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Gray-Scale Linear Mapper (GLM) Tactical Environmental Support System (TESS (3)) Documentation

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Abstract

The Gray-scale Linear Mapper (GLM) software module is a general purpose digital image processing function that permits the user to interactively change the linear intensity transformation of the input image. Most images contain a wide range of pixel values, whether they include clouds, ocean and/or land scenes. Thus, assigning the available gray shades to the entire dynamic range of the image stretches the contrast and brightness to a limit that typically does not adequately enable the viewer to see the full detail inherent in the full precision of the image.

The GLM function allows the operator to modify the contrast and brightness of a given image by moving the cursor within a triangle displayed on the screen via the cursor. The user can linearly change the intensity to gray-scale mapping in real time via the cursor and display literally hundreds of new enhancements within a matter of seconds. This permits the operator to zero in on the dynamic range of interest (e.g., 10-15 °C) and extract the full information content within the digital image. This powerful, but easy to use software function allows the user to glean more detail from the imagery for a variety of applications.

Acknowledgments

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**GRAY-SCALE LINEAR MAPPER (GLM)
TACTICAL ENVIRONMENTAL SUPPORT SYSTEM (TESS(3))
DOCUMENTATION**

1.0 SCOPE

1.1 Identification

The Computer Software Configuration Item (CSCI), identified as the Gray-scale Linear Mapper (GLM) Version 1.0, is a software module targeted for implementation on the Massachusetts Computer Corporation machine (MASSCOMP) and used to interactively enhance the display of a digital satellite image. This function will allow the user to quickly extract image information by focusing on pixel count values within a region of interest.

1.2 CSCI Overview

The GLM interactively manipulates a positive or negative linear intensity transformation of a displayed satellite image. Changes are made only to the image displayed on the MASSCOMP graphics monitor. The GLM is designed to be a general purpose routine that can be used to enhance any satellite image displayed on a MASSCOMP graphics monitor.

1.3 Document Overview

This Software Requirements Specification (SRS) establishes the requirements for the CSCI identified as the GLM Version 1.0.

2.0 APPLICABLE DOCUMENTS

2.1 Government Documents

Not applicable.

2.2 Non-Government Documents

The following documents, of the exact issue shown, form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

"Graphics Application Programming Manual," Revision G, Massachusetts Computer Corporation, March 1986.

"System 600 Version 2.0 Command Reference," Volume 2, International Imaging Systems, August 1987.

3.0 ENGINEERING REQUIREMENTS

3.1 CSCI External Interface Requirements

The following items constitute the external interface required for the GLM routine.

- Display Image - Image currently displayed on the MASSCOMP graphics monitor.
- Minimum limit (ix) - Horizontal location of the cursor displayed within the triangle.
- Maximum limit (iy) - Vertical location of the cursor displayed within the triangle.
- Button State (ibutton) - Current mouse/trackball button state.

3.2 CSCI Capability Requirements

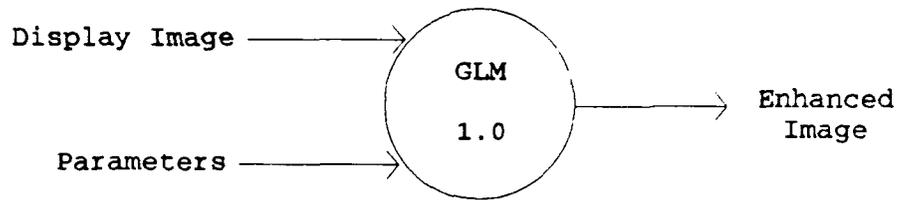
The GLM routine performs a linear intensity transformation on the input image based on the minimum and maximum limits specified. The transformation algorithm has the following form:

$$\text{colorbyte}(n) = \text{char}((k - \text{min}) * 255.0 / 1.0 * (\text{max} - \text{min}))$$

where:

- colorbyte(n) = one of three Red, Green, and Blue (RGB) values to be loaded into the color map register.
- k = the index number of the color map register to be loaded.
- min = the minimum intensity limit relative to the horizontal location of the mouse cursor within the triangle.
- max = the maximum intensity limit relative to the vertical location of the mouse cursor within the triangle.

3.3 CSCI Internal Interfaces



Data Definitions:

- Display Image - Image displayed on the MASSCOMP graphics monitor.
- Parameters - User supplied inputs, via mouse/trackball, used to control the transformation process.
- Enhanced Image - Enhanced image displayed on the MASSCOMP graphics monitor.

Process Definitions:

- GLM 1.0 - Linearly scales 255 shades of gray, ranging from black to white, based on the minimum and maximum limits specified by the user.

3.4 CSCI Data Element Requirements

Button State (ibutton) - Mouse button state, no default.

3.5 Adaption Requirements

The GLM is specifically designed for a MASSCOMP graphics monitor.

3.6 Sizing and Timing Requirements

Changes made by GLM to the output image are immediate.

3.7 Safety Requirements

Not applicable.

3.8 Security Requirements

Not applicable.

3.9 Design Constraints

The GLM routine is designed to execute on the MASSCOMP machine with a pixel graphics monitor and mouse/trackball installed.

3.10 Software Quality Factors

Not applicable.

3.11 Human Performance

The mouse/trackball is used to select the minimum and maximum gray-scale limits, which are linearly transformed and immediately displayed on the MASSCOMP graphics monitor. Messages are provided to instruct the user on how to vary the gray-scale intensity using the mouse/trackball.

3.12 Requirements Traceability

Not applicable.

4.0 QUALIFICATION REQUIREMENTS

Not applicable.

5.0 PREPARATION for DELIVERY

Not applicable.

6.0 NOTES

Abbreviations and Acronyms:

CSCI	- Computer Software Configuration Item
GLM	- Gray-scale Linear Mapper
MASSCOMP	- Massachusetts Computer Corporation
RGB	- Red, Green, and Blue intensity values
SRS	- Software Requirements Specification

SOFTWARE DESIGN DOCUMENT
for the
GRAY-SCALE LINEAR MAPPER (GLM)

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1.0 SCOPE

1.1 Identification

The Computer Software Configuration Item (CSCI), identified as the Gray-scale Linear Mapper (GLM) Version 1.0, is a software routine targeted for implementation on the Massachusetts Computer Corporation machine (MASSCOMP) used to interactively enhance the display of a digital satellite image. This function will allow the user to quickly extract image information by focusing on pixel count values within a region of interest.

1.2 System Overview

The GLM interactively manipulates a positive or negative linear intensity transformation of a displayed satellite image. Changes are made only to the image displayed on the MASSCOMP graphics monitor. The GLM is designed to be a general purpose routine that can be used to enhance any satellite image displayed on a MASSCOMP graphics monitor.

1.3 Document Overview

This Software Design Document (SDD) describes the software design details of the GLM, Version 1.0.

2.0 REFERENCED DOCUMENTS

"Software Requirements Specification (SRS) For The Gray-scale Linear Mapper," Version 1.0, Sverdrup Technology, Inc., May 1992.

3.0 PRELIMINARY DESIGN

3.1 CSCI Overview

The GLM linearly scales 255 shades of gray, ranging from black to white, based on the minimum and maximum limits specified by the user.

The following items constitute a summary of the components required for the GLM routine:

- Initialize GLM - Initializes the GLM operation by assigning the graphics processor, loading the color map registers, and setting the graphics cursor mode.

- Load Gray-scale - Loads a linear transformation of the minimum and maximum gray-scale limits specified by the user into the appropriate color map registers

3.1.1 CSCI Architecture

The GLM component initializes the MASSCOMP graphics processor and enhances the image on the MASSCOMP graphics monitor.

The following items constitute the interface for the GLM component:

- | | | |
|------------------------|---|--|
| Display image | - | Image currently displayed on the MASSCOMP graphics monitor. |
| Minimum limit (ix) | - | Horizontal location of the cursor displayed within the triangle. |
| Maximum limit (iy) | - | Vertical location of the cursor displayed within the triangle. |
| Button State (ibutton) | - | Current mouse/trackball button state. |

3.1.2 System States and Modes

Not applicable.

3.1.3 Memory and Processing Time Allocation

The GLM is specifically designed for a MASSCOMP graphics monitor. Changes made by GLM to the output image are immediate.

3.2 CSCI Design Description

3.2.1 GLM

The GLM component initializes operation by setting up the graphics environment. The structure flow chart for GLM is shown in Appendix A.

The GLM component receives minimum and maximum gray-scale limits and button state from the user. The mouse/trackball is used to select these minimum and maximum gray-scale limits, which are linearly transformed and immediately displayed on the MASSCOMP color graphics monitor. Messages are provided to instruct the user on how to vary the gray-scale intensity.

4.0 DETAILED DESIGN

4.1 GLM Design Specification

The GLM initializes operation by assigning the graphics processor, loading the color map registers, and setting the graphics cursor mode. It then enhances the image on the MASSCOMP graphics monitor.

4.2 GLM Design

The following is the pseudocode for the GLM component:

Display the GLM title and the date it was last modified.

Assign the MASSCOMP graphics processor (MGIASNGP). This step may not be required within an integrated system where the graphics processor is assigned prior to calling the GLM routine.

Set the graphics cursor mode where the cursor is displayed as it follows the tracking device (MGICURSMODE).

Select the graphics plane on which to operate (MGIPLN).

Load and enhance the gray-scale level of the output image based on minimum and maximum limits specified by the user via the mouse/trackball.

The minimum and maximum limits are linearly transformed and immediately displayed on the MASSCOMP graphics monitor.

Deassign MASSCOMP graphics processor (MGIDEAGP). This step may not be required within an integrated system, as well.

Minimum limit (ix) - Horizontal location of the cursor displayed within the triangle.

Maximum limit (iy) - Vertical location of the cursor displayed within the triangle.

Button State (ibutton) - Current mouse button state.

The transformation algorithm has the following form:

$$\text{colorbyte}(n) = \text{char}((k - \text{min}) * 255.0 / 1.0 * (\text{max} - \text{min}))$$

where:

colorbyte(n) = one of three Red, Green, and Blue (RGB) values to be loaded into the color map register.

k = index number of the color map register to be loaded.

min = minimum intensity limit relative to the horizontal location of the mouse cursor within the triangle.

max = maximum intensity limit relative to the vertical location of the mouse cursor within the triangle.

5.0 CSCI DATA

Button State (ibutton) - Mouse button state, no default.

6.0 CSCI DATA FILES

Not applicable.

7.0 REQUIREMENTS TRACEABILITY

Not applicable.

8.0 NOTES

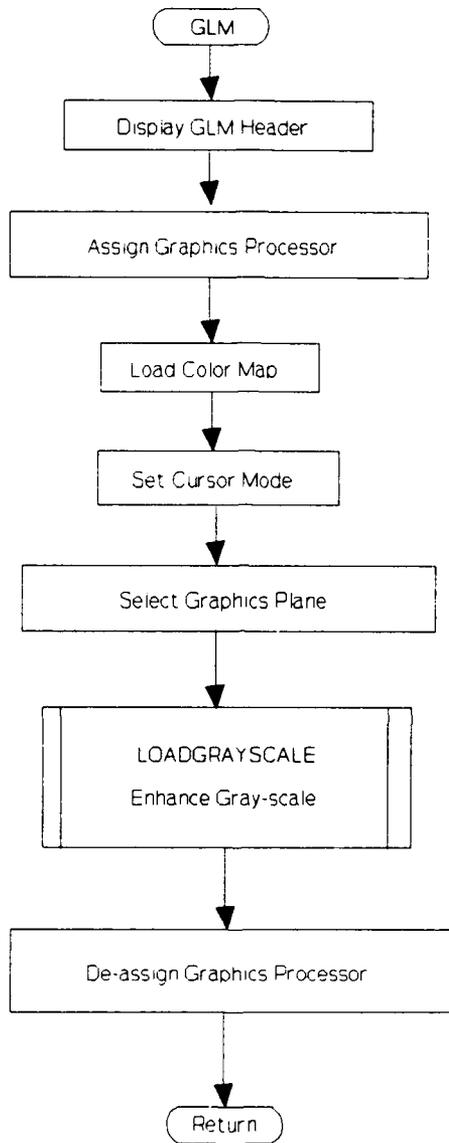
Abbreviations and Acronyms:

CSC	- Computer Software Component
CSCI	- Computer Software Configuration Item
CSU	- Computer Software Unit
GLM	- Gray-scale Linear Mapper
MASSCOMP	- Massachusetts Computer Corporation
RGB	- Red, Green, and Blue intensity values
SDD	- Software Design Document
SRS	- Software Requirements Specification

9.0 APPENDIX

Appendix A contains the flow chart for the GLM software.

Appendix A
GLM Flow Charts



SOFTWARE TEST DESCRIPTION
for the
GRAY-SCALE LINEAR MAPPER (GLM)

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1.0 SCOPE

1.1 Identification

The Computer Software Configuration Item (CSCI), identified as the Gray-scale Linear Mapper (GLM) Version 1.0, is a software routine targeted for implementation on the Massachusetts Computer Corporation machine (MASSCOMP) and used to interactively enhance the display of a digital satellite image. This function will allow the user to quickly extract image information by focusing on pixel count values within a region of interest.

1.2 System Overview

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1.3 Document Overview

The Software Test Description (STD) provides the test case and procedures necessary to perform formal qualification testing of the GLM, Version 1.0.

2.0 REFERENCED DOCUMENTS

"Software Design Document (SDD) For The Gray-scale Linear Mapper," Version 1.0, Sverdrup Technology, Inc., May 1992.

"Software Requirements Specification (SRS) For The Gray-scale Linear Mapper," Version 1.0, Sverdrup Technology, Inc., May 1992.

3.0 FORMAL QUALIFICATION TEST PREPARATIONS

Not applicable.

4.0 FORMAL QUALIFICATION TEST DESCRIPTIONS

The Gray-scale Linear Mapper Test Case (GLMTC) will receive input parameters and produce an enhanced image on the MASSCOMP graphics monitor. The following sections describe the GLMTC using an input test image file, **SSTIMAGE.DAT**, containing Sea Surface Temperatures (SST).

4.1 GLMTC

The mouse/trackball is used to select minimum and maximum gray-scale limits, which are linearly transformed and immediately displayed on the MASSCOMP color graphics monitor. Messages are provided to instruct the user on how to vary the gray-scale intensity.

4.1.1 GLMTC Requirements Traceability

The GLMTC is specifically designed for a MASSCOMP graphics monitor.

4.1.2 GLMTC Initialization

The GLMTC initializes the GLM operation by assigning the graphics processor, loading the color map registers, and setting the cursor mode.

4.1.3 GLMTC Test Inputs

The following items constitute the interface between the GLMTC and the external environment:

Display image	-	Image currently displayed on the MASSCOMP graphics monitor
Minimum limit	-	Horizontal location of the cursor displayed within the triangle.
Maximum limit	-	Vertical location of the cursor displayed within the triangle.
Button State	-	Current mouse button state.

4.1.4 GLMTC Expected Test Results

The GLMTC will enhance the image displayed on the MASSCOMP graphics monitor. Changes are made only to the graphics screen.

4.1.5 GLMTC Criteria for Evaluating Results

The GLMTC will use any digital satellite image that is displayed on the monitor as input. The image on the MASSCOMP graphics monitor must be visually examined to evaluate its quality during GLM execution. The brightness and contrast of the gray-scale levels can be raised and lowered to provide a more viewable image.

4.1.6 GLMTC Test Procedure

To execute the GLMTC, enter the following commands:

1. Invoke the program by entering the command "GLM."
2. Roll the mouse/trackball to enhance the displayed output image pressing button 2. Up - increases max temperature values. Right - increases min temperature values.
3. Click mouse/trackball button 1 or 3 when finished.

4.1.7 GLMTC Assumptions and Constraints

The GLM test will be performed on a MASSCOMP GA1000 running Real Time UNIX 4.0A or higher.

5.0 NOTES

Abbreviations and Acronyms:

CSCI	- Computer Software Configuration Item
GLM	- Gray-scale Linear Mapper
GLMTC	- Gray-scale Linear Mapper Test Case
MASSCOMP	- Massachusetts Computer Corporation
SDD	- Software Design Document
SRS	- Software Requirements Specification
SST	- Sea Surface Temperature
STD	- Software Test Description

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