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ELVISS Software Prototype System Manual

April 20, 2001

the HFE group

Technical Report

Contract No. W7711-007674/001/TOR

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Author

Murray G. Gamble

Reviewed by

Nadine Wellwood

Documentation Manager
The HFE Group

Approved for release by

Nadine Wellwood

Quality Assurance Manager
The HFE Group

The HFE Group
220 Laurier Ave. West, Suite 350
Ottawa, Ontario, Canada
K1P 5Z1

Abstract

The HFE Group has performed development for, and modifications to, a software prototype of the Enhanced Low-Light Level Visible and Infrared Surveillance System (ELVISS) user interface. The intent of this work was to enhance the capability of the ELVISS software to allow the empirical investigation of different interface and sensor characteristics on search and detection capability under different simulated environmental conditions.

The execution of this work required the use of several software tools on Silicon Graphics, Inc. (SGI) and personal computer (PC) platforms. The prototype was developed using Virtual Prototypes, Inc. (VPI) VAPS software and SGI OpenGL Performer software. In addition to the modification of the prototype, a scenario generation interface was developed using SGI OpenGL Performer software and the public domain Fast Light Tool Kit (FLTK).

Résumé

The HFE Group a exécuté le développement pour, et les modifications à, un prototype de logiciel de l'interface utilisateur pour la système aéroporté d'imagerie multi-capteurs (ELVISS). L'intention de ce travail était de mettre en valeur la capacité du logiciel ELVISS pour permettre la recherche empirique sur différentes caractéristiques d'interface et de capteur sur la capacité de recherche et de détection dans différentes conditions environnementales simulées.

L'exécution de ce travail a exigé l'utilisation de plusieurs outils de logiciel sur Silicon Graphics, Inc. (SGI) et plateformes d'ordinateur individuel (PC). Le prototype a était développée avec logiciel de Virtual Prototypes, Inc. (VPI) VAPS et logiciel SGI OpenGL Performer. En plus de la modification du prototype, une interface de génération de scénario a été développée en utilisant le logiciel SGI OpenGL Performer et le le logiciel Fast Light Tool Kit (FLTK).

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Executive summary

This document provides an overview of software developed to support the empirical investigation of a simulated user interface for an Enhanced Low-Light Level Visible and Infrared Surveillance System (ELVISS).

The ELVISS is an electro-optical imaging system being developed by the Defence Research Establishment Valcartier (**DREV**) to enhance the capability of search and rescue (**SAR**) crews to operate effectively at night and in degraded weather conditions. ELVISS is a dual sensor system comprising an active-gated TV (**AGTV**) and a Forward Looking Infrared (**FLIR**) imaging system. By coordinating the use of a pulsed laser illuminator and AGTV camera, the AGTV component of ELVISS provides effective imaging in the absence of ambient light. In addition, the active range gate allows the AGTV system to penetrate meteorological phenomena such as fog, snow and rain much more effectively than a FLIR camera. The FLIR camera is a passive thermal imaging system that produces an image based on temperature variation by detecting mid-infrared and far-infrared radiation. Both sensors are boresighted and are packaged in a gimballed "ball" that is mounted on the exterior of an aircraft or vehicle.

In order to ensure that a SAR operator would be able to use the system effectively and with a minimal amount of training, a prototype human-machine interface (**HMI**) was developed to evaluate design concepts. Two key software packages were utilized to develop the prototype: Virtual Prototypes, Inc.'s (**VPI**) Virtual Applications Prototyping System (**VAPS**) and Silicon Graphics, Inc.'s (**SGI**) OpenGL Performer. VAPS was utilized to prototype the 2D elements of the HMI while Performer was used to render a 3D visualization of the virtual mission world in order to simulate dynamic AGTV and FLIR sensor imagery. Performer was also used to generate a moving map display for the HMI.

The ELVISS HMI prototype represents a potentially cost effective way of evaluating operator performance with respect to a candidate user interface. The existing prototype, however, had only a limited capability to record objective data and does not provide sufficient capability to develop experimental scenarios or to manipulate sensor and interface characteristics.

The HFE Group was contracted to enhance the capability of the ELVISS software prototype to allow the empirical investigation of different interface and sensor characteristics on search and detection capability under different environmental conditions.

Gamble, M. G. 2001. ELVISS Software Prototype - System Manual. CR 2001-029, The HFE Group.

Sommaire

Ce document fournit une vue d'ensemble de logiciel développée pour supporter la recherche empirique sur une interface utilisateur simulée pour la système aéroporté d'imagerie multi-capteurs (ELVISS).

L'ELVISS est un système électro-optique de formation image développé par la Centre de Recherche de Defence Valcartier (CRDV) pour mettre en valeur la capacité de la recherche et pour sauver les équipages (SAR) pour fonctionner pertinemment la nuit et en conditions atmosphériques dégradées. ELVISS est un système duel de capteur comportant une TV actif-déclenchée (AGTV) et un système regardant vers l'avant de formation image d'InfraRed (FLIR). En coordonnant l'utilisation d'un bloc d'éclairage pulsé de laser et de l'appareil-photo d'AGTV, le composant d'AGTV d'ELVISS fournit la formation image pertinente en l'absence de la lumière ambiante. En outre, la porte active d'intervalle permet au système d'AGTV de pénétrer des phénomènes météorologiques tels que le brouillard, neige et de pleuvoir beaucoup plus pertinemment qu'un appareil-photo de FLIR. L'appareil-photo de FLIR est un système thermique passif de formation image qui produit une image basée sur la variation de la température en détectant le rayonnement mi-infrarouge et lointain. Les deux capteurs sont boresighted et sont empaquetés dans balle de capteurs cela est monté sur l'extérieur d'un avion ou d'un véhicule.

Afin de s'assurer qu'un opérateur de SAR pourrait utiliser le système pertinemment et avec une quantité minimale de formation, une interface homme-machine de prototype (IHM) a été développée pour évaluer des concepts de construction. Deux progiciels principaux ont été utilisés pour développer le prototype: de Virtual Prototypes, Inc. (VPI) VAPS et SGI OpenGL Performer. VAPS a été utilisé au prototype les 2D éléments du IHM tandis que Performer était utilisé pour rendre une visualisation 3d du monde virtuel de mission afin de langage figuré simuler capteur dynamique d'AGTV et de FLIR. L'interprète a été également utilisé pour produire d'un affichage mobile de carte pour le IHM.

Le prototype d'ELVISS IHM représente une voie potentiellement rentable d'évaluer l'exécution d'opérateur en ce qui concerne une interface utilisateur de candidat. Le prototype existant, cependant, a eu seulement une capacité limitée pour enregistrer des données objectives et ne fournit pas la capacité suffisante pour développer les scénarios expérimentaux ou pour manipuler des caractéristiques de capteur et d'interface.

The HFE Group a été contracté pour mettre en valeur la capacité du prototype de logiciel d'ELVISS pour permettre la recherche empirique sur différentes caractéristiques d'interface et de capteur sur la capacité de recherche et de détection dans différentes conditions environnementales.

Gamble, Murray G. 2001. ELVISS Software Prototype - User Manual. CR 2001-029, The HFE Group.

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1. Introduction

1.1 General

The Department of National Defence (DND) is developing a flyable prototype of an Enhanced Low-Light-Level Visible and Infrared Surveillance System (**ELVISS**). The HFE Group has been contracted to enhance the capabilities of an ELVISS software prototype to allow the empirical investigation of different interface and sensor characteristics on search and detection capability under different simulated environmental conditions.

1.2 Background

DND has identified a requirement to enhance the capabilities of Search And Rescue (**SAR**) operators to conduct operations at night and under degraded weather conditions. To this end, the Defence Research Establishment Valcartier (**DREV**) is developing a multi-sensor system composed of an Active Imaging System (the Airborne Laser-Based Enhanced Detection and Observation System (**ALBEDOS**)) and a thermal Infrared (**IR**) imaging system. By coordinating the use of a pulsed laser illuminator and AGTV camera, the AGTV component of ELVISS provides effective imaging in the absence of ambient light. In addition, the active range gate allows the AGTV system to penetrate meteorological phenomena such as fog, snow and rain much more effectively than a FLIR camera. The FLIR camera is a passive thermal imaging system that produces an image based on temperature variation by detecting mid-infrared and far-infrared radiation. Both sensors are boresighted and are packaged in a gimballed "ball" that is mounted on the exterior of an aircraft or vehicle.

In order to ensure that a SAR operator would be able to use the system effectively and with a minimal amount of training, a prototype human-machine interface (**HMI**) was developed to evaluate design concepts. Two key software packages were utilized to develop the prototype: Virtual Prototypes, Inc.'s (**VPI**) Virtual Applications Prototyping System (**VAPS**) and Silicon Graphics, Inc.'s (**SGI**) IRIS Performer. VAPS was utilized to prototype the 2D elements of the HMI while Performer was used to render a 3D visualization of the virtual mission world in order to simulate dynamic AGTV and FLIR sensor imagery. Performer was also used to generate a moving map display for the HMI.

The ELVISS HMI prototype represented a potentially cost effective way of evaluating operator performance with respect to a candidate user interface. The initial prototype, however, had only a limited capability to record objective data and did not provide sufficient capability to develop experimental scenarios or to manipulate sensor and interface characteristics.

1.3 Aim

The aim of this report is to provide a system overview of software developed to support empirical investigation of a simulated user interface for the ELVISS.

1.4 Objectives

The specific objectives of this report are to:

a. Describe the capabilities and limitations of the software developed to support the conduct of experimentation using the ELVISS software prototype;

b. Define the minimum requirements of the hardware and software environment needed to utilize the software developed for this project; and

c. Provide information about the various algorithms used to generate runtime parameters, and to calculate scoring values during the execution of an experiment.

1.5 Scope

This report addresses the modification of existing ELVISS prototype software as well as the creation of new software to support the generation of experimental scenarios.

1.6 Report Outline

The report is structured as follows:

a. Section One describes the background, aim and scope of this document;

b. Section Two describes the capabilities of the developed software;

c. Section Three explains the limitations of the developed software;

d. Section Four defines the hardware and software requirements for the execution and/or modification of the developed software; and

e. Section Five documents the algorithms utilized in the developed software.

2. Capabilities

2.1 General

The software developed to support the conduct of experimentation on the ELVISS HMI prototype can be categorized into two categories: scenario generation and experiment execution.

Scenario generation is accomplished via the ELVISS Scenario Generation Environment (SGE). The ELVISS SGE provides the experimenter with the capability to define, modify and save various elements that, when combined, comprise an experimental scenario.

Experiment execution is accomplished using the modified ELVISS HMI prototype. The original HMI prototype has been modified to allow the dynamic configuration and conduct of an experimental scenario and provides data collection capabilities.

2.2 ELVISS Scenario Generation Environment (SGE)

The ELVISS SGE provides the capability to define experimental scenarios for use with the ELVISS HMI prototype. The SGE comprises a graphical user interface (GUI) featuring a moving-map display of the geographic scenario area, as well as graphical controls providing the means to manipulate scenario parameters. The SGE GUI is depicted in Figure 1.

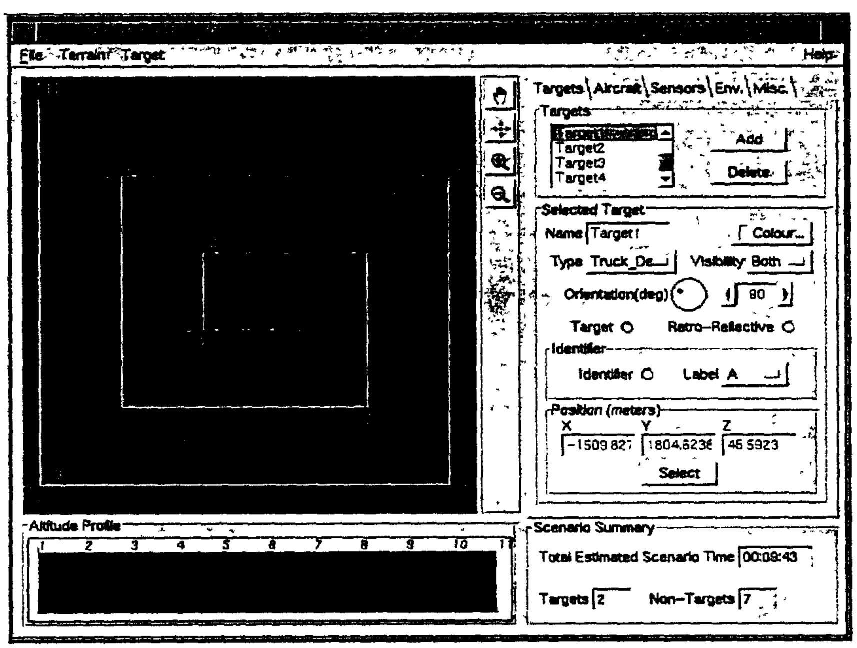

Figure 1. *ELVISS SGE User Interface*

The SGE allows the experimenter to control the following scenario elements:

a. Position and appearance of target objects on the scenario landscape;

b. Flight plan of the simulated search aircraft;

c. Configuration of the sensor package and HMI screen layout; and

d. Environmental parameters controlling the effectiveness of the simulated sensors.

In addition, the SGE provides the following features:

a. Realtime manipulation of the moving-map display (zoom and pan);

b. Graphical depiction of the aircraft altitude profile throughout the scenario;

c. Estimation of scenario duration; and

d. Total number of targets and non-targets defined in the scenario.

2.2.1 Manipulation of Targets

The SGE provides an interface whereby an experimenter may manipulate target objects that will form part of an experimental scenario. At the highest level, the SGE allows a user to "Add" and "Delete" targets from the scenario. Once a target has been added to the scenario, a user may modify various parameters that affect the position and appearance of the target object when viewed in the HMI prototype. Table 1 describes the modifiable target parameters and defines the valid range of values for each parameter as well as the units of each parameter, where applicable.

Table 1. *Target Parameters*

PARAMETER	VALID RANGE	UNITS
Name	Any alpha-numeric string (maximum of TBD characters)	N/A
Target	Boolean value	N/A
Retro_reflective	Boolean Value	N/A
Type	Pick list	N/A
Visibility	Pick list (Both, AGTV Only, IR Only)	N/A
Orientation	0 to 359	Degrees
Identifier	Boolean value	N/A

Identifier Label	Pick list (A to F, 0 to 9)	N/A
Position (x, y, z)	Single precision floating point value	Meters
AGTV Colour Adjust	Boolean value	N/A
AGTV Colour	Single precision floating point value	N/A
FLIR Colour Adjust	Boolean value	N/A
FLIR Colour	Single precision floating point value	N/A

A user may modify the position of a selected target by two methods: entering the discrete values for "x", "y" and "z" or by selecting a position via the moving-map display.

2.2.2 Manipulation of Flight Plan

The SGE allows the experimenter to modify the sequence of waypoints (or flight plan) of a simulated search aircraft to which the simulated sensor package is mounted. The flight plan interface allows the experimenter to select between three different methods of creating a flight plan. They are:

a. User defined flight plan. The user may interactively "Add" and "Delete" waypoints from the flight plan. For each waypoint the user may modify the position (x, y, altitude) and the speed of the aircraft at that waypoint.

b. Creeping line search pattern. The user may create a flight plan based on an algorithm that builds a "Creeping Line Ahead" flight pattern. The user selects a "Start Point" for the pattern and provides additional parameters necessary for the SGE to automatically construct the flight plan.

c. Expanding square search pattern. The user may create a flight plan based on an algorithm that builds an "Expanding Square" flight pattern. The user selects a "Start Point" for the pattern and provides additional parameters necessary for the SGE to automatically construct the flight plan

Table 3 and Table 4 describe the modifiable flight plan parameters for each of the flight plan creation methods mentioned above.

Table 2. User Defined Flight Plan Parameters*

PARAMETER	VALID RANGE	UNITS
Waypoint Position (x, y, altitude)	Single precision floating point value	Meters
Speed	1 to 200	Knots

*These parameters apply to each waypoint in the flight plan

Table 3. Creeping Line Flight Plan Parameters

PARAMETER	VALID RANGE	UNITS
Start Position (x, y, altitude)	Single precision floating point value	Meters
Speed	1 to 200	Knots
S	0.1 to 10.0	Kilometres
Leg Length	0.1 to 100 0	Kilometres
# of Legs	1 to 150	N/A

Table 4. Expanding Square Flight Plan Parameters

PARAMETER	VALID RANGE	UNITS
Start Position (x, y, altitude)	Single precision floating point value	Meters
Speed	1 to 200	Knots
S	0 1 to 10 0	Kilometres
# of Legs	1 to 150	N/A
Direction	Pick list (CW, CCW)	N/A

2.2.3 Manipulation of Sensors

The SGE provides the user with the capability to modify the characteristics of the simulated ELVISS sensors. These characteristics affect the window layout configuration to be used by the HMI prototype, as well as the Field Of View (FOV) or zoom of the individual sensors. Table 5 describes the modifiable sensor parameters and defines the valid range values and units for each parameter, as applicable.

Table 5. Sensor Parameters

PARAMETER	VALID RANGE	UNITS
Sensor Window Configuration	Pick list (Both Equal, AGTV Primary, FLIR Primary, AGTV Only, FLIR Only)	N/A
Slave Sensor FOV	Boolean value	N/A
AGTV Zoom	0 5 to 40 0	Degrees
FLIR Zoom	0 5 to 40.0	Degrees
FLIR Zoom Method	Pick list (Continuous, Discrete)	N/A
Simulate CCD	Boolean value	N/A
Default AGTV Beam Width	Pick list (Wide, Narrow)	N/A
AGTV Narrow Beam Size	Pick list (2, 5)	Degrees
AGTV Wide Beam Size	Pick list (10, 15, 20)	Degrees

2.2.4 Manipulation of Environment

The SGE allows the user to modify the characteristics of the simulated visual environment to be created in the HMI prototype. These characteristics affect the simulated "weather" and allow the user to define the effectiveness of each simulated sensor under the given environmental conditions. Table 6 describes the modifiable environment parameters and defines the valid range values and units for each parameter, as applicable.

Table 6. Environment Parameters

PARAMETER	VALID RANGE	UNITS
Time of Day (TOD)	0.0 to 1 0	N/A
Visibility	Pick list (Clear, Foggy)	N/A
Fog Range	1 to 10000	Meters
AGTV Weather Effect	1 to 5	N/A
FLIR Weather Effect	1 to 5	N/A

2.2.5 Manipulation of Additional Scenario Parameters

The SGE allows to you control additional scenario settings. These miscellaneous settings control the default configuration of the HMI Prototype display and of the HMI control hardware. Table 7 describes the modifiable miscellaneous scenario parameters and defines the valid range values and units for each parameter, as applicable.

Table 7. Miscellaneous Parameters

PARAMETER	VALID RANGE	UNITS
Map Scale	Pick list (1:50000, 1 250000)	N/A
Map Orientation	Pick list (North Up, Aircraft Up, Sensor Up)	N/A
Aircraft Symbol	Pick list (Icon 1, Icon 2, Icon 3)	N/A
Scan Enabled	Boolean value	N/A
Scan Rate	Pick list (1 5, 3 0, 4 5)	Deg/s
Scan Width	Pick list (30, 60, 90)	Deg
Joystick Mode	Pick list (Aircraft, Cursor)	N/A
Zoom Control Mode	Pick list (Forward=Zoom In, Forward=Zoom Out)	N/A

2.2.6 Target Preview

The SGE provides the user with the capability to "preview" the placement and orientation of an individual target on the scenario landscape. When initially invoked, the target preview applet places the user in a rotating orbit about the selected target. The user has the option of placing the target preview applet into a manual manipulation mode wherein the user may modify the azimuth, elevation and distance from the selected target. The target preview applet is depicted in Figure 2.

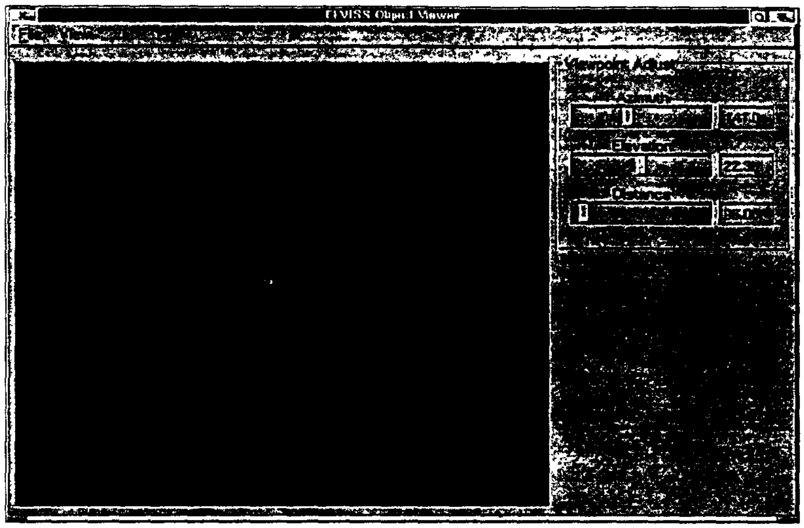

Figure 2. ELVISS SGE Target Preview Application (Manual Mode)

2.2.7 File Input/Output

The SGE provides the user with the capability to "load" and "save" entire scenarios as well as individual scenario elements. This merits some discussion. A "scenario", as defined in the context of this software, is comprised of several scenario elements. Scenario elements include a target list, a flight plan and a prototype configuration.

A target list comprises a sequence of target definitions containing the parameters defined in Table 1. A flight plan consists of a sequence of waypoints representing the parameters defined in Table 2, Table 3or Table 4. A prototype configuration consists of the HMI prototype configuration parameters defined in Table 5 and Table 6, as well as a reference to a terrain landscape. By defining new scenario elements or by mixing and matching existing scenario elements, the user can create an infinite number of scenario possibilities.

The input/output file format specifications for the various file types supported by the SGE are provided in Section 6 of the *ELVISS Software Prototype User Manual.*

2.3 ELVISS Human Machine Interface (HMI) Prototype

The ELVISS HMI Prototype is the simulation of the ELVISS user interface. The HMI Prototype utilizes the data generated by the ELVISS SGE to construct and execute a simulated scenario. The simulated scenario comprises the visualization of a scenario landscape (or terrain) as viewed through a simulated AGTV and simulates FLIR, the population of the terrain with target objects, the flight of a simulated search aircraft over the terrain and the configuration and layout of the HMI itself.

The original HMI Prototype has been modified to incorporate an advanced data collection capability. This data collection capability allows the experimenter to capture important information about the interaction between the HMI Prototype operator and the prototype throughout the execution of an experimental scenario.

With the exception of the added capability to read the scenario definition data generated by the ELVISS SGE and to collect data during the execution of experimental scenarios, the modified HMI Prototype maintains all the functionality of the original HMI prototype. A complete description of the capabilities of the original HMI prototype may be found in Neal, B. (April 28, 1999). *ELVISS Human Engineering Design Approach Document – Operator*. Canadian Marconi Company.

3. Limitations

3.1 General

The ELVISS SGE and the ELVISS HMI Prototype have limitations that affect the overall fidelity of the ELVISS simulation. Limitations are inherent to any computer simulation of a real world system and as such should be taken into consideration when employing the software as part of an empirical study.

The following sections provide an itemization of the limitations of the ELVISS SGE and ELVISS HMI Prototype. It should be noted that some limitations of the ELVISS software are the result of the hardware and software associated with the computing platform (SGI OCTANE workstation) on which the SGE and HMI Prototype are currently hosted. These hardware and software elements will be discussed in Section 4 - Operating Requirements.

The limitations of the ELVISS software will be discussed at a system level as opposed to discussing the limitations of the ELVISS SGE or ELVISS HMI Prototype individually.

3.2 Sensor Simulation

The ELVISS software includes the simulation of two electro-optical sensors: an Active Gated TV (AGTV) and a Forward Looking Infrared (FLIR) imaging system. In fact, the implementation of these sensors would be best described as an "emulation" rather than a "simulation". This is due to the fact that the sensor-like imagery being presented in the HMI Prototype is not the result of a physics based approximation of an AGTV and FLIR system. Rather the imagery is a "mock-up" of the sensor imagery intended only to provide the "look and feel" of these electro-optical sensors for the purpose of providing a more complete HMI. As such, the HMI Prototype should not be used to measure the effectiveness of an AGTV or FLIR sensor.

During the modification of the ELVISS HMI Prototype a limitation of the SGI OCTANE workstation was discovered. This limitation affects the ability to provide certain simulated environmental phenomenon in conjunction with the simulated FLIR. The FLIR "simulation" is achieved by using a hardware extension available on SGI platforms that allow the manipulation of the colour table of the rendered image at runtime. The GL_TEXTURE_COLOR_TABLE_SGI extension was found to be incompatible with the use of simulated "fog" on the OCTANE platform. Further investigation determined that this incompatibility only exists with OCTANE EMXI hardware and that more capable SGI platforms (i.e. ONYX) do not exhibit this incompatibility. As a result, the use of fog has been disabled for the simulated FLIR sensor and adjustments to fog settings in the SGE will not have any effect on the rendering of the FLIR visuals. The fog function is enabled for the simulated AGTV sensor.

3.3 Targets

The ELVISS HMI Prototype has been delivered with a number of target models (vehicles, people, geometric primitives). Three variants of each model have been provided: colour, black & white and IR (white hot). These target models are limited insofar as the IR representation is not the result of a physics based analysis of the IR characteristics of these objects. Rather, the IR representation is based on a qualitative knowledge of the "likely" appearance of the object under general circumstances (i.e. engine running, where applicable).

An ELVISS Experimental Scenario is currently limited to a maximum of one hundred and fifty (150) targets.

3.4 Aircraft Flight Simulation

The ELVISS HMI Prototype simulates the movement of the sensor package through the simulated landscape as if it were attached to an imaginary search aircraft. The HMI Prototype does not, however, include a flight simulation model to control this movement. The HMI Prototype utilizes a simplistic path navigation algorithm that allows the movement of the simulated sensor "viewpoint" along straight-line segments between "waypoints" defined in the ELVISS SGE. The movement of the viewpoint is "smoothed" in the vicinity of the waypoints so as not to create a sudden change in direction as the path navigation algorithm transitions from one path segment to the next.

In real life, a search and rescue (SAR) aircraft would endeavour to maintain a consistent relative altitude (altitude above ground level or AGL) as it flies along a search path. This is not practical with the simplistic path navigation algorithm utilized by the HMI Prototype. As such, the HMI Prototype is limited insofar as it relies upon the absolute altitude (altitude above sea level or ASL) defined by the various waypoints to control the altitude of the simulated search aircraft. This is of particular note in the case of a flight plan based upon a SAR pattern (i.e. Creeping Line Ahead, or Expanding Square). When either of these SAR patterns is selected, the ELVISS SGE creates a flight plan based on a user provided "Start Point". The altitude specified for the "Start Point" will dictate the altitude to be maintained throughout the execution of the flight pattern.

The simplistic path navigation algorithm utilized by the HMI Prototype does not provide for acceleration or deceleration between waypoints. As such, any differential in the speed of movement along the flight path from one segment to the next will result in an instantaneous acceleration or deceleration to the newly requested speed. This limitation only affects a "User Defined" flight plan since this is the only flight plan type that allows for the definition of simulated aircraft speed on a per-waypoint basis (the simulated aircraft speed for "Creeping Line" and "Expanding Square" flight patterns are a function of the speed defined for the "Start Point" of the pattern).

An ELVISS Experimental Scenario is currently limited to a maximum of one hundred and fifty (150) waypoints.

3.5 Prototype Performance

The ELVISS HMI Prototype has been optimized to maximize the runtime performance of the prototype software. Despite these optimizations, the HMI Prototype suffers from performance limitations resulting from the graphics capabilities of the SGI OCTANE workstation. The most noticeable element of this limited graphics capability is the update rate of the prototype and sensor images. The HMI Prototype is currently capable of achieving a maximum update rate of 30 Hz – this falls short of a desired update rate of 60 Hz[1]. The maximum achievable update rate is directly affected by the complexity of the visual terrain database that is employed for a particular scenario. The use of simplistic terrain databases will result in increased runtime performance, while the use of complex terrain databases will result in decreased runtime performance.

The complexity of a terrain database merits further discussion. A terrain databases (as well as any 3D model) has two main characteristics that drive the hardware requirements for the computing platform on which it will be rendered: the number of polygons used to construct the model and the amount of texture utilized by the model. In the case of the SGI OCTANE platform, the latter requirement is most noteworthy. The SGI OCTANE (with EMXI graphics hardware) has 4 MB of texture memory. This is very low by current graphics hardware standards. As a result, the rendering performance of the system is extremely sensitive to the amount of texture memory required to support the visualization of a 3D model. This limitation will be apparent to the user insofar as the system will become unresponsive if the 4 MB texture limit is exceeded.

3.5.1 Understanding Performance with a Large Number of Target Objects

Similar to the performance limitations imposed by the complexity of the terrain database, the runtime performance of the ELVISS Prototype is affected by the number of target objects present in a scenario. Since each target object is composed of a limited number of polygons and each target object utilizes a portion of the system texture memory, the rendering demands on the OCTANE workstation are increased with the addition of target objects.

Steps have been taken, however, to mitigate the performance degradation due to an increase in target objects. These steps include the use of Level-of-Detail (**LOD**) composition for target objects. LOD can be described as a strategy for reducing the number of polygons used to represent a geometric

[1] An update of 60 Hz would accurately represent the real life refresh rate of an AGTV and/or FLIR camera. It should be noted, however, that a 60 Hz update rate was not a requirement for the HMI Prototype.

object by "switching" between numerous versions (of varying complexity) of an object at runtime, based on the distance of the viewpoint from the object. When the viewpoint is far away from an object, a representation of the object with a low number of polygons is utilized. As the viewpoint approaches the object, the low-polygon representation is replaced with a more complex version of the object (made up of more polygons). By trading off the complexity of the representation with the distance from the object, an attempt is made to balance the rendering capabilities of a system while presenting only the information that is required to accurately represent the appearance of a target object.

While this approach is helpful, it cannot address all possible scenarios. If for instance a large number of target objects (specifically those of a complex nature, i.e. a tank model) were assembled in a confined geographic area, LOD would not be helpful when the user "zoomed in" on this area. This is because the act of "zooming in" has moved the rendering viewpoint close to the collection of objects and forced them all to the highest level of detail. Further optimizations are possible to address these situations (i.e. the use of performance driven LODs) but are of limited use on the OCTANE platform.

3.6 Data Collection

As with the runtime performance of the HMI Prototype, the data collection functions of the prototype have been modified/optimized in order to achieve the maximum timing resolution possible, within the limitations hardware and software limitations of the SGI OCTANE workstation. The data collection component of the HMI Prototype uses UNIX interval timers to achieve a superior timing resolution. In addition, the data collection component is executed with super-user privileges to ensure that data collection activities will not be pre-empted by less critical system activities. By employing this approach, the HMI Prototype is capable of achieving a data collection timing resolution of 10 milliseconds.

4. Operating Requirements

4.1 General

The following table lists the minimum system requirements to install and run the ELVISS SGE and ELVISS HMI Prototype.

Table 8. Minimum Configuration Requirements

HARDWARE	SOFTWARE	MEMORY
▪ SGI OCTANE or better ▪ EMXI Graphics or better ▪ BG Systems FlyBox ▪ Sensor Control Box (custom hardware developed by BAE Systems Canada)	▪ IRIX 6 5 OS or later ▪ IRIX 6.5 current patches ▪ OpenGL Performer 2.2 or later ▪ SGI MIPS Pro C & C++ compilers (ver. 7.1 or later) ▪ VAPS 4 1 (or later) Development Environment (for additional modifications only) ▪ CCG 4 1 (or later – for additional modifications only) ▪ FLTK 1 10 or later	▪ 128 MB memory (64 MB minimum) ▪ 128 MB swap space (64 MB minimum) ▪ 100 MB disk space for binaries and source code

5. Algorithms

No special algorithms were used by the ELVISS Scenario Generation Environment (SGE) or by the ELVISS Human Machine Interface (HMI) Prototype in the generation of runtime parameters.

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List of symbols/abbreviations/acronyms/initialisms

AGTV	Active Gated TV
ALBEDOS	Airborne Laser-Based Enhanced Detection and Observation System
ASCII	American Standard Code for Information Interchange
DND	Department of National Defence
DREV	Defence Research Establishment Valcartier
ELVISS	Enhanced Low-Light Level Visible and Infrared Surveillance System
FLIR	Forward Looking Infrared
FLTK	Fast Light Tool Kit
FOV	Field of View
HMI	Human Machine Interface
IR	Infrared
MMD	Moving Map Display
N/A	Not Applicable
PC	Personal Computer
SAR	Search and Rescue
SGE	Scenario Generation Environment
SGI	Silicon Graphics, Inc.
VAPS	Virtual Applications Prototyping System
VPI	Virtual Prototypes, Inc.
Wx	Weather

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14 ABSTRACT

(U) The HFE Group has performed development for, and modifications to, a software prototype of the Enhanced Low-Light Level Visible and Infrared Surveillance System (ELVISS) user interface. The intent of this work was to enhance the capability of the ELVISS software to allow the empirical investigation of different interface and sensor characteristics on search and detection capability under different simulated environmental conditions.

The execution of this work required the use of several software tools on Silicon Graphics, Inc. (SGI) and personal computer (PC) platforms. The prototype was developed using Virtual Prototypes, Inc. (VPI) VAPS software and SGI OpenGL Performer software. In addition to the modification of the prototype, a scenario generation interface was developed using SGI OpenGL Performer software and the public domain Fast Light Tool Kit (FLTK).

15. KEYWORDS, DESCRIPTORS or IDENTIFIERS

(U) sensor surveillance system, design interface

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