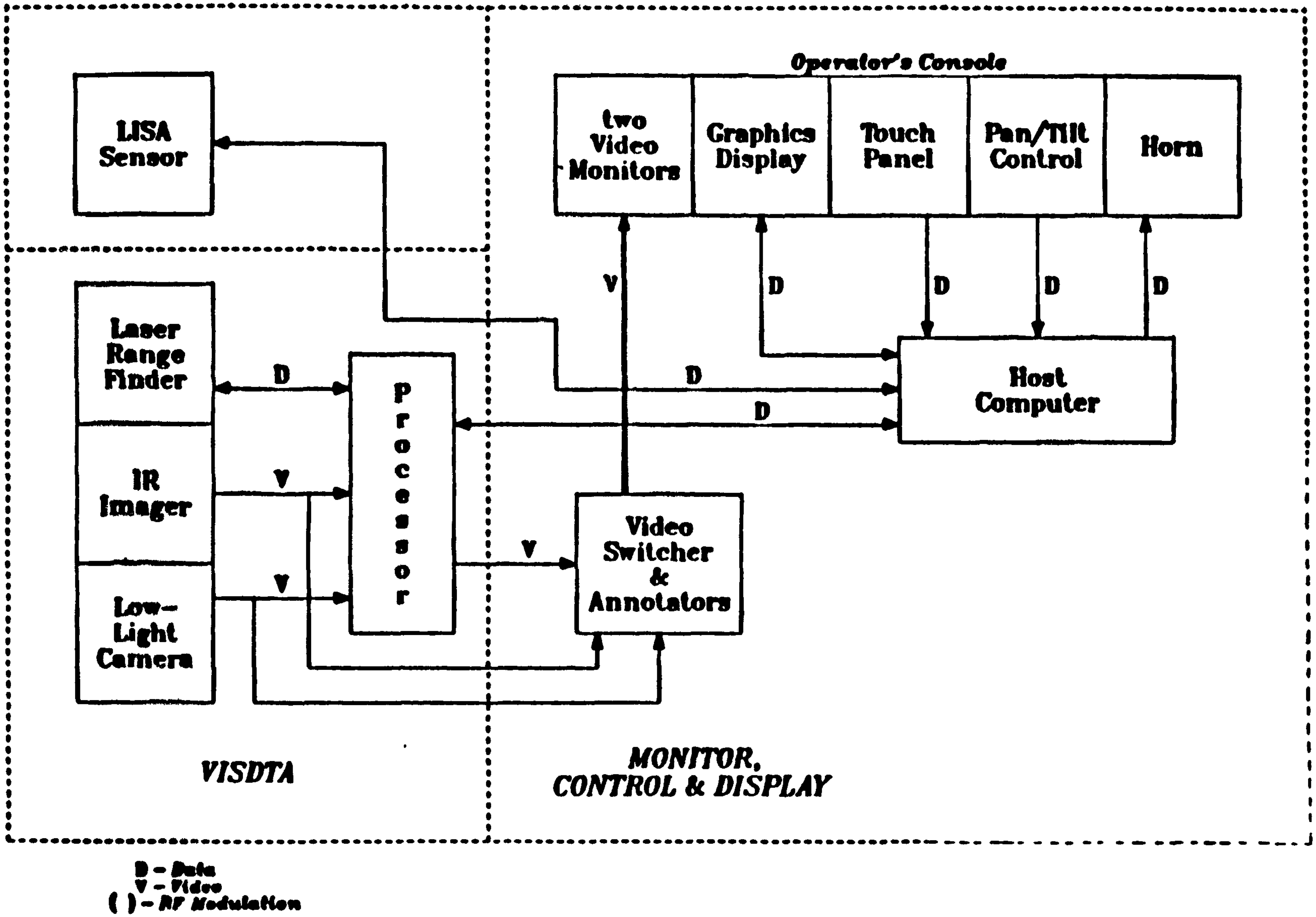

FIGURE 1. MIDAS BLOCK DIAGRAM

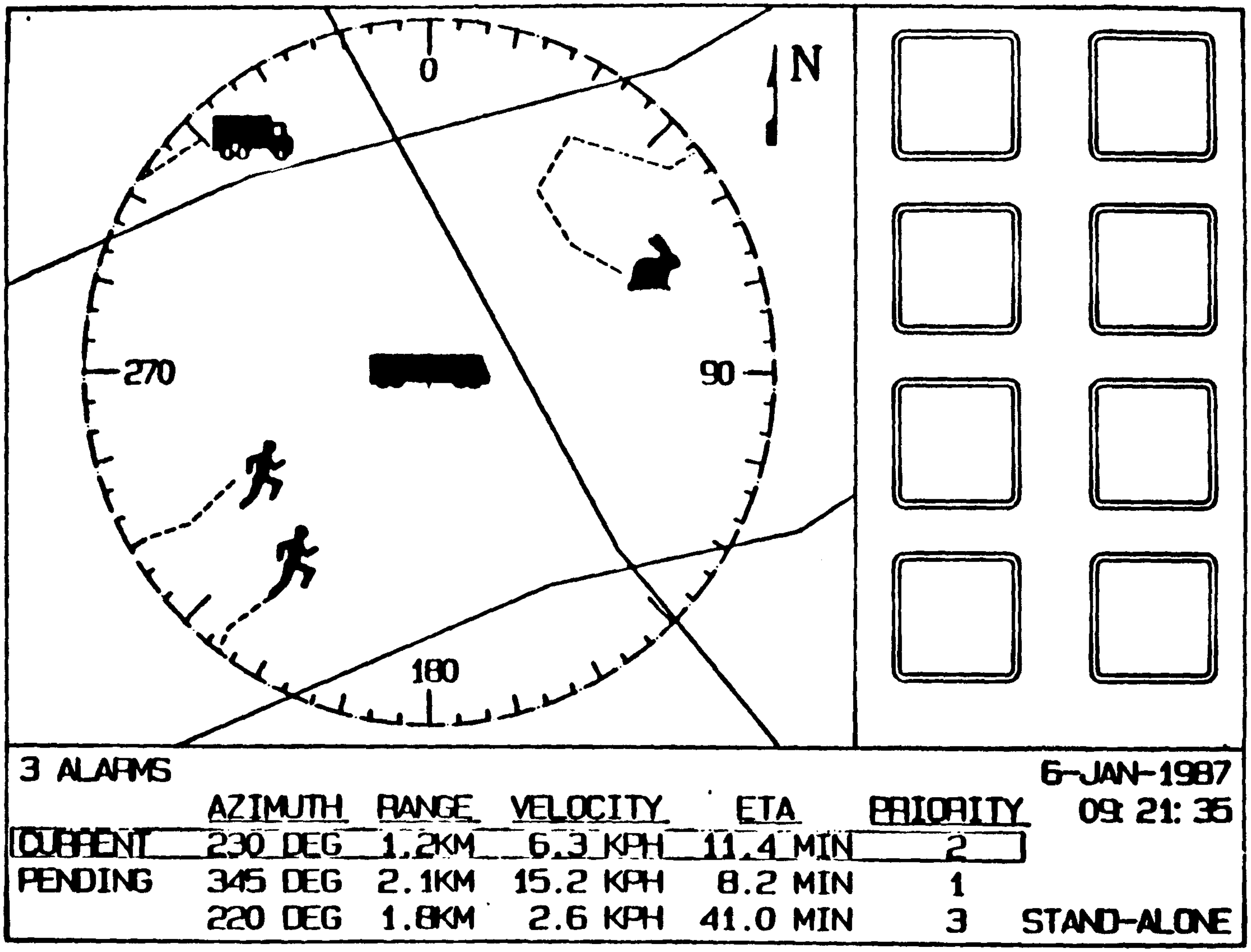

FIGURE 2. SITUATION DISPLAY

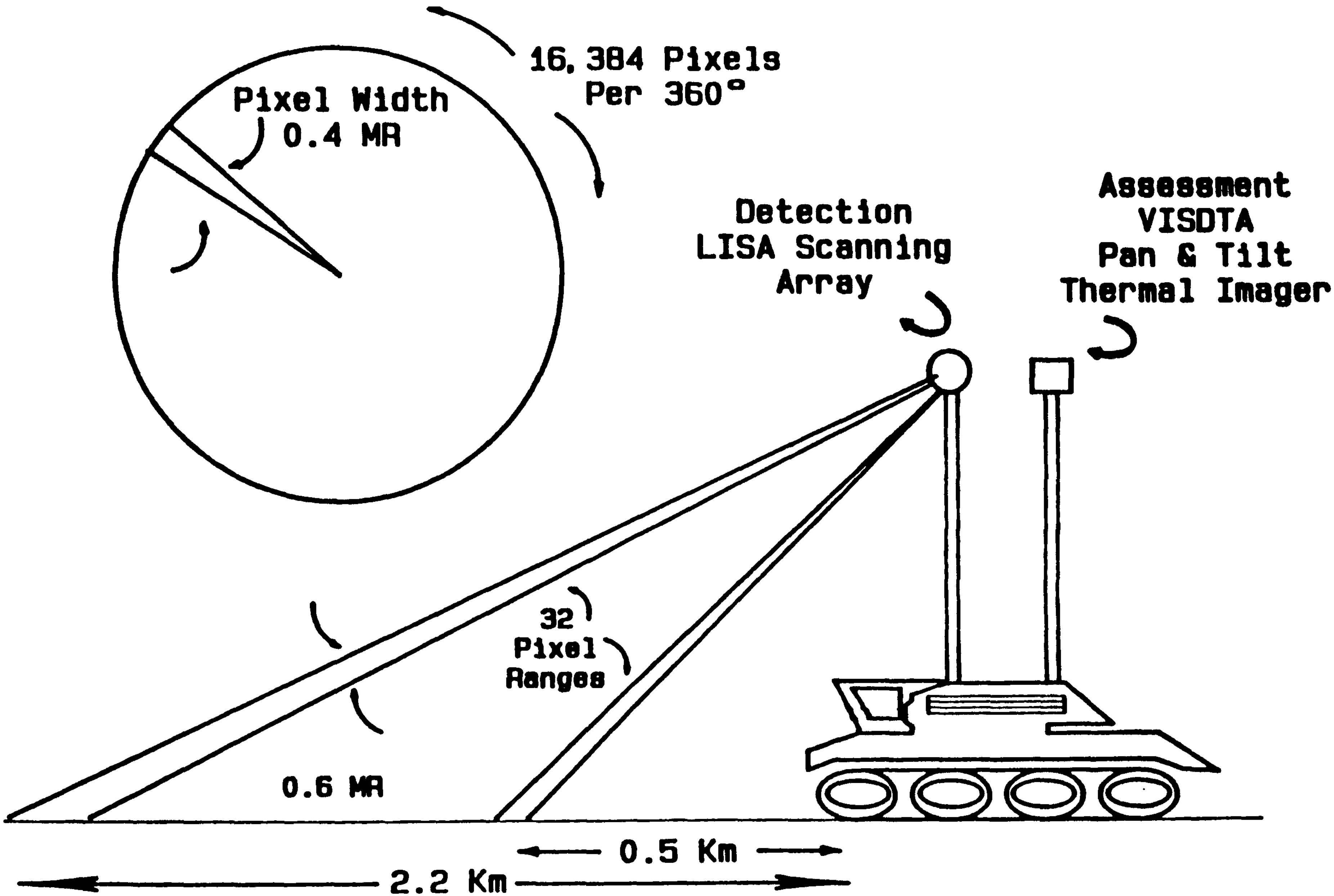

FIGURE 3. MIDAS GEOMETRY

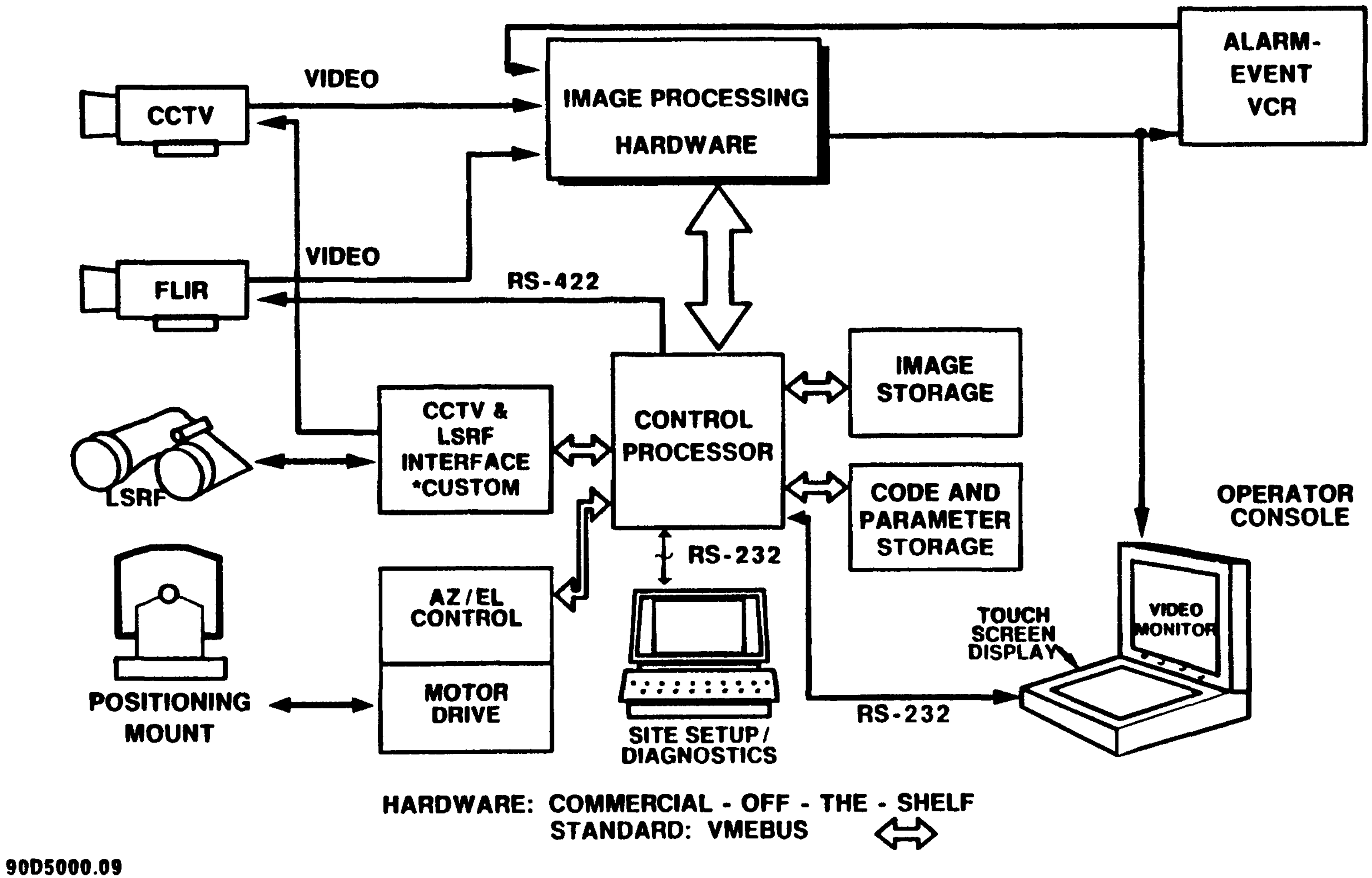

FIGURE 4. VISDTA BLOCK DIAGRAM.