CONTROL OF ASYNCHRONOUS TACTICAL GRAPHICS DISPLAY

Harlan H. Black
CENTER FOR C3 SYSTEMS

December 1987

DISTRIBUTION STATEMENT
Approved for public release; distribution is unlimited.

CECOM
US ARMY COMMUNICATIONS-ELECTRONICS COMMAND
FORT MONMOUTH, NEW JERSEY 07703-5000
CONTROL OF ASYNCHRONOUS TACTICAL GRAPHICS DISPLAY (U)

This report describes an approach and methodology for providing automated control in a multi-process environment for the display and management of tactical graphical icons in an object-oriented environment.
CONTROL OF ASYNCHRONOUS TACTICAL GRAPHIC DISPLAY

Harlan H. Black

US Army
Communications/Electronics Command
Attn: AMSEL-RD-C3-IR-1(Black)
Fort Monmouth NJ 07703

ABSTRACT

This paper describes an approach and methodology for providing automated control in a multi-process environment for the display and management of tactical graphical icons in an object-oriented environment.

I. THE RESEARCH DOMAIN

A. CORPS MANEUVER CONTROL PLANNING

The US Army Communications-Electronics Command at Fort Monmouth, New Jersey, has been performing exploratory research to apply Artificial Intelligence (AI) technology to the problem of maneuver control planning for a corps commander. The project consists of a group of coordinated research efforts in object-oriented tactical graphics, man-machine interface, terrain reasoning, planning, plan recognition, knowledge acquisition, and representation.

B. THE DEVELOPMENT ENVIRONMENT

An experimental test-bed was constructed which consists of a network of Lisp machines and a large-screen tactical display. This provides a state-of-the-art AI environment in which the capabilities of an object-oriented approach can be explored for tactical decision aids. An icon on the screen represents a Lisp object, and associated with it can be its graphical and reasoning attributes, as well as its functionality, via message passing.

C. THE MAN-MACHINE INTERFACE

To the user, the prototype system is an intelligent plan editor. It monitors his inputs during plan development and provides critiques. It's designed to support his planning, not to do the planning for him.

The prototype's man-machine interface provides the following functionality:

- It brings system planning capabilities to the user.
- It shows the state of the planning system and database to the user.
- It allows the user to provide textual and graphical input.
- It permits the user to asynchronously modify the situation, goals, and resources present in the various knowledge bases.
- It presents a computer mediated planning environment as close as possible to that in which current planning activities are carried out.

Additional interface functionality, not yet implemented, can allow the user to control the display of information and graphics on the tactical displays.

Currently, the prototype uses two display monitors. A monochrome screen displays a command menu and four plan-editing windows for textual input. Each window is of a type that matches a particular planning function. The user may use the command menu to select a particular type of window for display. The second monitor is a color graphical display of the battlefield background, overlaid with symbology.

D. THE PROCESS MODEL

On a machine reasoning level, the maneuver control planning problem was seen to be best expressed in terms of a collection of asynchronous, cooperative processes. The user himself is considered a process. These processes perform different planning tasks and communicate with each other directly through message passing and indirectly through one or more shared knowledge bases. They work in parallel, just like the corps command staff. The display windows on the monochrome display are associated with unique reasoning processes and provide the user interface to them.

For the reasoning subsystem, user control is causal. Reasoning is data driven by modifications to the tactical database. Plans are evaluated as new information arrives or old information changes, and other processes are invoked or spawned to evaluate plan consistency. For the textual and graphic displays, the user shares control with the reasoning processes.
E. PROCESS COOPERATION AND SYMBOLOGY CONTROL

"Screen clutter is a major concern" [1]. "For tactical applications, the transition to ADP systems depends, in part, on a viable resolution to the clutter problem" [2]. On the textual display, declutter is no issue, as there are always four windows visible. The only concern is that of contention. When it occurs from conflicting requests by reasoning processes, the user is notified and decides. This was not viewed as being a distraction, as it relates to the reasoning, itself, and may provide valuable insight to the user about how the system is processing or viewing the problem at hand. However, for the tactical display, screen content needs to be kept at a minimum. When a process no longer requires a symbol to be seen on the screen, it needs to issue a request for its erasure. This can create a conflict if another process may also desire its display. To ask the user to resolve matters as they come up on an icon by icon basis is distracting. A method of providing display control in an automated manner was required and is the subject of this paper.

II. DISPLAY ACCESS LANGUAGE

A. REQUIREMENTS

To provide the prototype developers a uniform way of performing graphical operations and to resolve the display control issue in an automated manner, a display access language was designed and implemented.

1. GRAPHICAL REQUIREMENTS

In conventional tactical command centers, tactical icons and symbology are taped onto one or more plastic overlays that may be mounted or saved. A mechanism for grouping icons for display operations was therefore needed. An icon may be placed on a plastic overlay that is not yet mounted on the map and is therefore not yet visible to the user. Conditional icon display was therefore also needed. For efficiency, calls for

<table>
<thead>
<tr>
<th>Icon Attributes</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owning-process</td>
<td>Which process owns/created the icon?</td>
</tr>
<tr>
<td>Location</td>
<td>Where is the icon? How is it drawn?</td>
</tr>
<tr>
<td>Associated-with-overlays</td>
<td>With which overlays is the icon associated with?</td>
</tr>
<tr>
<td>Visible-on-maps</td>
<td>On which map is icon now visible? Which color was used? Did the user request icon declutter?</td>
</tr>
<tr>
<td>Visibility-reasons</td>
<td>For each map that icon is visible, was the display request for icon display or for overlay display? Which process made the request?</td>
</tr>
<tr>
<td>Highlighted-on-maps</td>
<td>On which map is icon now highlighted? Which color was used? Did the user request icon declutter?</td>
</tr>
<tr>
<td>Highlight-reasons</td>
<td>For each map that icon is highlighted on, was the display request for icon highlighting or for overlay highlighting? Which process made the request?</td>
</tr>
</tbody>
</table>

Table 1: Selected Icon Attributes, Attribute Types, and Purposes
display operations needed to be minimized. The system had to know not to issue a call for icon display if the icon was already visible. Also, the system should know not to highlight an icon that was not visible on the map. Because tactical commanders often simultaneously refer to several maps of different scales, multiple color displays had to be managed. Finally, a method of highlighting or displaying an icon in a special color was required.

2. DISPLAY MANAGEMENT REQUIREMENTS

A method of controlling the display and erasure of each icon was needed. A decluttering mechanism, that is, a means of providing the user with control and override for an icon's display in an automated environment, was also required.

B. VIRTUAL OVERLAYS

To meet the graphical requirements, a virtual overlay, a Lisp object, was designed with attributes, attribute values, and a defined functionality. Tactical icons were given an associated-with-overlays attribute where the names of all overlays that the icon was 'on' could be stored in a list. Every member of this list was unique. Overlay objects were given a similar overlay-components attribute, a list of names of icons. Thus, graphical operations could be performed on an single icon and on a group of icons. The overlay had an on-maps attribute, a list of names of map displays. This signified whether the overlay was 'mounted' on a particular map or not. By default, a call for an icon's display when its associated overlay was not mounted on its map would not be executed, providing a mechanism for conditional display. Associated with the icon was a visible-on-maps attribute, a list of lists. If no process requested the icon's display, the list was nil. Otherwise, each sub-list consisted of the name of a map display, the name of the color(s) that were used to draw the icon, and the Lisp atom t or nil. The latter was used to designate whether the user requested the icon's erasure, for declutter. Every map name was unique. Thus, the system could easily determine whether a call to display an icon was unnecessary.

<table>
<thead>
<tr>
<th>Display Access Language</th>
<th>For Tactical Icons</th>
<th>For Tactical Overlays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display:</td>
<td>Show-Icon</td>
<td>Show-Overlay-Icons</td>
</tr>
<tr>
<td></td>
<td>Erase-Icon</td>
<td>Erase-Overlay-Icons</td>
</tr>
<tr>
<td>Highlight:</td>
<td>Highlight-Icon</td>
<td>Highlight-Overlay-Icons</td>
</tr>
<tr>
<td></td>
<td>Dehighlight-Icon</td>
<td>Dehighlight-Overlay-Icons</td>
</tr>
<tr>
<td>User Override:</td>
<td>Declutter-Icon</td>
<td>Declutter-Overlay-Icons</td>
</tr>
<tr>
<td></td>
<td>Restore-Icon</td>
<td>Restore-Overlay-Icons</td>
</tr>
<tr>
<td>Grouping:</td>
<td>Associate-Icon-With-Overlays</td>
<td>Associate-Overlay-With-Icons</td>
</tr>
<tr>
<td></td>
<td>Dissociate-Icon-From-Overlays</td>
<td>Dissociate-Overlay-From-Icons</td>
</tr>
<tr>
<td></td>
<td>Clear-Overlay-From-Icons</td>
<td></td>
</tr>
<tr>
<td>Utility:</td>
<td>Move-Icon</td>
<td>Mount-Overlay-Into-Maps</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Remove-Overlay-From-Maps</td>
</tr>
</tbody>
</table>

Table 3: Display Access Language For Tactical Graphics
sary. Since this was stored as a list, multiple map displays could be easily managed. Indication of user override was built into the attribute’s structure. Data on icon highlighting was similarly stored in the icon’s highlighted-on-maps attribute.

C. VISIBILITY AND HIGHLIGHT REASONS

To minimize screen content and to provide display control in an automated manner, for every icon that was called for display or highlighting, the reasons associated with this operation were stored in the icon’s visibility-reasons and highlight-reasons attributes. The reasons specified the map that the icon is to be visible or highlighted on, the process that requested the operation, and whether the request was for the icon to

```
Show-Icon
(Show-Icon ICON (&key (map-alu nil) (overlays in-overlays)
    (conditional-show t) (caller owner)))
```

<table>
<thead>
<tr>
<th>Required Arguments: ICON, unique icon identifier.</th>
<th>Optional Keyword Arguments:</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>Map-alu List of two elements. First is the name of a map object. Second is the name of a color object.</td>
<td>Map-alu</td>
<td>Nil</td>
</tr>
<tr>
<td>Overlays List of names of overlay objects.</td>
<td>Overlays</td>
<td>Overlays that icon is associated with</td>
</tr>
<tr>
<td>Conditional-show T or nil</td>
<td>Conditional-show</td>
<td>T</td>
</tr>
<tr>
<td>Caller Name of a process.</td>
<td>Caller</td>
<td>Name of process that owns/created icon</td>
</tr>
</tbody>
</table>

Purpose:

**Draws icon on map window if not already visible and there is no indication of user override.** If there is no entry for map in icon’s visible-on-maps attribute, function adds one. Entry is of the form (Name-of-map color-list t). If there is no entry for map in icon’s visibility-reasons attribute, function adds one. Entry is of the form (Name-of-map visibility-reason). If there is a map entry but no icon-related visibility reason for the calling process, function adds one. Visibility-reason is of the form (Name-of-icon name-of-process).

Options:

**Specification of map window and color:**

Uses map-alu argument, if provided. Otherwise, determines map from specified or implied overlays, and determines color from icon, if color attribute is non-nil, or from overlays.

**Conditional drawing of icon:**

If conditional-show argument is t, only draws icon when overlay is mounted on the map.

**Specification of visibility reason:**

If caller argument is non-nil, new visibility reason to add for the map is of the form (name-of-icon caller).

Example:

Given icon C with null visible-on-maps and visibility-reasons attributes, whose owning process is plan-process and which is associated with overlay O. Given overlay O that has not yet been mounted on map M. Function call (Show-Icon C :conditional-show nil) causes C to be drawn on M, sets C’s visible-on-maps attribute to (M color-list T), and sets the visibility-reasons attribute to (M (C plan-process)).

Figure 1: Show Icon Syntax and Functionality
be displayed/highlighted or whether it was for the overlay that the icon is associated with to be displayed/highlighted. These attributes were lists of lists. Each sub-list was for a unique map display the icon was visible/highlighted on. The sub-lists were of the form (Map-name (Vis-reason (Vis-reason) ...)). Each Vis-reason was of the form (Name Process), where name is the name of either the Icon or an overlay and process component attribute. For the tactical name of either the Icon or an overlay and process component attribute. The move-Icon function modifies those for clear-overlay, which uses all of the icons in the overlay’s overlay-components attribute. The move-Icon function modifies only the graphics display and the icon’s location attribute. For the tactical icons in the study, information in the location attribute was sufficient to redraw the icon. The mount and remove overlay functions modified the display or erase functions for the icons in its overlay-components attribute.

F. SHOW ICON

The syntax and description of the show-icon function is provided in Figure 1. The Lisp keyword syntax permits the user to specify the optional arguments in any order, in pairs of keywords and argument values. An example of its usage, utilizing message passing, is provided on the bottom of the figure.

III. CONCLUSION

The display language provides a flexible mechanism for tactical graphics control and display in a multi-process environment. It provides support for graphical functionality which emulates graphical operations in a conventional tactical environment and it provides a means of extending this functionality in a battlefield automated system.

IV. ACKNOWLEDGEMENTS

The author wishes to acknowledge the support and encouragement of Dr. Martin Wolfe and Mr. Edward Beach, of the US Army’s Communication/Electronics Command. The author also wishes to acknowledge the contribution of Dr. Norman Badler, University of Pennsylvania, who provided valuable insight to this effort.

V. REFERENCES


END
DATE
FILMED
DTIC
4/88