Infrared Technology for Target Detection & Classification

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P. M. Narendra
Chairman/Editor

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INFRARED TECHNOLOGY FOR TARGET DETECTION AND CLASSIFICATION

Volume 302

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INFRARED TECHNOLOGY FOR TARGET DETECTION AND CLASSIFICATION

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INTRODUCTION

Autonomous detection and classification of targets from infrared sensors has entered an era of explosive growth. This is due, in part, to the widespread acceptance of infrared sensors in a number of target acquisition systems such as attack helicopters, fighters, remotely piloted vehicles, shipboard systems, etc. Autonomous detection and recognition capability in these systems offers considerable system advantages—enhancing the reaction time, system effectiveness, reduced exposure, etc. Further, smart munitions cannot function without autonomous detection and recognition capability.

After more than a decade of development of algorithms in laboratory simulations, we are now fielding prototype hardware to evaluate their real time performance. The papers in these proceedings reflect this maturity of the field. The session on modeling attempts to systematize infrared target signatures. Algorithms for detection of targets in several environments are presented in Session 2. Session 4 extends detection to include classification into several different classes of targets including armored vehicles, ships and aircraft. Session 5 reports recent advances in target tracking which have been spawned by the development of target detection and classification algorithms and real time hardware.

I dedicate these Proceedings to the memory of Dr. Erica Rounds who, as chairperson till her untimely demise in June 1981, conceived the program, and the individual sessions and recruited the co-chairmen. I would like to extend my sincere appreciation to these co-chairmen—Dr. Lewis Pinson and Dr. Ernie Hall.

P. M. Narendra
Honeywell Systems and Research Center

INFRARED TECHNOLOGY FOR TARGET DETECTION AND CLASSIFICATION

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INFRARED TECHNOLOGY FOR TARGET DETECTION AND CLASSIFICATION

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SESSION 1

MODELING

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Infrared target array development

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Abstract

A "life size" thermal target array has been developed to facilitate in-flight testing of airborne weapon systems containing night vision subsystems. This in-flight testing to measure the performance of the night vision subsystem and its effect on overall weapon system performance is essential to the test and evaluation process of the particular weapon under test. This measurement of subsystem performance is called the Modulation Transfer Function, or MTF. In addition, a laser designator subsystem is frequently incorporated in a precision guided munition weapon system. In the test and evaluation of the designator, such quantities as beam quality (energy distribution), beam divergence, and beam wander are of interest. The thermal targets may be used to evaluate armored weapon systems. The capability of providing carefully controlled and variable thermal signatures in a field test environment is considered unique. The thermal target array consists of three targets: A six bar recognition target, a two bar detection target, and a laser designator scoring board (cross-hair). The image dimensions of 2.3 meters by 2.3 meters were derived from an optimized threat envelope. The thermal signatures of the targets are controllable to within 0.3°C about a differential setpoint. This differential setpoint is measured between the active element and the target background (or "ambient"). Several differential temperature settings are available to the test officer: 1.25°C, 3°C, 5°C, 7.5°C, and 10°C. This paper reviews the thermal array test objectives, target array fabrication, methodology of target utilization, and representative results.

Introduction

The Target Acquistion Designation System/Pilot Night Vision System (TADS/PNVS) for the YAH-64, Advanced Attack Helicopter (AAH) was scheduled for testing at the U.S. Army Yuma Proving Ground in 1980. It was considered desirable to use specially designed thermal targets for this test rather than relying on natural targets only.

Because such targets have general applicability to infrared (IR) night vision sensors, YPG developed the special targets with the help of the U.S. Army Night Vision and Electro-Optics Lab (NV & EOL), Fort Belvoir, VA, and the TVI Corporation of Kensington, MD. The targets were successfully applied during testing of the TADS/PNVS from January to March 1980, at YPG.

This paper describes the development of these targets.

Test objectives

Performance parameters

Three basic considerations in target design are size, realism, and repeatability of testing.

These targets were chosen to have an active size of approximately 8x8 feet or essentially "life-size". This allows the system under test to be operated at realistic ranges, times of approach, and not least, in an actual operating vehicle with all the attendant noise, vibration, and inherent distractions.

Although it may seem intrinsically better to have the target look like a "tank", "truck" or whatever, this actually leads to poor repeatablility in testing because it tests operator training as much as the system. A reasonable alternative with good repeatability and simple design has been shown to be the use of "resolution bar targets". Based on studies of object identification, it was determined that a 2-Bar target would serve for detection (i.e. there is an object) and that resolution of a 6-Bar target would indicate recognition (there is a tank).[1]

Another major item of importance in targets is image contrast. In thermal targets, this is equivalent to temperature differential. This differential was chosen to range between 1.25°C and 10°C above ambient in roughly 5 equal steps.

Basic methodology

The basic methodology was to have heated panels surrounded by an unheated background. The temperature difference was to be referenced to the non-heated surroundings. A goal was to control this temperature difference to within Ø.2°C of the desired difference.

To meet the requirements for control and uniformity, the panels were heated by direct resistance electric heat and controlled electronically.

The targets were designed to be portable and capable of being oriented both vertically and horizontally.

Design of the Thermal Bar Targets

System description[2]

The Thermal Bar Target system consists of a series of three separate controllable thermal signature targets for field test applications:

a. The Recognition Target (Figure 1) is composed of six heated bars, each of which is approximately Ø.19 meters wide by 2.3 meters long. Each bar is separated by a background of the same dimensions. The pattern is centered in a board of approximately 2.7 meters by 2.7 meters.

b. The Detection Target (Figure 2) is composed of two heated bars, each of which is approximately 1.15 meters wide by 2.3 meters long. The bars are separated by a background of the same dimensions as one of the bars. The pattern is centered in a board of approximately 5.75 meters by 5.75 meters.

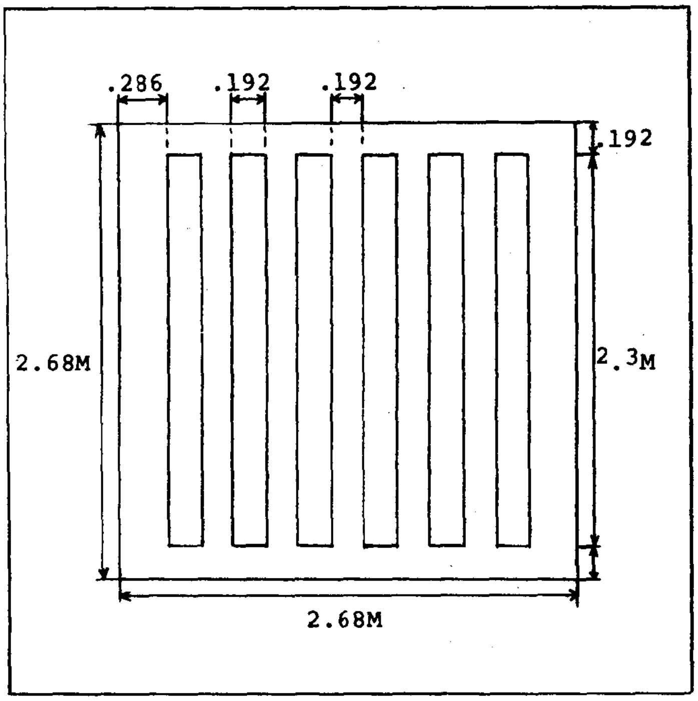
c. The Laser Scoring Board (Aimpoint Cross 'cross-hair') (Figure 3) is composed of four heated squares, each of which is approximately one meter by one meter, separated by an approximately Ø.2 meter wide field so as to form a cross when positioned upon a background.

The Targets are composed of a basic heater module mounted on a basic frame within a background, a control unit, and a power unit. The interface and operation of each system is quite similar.

The Recognition (6-Bar) and Detection (2-Bar) targets use the same configuration of heater modules which includes twelve individual heater panel elements. A thermistor is bonded to each heater panel element and the composite module is terminated to a single connector. The heater panel modules for the 6-Bar and the 2-Bar targets are mechanically and electrically interchangeable. The panel modules for the Aimpoint Cross are also composed of twelve individual panels and thermistors and they are electrically compatible with the other modules. However, the mechanical configuration is unique to the Aimpoint Cross. A control unit houses the controller cards and master controller card for each system. The controller card includes twelve temperature controllers and controls one heater panel module. A master card establishes the ambient reference, average ambient control signals, and set point control circuitry. Also included in the control unit is a set point selector switch. The configuration of the master card is unique to each target while the controller cards are interchangeable for all the targets. A control unit requires the master card and one controller card for each heater module (twelve panel elements). The 6-Bar target has six controllers while 2-Bar and Aimpoint Cross each have twelve.

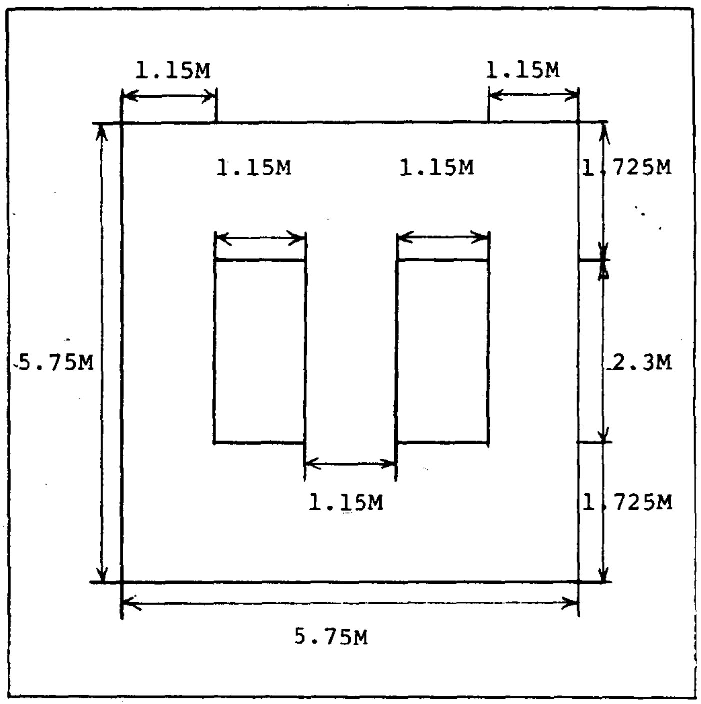
Each system has a separate power unit which includes DC power supplies for heater current and a separate supply for the controller output state base drive. Each system has a single thermistor located on the structure to establish the ambient temperature reference point. Additional thermistors are located on the structure adjacent to each heated area of the target to establish an ambient reference for control. Four thermistors surround each active area for each target.

Structurally, the overall width of the 6-Bar Recognition target is 2.68 meters with a height of 2.68 meters. The 2-Bar Detection target incorporates a width and height of 5.75 meters respectively. The Laser Scoring Board, provided as a 3.3 meter by 3.3 meter insert, was mounted against a standard 2Ø foot square plywood-faced range target. As delivered, the stand-alone recognition and detection targets provided a wooden structure, balanced on support struts, secured via tow lines connected to trailer tie downs to provide structural integrity against wind loading. The structural frame provides a series of points to which the actual target backing is secured. Wind loads are thereby transferred to the frame for both front and rear loads. Frontal wind loads are transferred to the frame by applying a compressive load to the target backing material and the thermal panels themselves. Winds against the rear surface apply an undesirable tensile load to the panels and backing materiel.



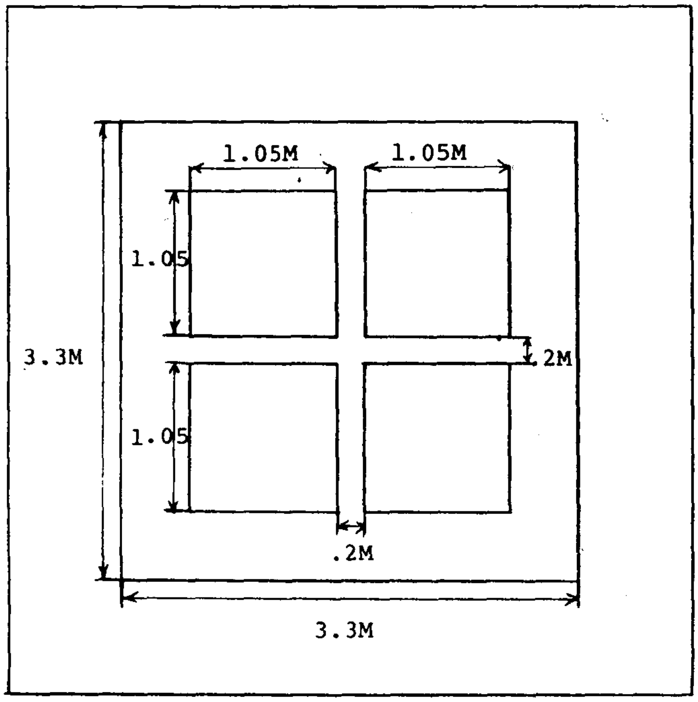
Recognition (6-Bar) Target

Figure 1



Detection (2-Bar) Target

Figure 2



Laser Scoring Board (Aimpoint Cross)

Figure 3

The thermal signature is generated by applying a DC potential difference across a proprietary conductive film, ENERGY KOTE (Reg. Trademark), deposited on an insulative backing material. Individual heater elements are constructed for the Detection and Recognition targets Ø.19 meter by Ø.19 meter with a bus bar along each opposing side and a thermistor bonded to the geometric center of the square element to measure the absolute temperature of the element. The Laser Scoring Board utilizes a Ø.17 meter by Ø.17 meter element. Each module of the 6-Bar and 2-Bar targets is constructed of panels of twelve by one elements. Aimpoint Cross modules are constructed of panels of six by two elements. The modules are thermally insulated from the background.

The background provides the definition of system "ambient". This background is thermally coupled to the basic structure and is decoupled from the heating film. The thermal mass of the structure is such that although gradients will exist, significant temperature changes are not readily effected in the structure because temperature excursions are integrated over the "ambient" area. Multiple temperatures are sensed on the background and an average background temperature immediately adjacent to the control surface involved is defined as ambient. The individual elements are controlled against that ambient.

Because the heating film deposition is insulated from ambient to control heat loss, a variable rate in thermal control exists. The heat up time of the target is quite short because the film is of a low thermal mass and is decoupled thermally by an air gap. No active cooling is provided and, therefore, the heat loss must be through the insulation and surface of the elements.

Each panel module controls to a temperature established above the average ambient. Therefore, the panels are at approximately the same temperature. This may not be the case for the background plate as gradients may exist over the surface. A given panel element may therefore be at a differential temperature other than a selected value above the background plate immediately adjacent to it, but it controls to the average plate temperature. The selection of the transducer locations on the integrating background plate and the number of transducers greatly influences the quantitative measurement of the "average ambient". As the plate average changes, the controllers, and hence the heaters track that change. The heaters are non-synchronous, and will cycle on and off as their individual sensors and controllers dictate. The rate and reset control, inherent in the design, will smooth temperatures because of the asynchronous operation and the differences in thermal paths due to construction and material differences. Because the panel element only applies heat, cool-down control is determined by the response time of the structure, by the background plate, and by the insulation scheme used in the heater panels.

Table 1--Set Points Selected for the Thermal Target System

Set Point	Ø	1	2	3	4	5
Temperature °C Differential	Off	1.25	3.Ø	5.Ø	7.5	1Ø.Ø

Theory of operations[2]

A set point (Table 1) is selected by the selector switch which establishes a reference voltage to the summing network in the controllers. The set point voltage is varied as a function of the actual ambient temperature through a feedback amplifier to compensate for the nonlinearity in the thermistors. Four thermistors are connected in parallel to obtain an average of the temperature adjacent to the panel and this signal is similarly applied to the summing network. A trim resistor potentiometer adjusts the summing network for variations in the sensing thermistor. The resultant output of the summing junction provides a reference to the control amplifier. A thermistor mounted on the heater panel element provides the other input to the amplifier. When the panel temperature is below the reference temperature, the input voltage will be above the reference and hence saturate the amplifier, turning on the heater via the output transistor. Once the panel temperature stabilizes, the voltage across the thermistor is reduced, shutting off the control transistor.

The heater panel modules are configured to be interchangeable for the 6-Bar Recognition and 2-Bar Detection targets. Each module is composed of twelve discrete heater panel elements composing a bar approximately Ø.19 meters by 2.3 meters. Each panel element is monitored by a thermistor for control. The bar assemblies are harnessed to a connector which mates with the connector located on the control unit. Any heater module can interconnect with any controller connector on the control unit and similarly any controller can control any heater panel. For the Laser Scoring Board, the basic heater module is composed of twelve heater panel elements arranged to provide a module of approximately Ø.33 meters by one meter.

Formed metal pans provide the structure and "ambient" background for the overall target. Because the active heated area is controlled against the "average ambient temperature" immediately adjacent to the control surface, selected background panels are instrumented with thermistors. This instrumentation is different for each target because the active area configurations differ. For the Recognition target, the background adjacent to each of the six active modules is instrumented. The end pans have two thermistors while those pans between active modules have four thermistors. The thermistors are grouped in fours to measure the temperature adjacent to the active area. The thermistors for each pan are terminated to a Winchester Connector and connected via a harness from those connectors to the thermistor input connector located on the control unit. A single thermistor is located on a pan to measure the actual temperature of the environment and it is also included in this harness. For the 2-Bar Detection target, the active areas are a grouping of six heater modules that form two active bars. The background thermistors are configured to measure those two areas. Thus, four thermistors surround each area.

The Laser Scoring Board has four active areas each of which is surrounded by four thermistors.

The control units house the control electronics and provide an interface junction box for the heater panels and thermistor harnessing. Each control unit contains a printed circuit board card frame to contain the controller cards and a master card. The card frame is wired to the interface connectors for the panels and also to a test connector for each panel. The test connector provides a test point for each thermistor which is located on the heater panel elements and it will provide a point to measure the voltage which appears at the control amplifier. By monitoring this voltage, the panel temperature can be obtained and also a determination of temperature control can be established. The wiring for all controller cards and test connectors is identical for all three targets in the system, with the only difference being that 6-Bar employs six controllers, six panel interface connectors, and six test connectors; while 2-Bar and Aimpoint Cross use twelve controllers, twelve interface connectors, and twelve test connectors.

The master cards are unique to each system. The number of average temperatures for each target differs and, therefore, the number of amplifiers used is different. Also, trim adjustment to the ambient reference amplifiers may vary from master card to master card. An average ambient for each controlled module is fed to the controller card summing junction. The ambient signal is associated with the panel under control. In the case of 6-Bar target, each of the six controllers has a separate ambient from the master card. For 2-Bar, which controls only two areas, only two references are provided and the controller inputs are bussed in groups of six each. For the Aimpoint Cross, four active areas are required, thus four reference inputs are used while the controller inputs are bussed in groups of three. Each target system includes a separate power unit which houses the DC power supplies for heater power and transistor drive. One power supply in each unit is designated as a 10 V power supply and it provides the base current drive for the controller output transistors and is the supply for the operational amplifiers. The power supplies designated as +28 V provide the actual heater power. The configuration of 6-Bar power unit is slightly different from that of 2-Bar or Aimpoint Cross. Two +28 V supplies are used with 6-Bar and are bussed separately to groups of three bars. The 2-Bar and Aimpoint Cross employ three +28 V power supplies, each of which is bussed to four bars. A single cable interconnects the power unit and the control unit. The main power ON/OFF switch and fusing are in the power unit.

Utilization of targets

Detection/Recognition Tests

The detection and recognition targets were placed 3 km apart at the far end of a straight predetermined flight path. As the aircraft flew along the flight path towards the targets, the observer would indicate verbally "detection" when he could resove the 2-Bar target and "recognition" when he could resolve the 6-bar target. Upon these indications, the tracking system tape was annotated to indicate the precise time and place of the event.

Laser Scoring Board (Aimpoint Cross)

The Aimpoint Cross was used in tests of laser designator systems. A near infrared vidicon was used to detect the laser pulses striking the target. A notch filter of 100 Angstroms was use to sharpen the test data about the wavelength of interest. Local video instrumentation was set up to display and record the data. This recorded data was then processed for time base correction and loaded onto a video disc in 10 second increments.

General Considerations

In all cases, the power source (generator) was shielded from view. This was done to preclude extra cues being available to the test operator.

Results

Thermal Signatures

The design requirement of $\pm 0.2^{\circ}C$ about a setpoint from $1.25^{\circ}C$ to $10^{\circ}C$ above ambient was generally not met.

Table 2 below describes the desired setpoint, Delta-t, the measured Delta-t, and the deviation from the desired setpoint for the 2-bar detection target. A similar table 3 describes the desired versus measured data for the laser scoring board.

DESIRED Delta-t	AVERAGE Delta-t	C FROM SETPOINT
1.25	1.59	+.34
3.0	2.98	-.02
5.0	4.57	-.43
7.5	6.88	-.62
10.0	7.30	-2.70

2-Bar Target

Table 2

DESIRED Delta-t	AVERAGE Delta-t	C FROM SETPOINT
1.25	1.31	+.06
3.0	2.63	-.37
5.0	4.53	-.47
7.5	6.46	-1.04
10.0	7.32	-2.68

Laser Scoring Board

Table 3

The signatures of the 2-bar detection target and the laser scoring board were measured at the Night Vision & Electro-Optic Laboratory using their Texas Instruments Thermoscope. The Thermoscope was calibrated immediately before measurement. Output was digitized and recorded on magnetic tape and later analyzed using their interactive Image Manipulation Facility.

Mechanical Problems

The main problems with using the arrays could be attributed to lack of ruggedness. The panels are both large and exposed and therefore subjected to considerable wind loads. The systems had to be braced even against the comparatively moderate winds occuring in Southwestern Arizona. The electronics were also somewhat exposed. Target flexure due to wind loading caused trouble because of strain on connections.

A desired condition in testing involving human perception is the ablility to move/change the targets to preclude "learning" by the subject. The targets were designed to be setup either vertically or horizontally; however, the times involved were excessive (4 hours for 6-bar and 1-1/2 days for 2-bar target) and thus precluded this feature from actually being used.

Conclusions

The Infrared Target Array has more than proven its usefulness as a test tool. In spite of the limitations previously indicated, the system targets are in constant demand. Subsequently, more rugged versions of these targets will be used with increased frequency to verify ideas/systems in the rigors of the "real" world, where operation in noise, dust, and distraction may prove to be a better judge of use than laboratory precision.

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Model for generating synthetic three-dimensional (3D) images of small vehicles

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Abstract

This paper describes a computer model for generating 3-D images of small vehicles. The paper shows examples and gives throughput, memory, and accuracy for implementation on a VAX computer. Each vehicle is described in terms of components such as wheels, chassis, and turret. The model decomposes these components into three-point facets which are the basis for generating an image. Each point of a facet can be assigned a specific temperature, emissivity, and reflectivity. Range contour imagery from the model is useful in developing identification and classification algorithms for laser radars.

Introduction

Image-generation models can provide data for (1) complimenting actual sensor imagery by interpolating between snapshots, (2) predicting imagery when no imagery is available, (3) doing studies of image-processing functions such as target recognition, and (4) exercising target detection/recognition/tracking algorithms.

Many excellent image-generation programs exist in industry. Among these are the model used by Grumman on the IRMA program and the models used by the military to study target vulnerability.[1] It is not the intent of this paper to define a new technique. Instead, this paper presents some of the experience gained in implementing one of the simpler of the image-generation methods. This experience may be of use by analysts who need to develop similar programs that can be adapted to their specific applications, such as terminal guidance and target recognition.

The remainder of this paper discusses vehicle description, the model, an algorithm for converting from vehicle description to an image, and memory and throughput requirements.

Vehicle description

The vehicle needs to be described in a format that can be accepted by the computer. Any one of many methods can be used. Three descriptions of varying complexity have been chosen: high order, medium order, and low order. The term "order" is used in a manner similar to that used in describing computer programs. A low-order description is a description in which the user does most of the work of defining the vehicle. It is analogous to machine language programming. A high-order description is one in which the computer does most of the definition. It is analogous to a higher-order programming language such as Pascal or Fortran.

Low-order vehicle description

The low-order description defines the target as a collection of triangular flat plates called "facets." Each facet is uniquely defined by a set of three points which define the vertices of the triangle. Points are ordered so that an observer walking around the facet in the order given by the points moves in a counterclockwise direction; that is, the facet is on the observer's left. Each facet is given a unique label.

Each point is defined by its location in a three-dimensional (3-D), rectangular coordinate system. The coordinate system has x and y horizontal and z vertical coordinates. The x-axis projects from the right side, the y-axis projects from the front, and the z-axis is positive upward. Each point has a unique identification number. Each point may have parameters associated with it such as temperature, emissivity, color, roughness, and reflectivity.

A vehicle element is a contiguous set of facets over which the parameters (temperature, reflectivity, etc.) vary smoothly. The choice of what can be called an element is arbitrary. Examples are tires, road wheels, vehicle bodies, turrets, antennas, and treads. Each element has additional data to define its position and orientation relative to the remainder of the target. These data include pitch, roll, and azimuth plus translation distances. It is important to note that pitch, roll, and azimuth axes might not intersect. Elements are important in saving computer memory since they allow sharing points used in defining facets.

Since each facet and each point must have a unique label, the model allows the user to number points and facets uniquely within a given element. The program then resolves the numbering for the overall vehicle. For example, one element may have points 1, 2, 3, and 4 and a second element may have points numbered 1, 2, 3, and 4. The model accepts both elements as inputs and renumbers the points of the second element to be 5, 6, 7, and 8.

The model allows the user to input an element as a set of points and facets and then permits the user to translate, rotate, and make mirror images of this element to produce other elements without entering more points and facets.

A typical target may contain over a thousand points and facets. Keeping track of all the points and facets is tedious. For this reason, a medium-order description is useful.

Medium-order vehicle description

The medium-order description simplifies defining the vehicle. Everything that is true about the low-order description is true about the medium-order description except that it is not necessary for the user to keep track of facets. The medium-order description allows the user to describe an element as a rectangular array of points and the model generates facets from this array.

The array is rectangular but the spacing between array points does not need to be uniform in any direction. An analogy may be made between the array and a net. The netting forms an array of intersections. If the netting is stretched, the intersections will not be a uniform distance apart. Describing an element by using an array of points can be thought of as draping a piece of netting around the element and defining a point everywhere an intersection of the net touches the element (Figure 1).

The array is defined assuming the net is stretched around the element in a counterclockwise direction. The points start at the bottom of the first column and go to the top of the first column. Then the points in the second column are entered beginning at the bottom and going to the top. Points are entered column by column, bottom to top until all columns have been accounted for. Thus, an array of n rows by m columns contains $n \times m$ points but defines $2(n-1)(m-1)$ facets.

The model allows the user four options in defining the array. First, the user can require that the array close on itself so that the points on the last column join with the points on the first column. An analogy would be to wrap a piece of net around a box until the net touches itself. Second, the user can request that the array have a bottom. Third, the user can request that the array have a top. Fourth, the user can request that the model make either one or both sides of a facet visible.

An element with a bottom uses the points on the bottom row to define a flat bottom for the box. Similarly, points on the top row of the array can be used to define a flat top for the box.

Occasionally, the top or bottom must have a point to make it convex or concave. If the bottom is to have this extra point, it must be added in addition to the points in the array. The same is true if the top is to be other than flat. Thus an $(n \times m + 2)$ array of points plus three control parameters can be used to specify a complex solid volume with a nonflat bottom and nonflat top. Figure 1 illustrates this technique.

High-order vehicle description

The medium-order description is much easier to use than the low-order description. It is possible to go a step upward to a high-order description language. Vehicle elements can be specified in more descriptive terms such as tires and chassis. However, high-order description is awkward for assigning parameters (e.g., temperature, reflectivity) to the facet points.

Model description

Figure 2 is a block diagram that describes the inputs, functions, and outputs of the model.

The inputs are a vehicle description, sensor parameters and viewer geometry, choice of desired image type, and choice of image corruption mechanism.

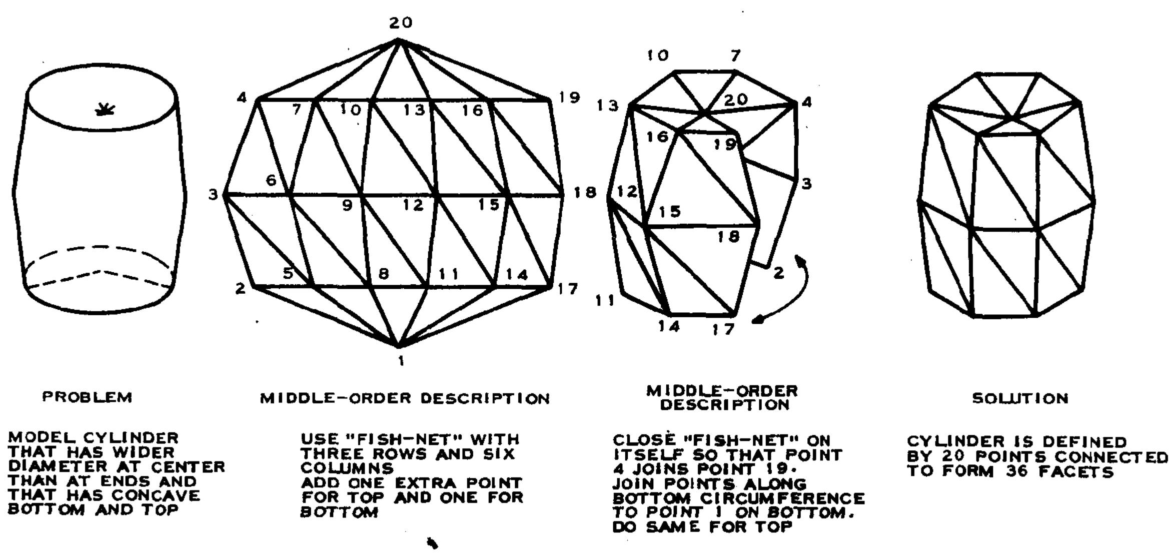

Figure 1. Example Description.

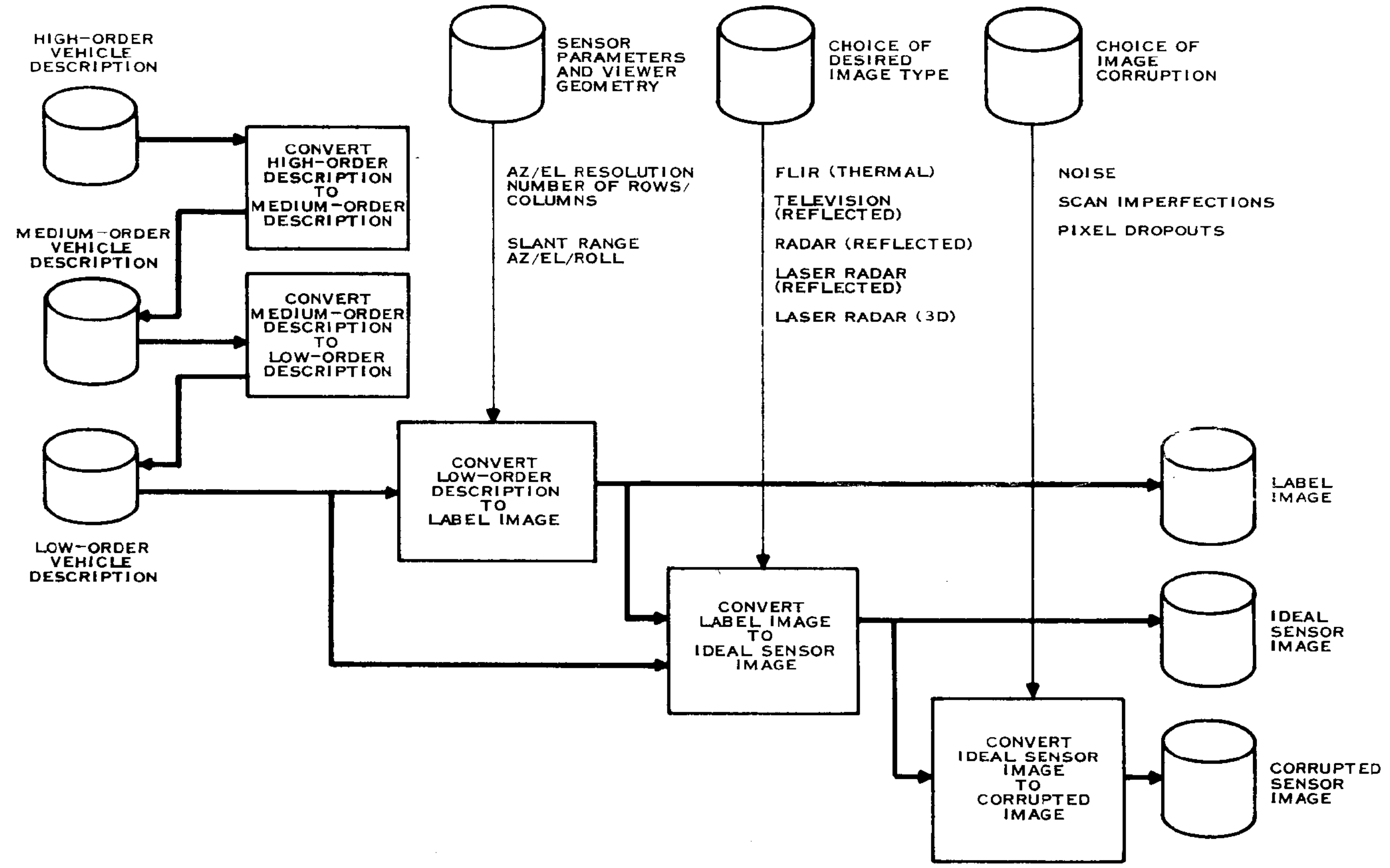

Figure 2. Block Diagram.

The model has five functions. The first two functions allow the user to input the target with either a high-order, medium-order, or low-order description. The third function converts the description to a label image. The label image is a two-dimensional image in which each pixel is assigned the label of the facet that is in the field of view of the pixel. The fourth function creates an image as it would be produced by an ideal sensor. The fifth function corrupts the image with noise, pixel dropouts, and scan imperfections.

The model has three outputs: label image, ideal sensor image, and corrupted sensor image.

Conversion from vehicle description to an image

The process of converting the low-order vehicle description to an image is an adaptation of the grid method.[2,3] The conversion starts by converting the low-order target description to a label image. The process involves projecting each facet of the target onto the label image. At each point of the projection, the pixel in the label image is given the value of the facet label. The process has eight steps (Figure 3).

Convert points from description coordinates to image coordinates

The first step converts the target points from target description coordinates to image coordinates. In doing the conversion, the user may elect either orthographic projection or central projection. Central projection assumes the viewer is a finite distance from the image plane and that the target is projected onto the image plane using a source of light at the viewer's eye. Orthographic projection is easier to work with, is independent of slant range, and is satisfactory for most applications. It is used here.[2]

Initialize label image

The first output of the model is the label image. The pixel values of the label image indicate which facet the pixel sees. At the start of the process, the facet a pixel can see has not been determined, so the label image is initialized to zero.

Determine visibility of each facet

There are two ways of determineing visibility. One is to compute the angle between the line of sight and a line perpendicular to the facet. If this angle is less than 90 degrees, the facet is visible. The second method is to project the three points defining the facet into the image plane and determine the area of the resulting projected triangle. The facet is visible if the area is greater than zero.