

Analysis of Modern Design Approach for Anti-Air Radar Screen

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Abstract

This study is a preparation phase for visualization of utilized information using ergonomic user interface and standardization of elements for anti-air radar screen. Therefore, we investigated the instances of anti-air radar screen for air defense weapon system for defense advanced country. Based on the collected data, we compared and analyzed the air defense weapon system radar screen design. In addition, we carry out a research for layout, configuration, standardization and design of the radar screen's elements. Ultimately, it is essential to share a variety of battle field conditions such as enemy threat, enemy/friendly information, terrain information that can be effectively recognized. In this paper, we conduct case study for ergonomically development of automated/standardized radar screen. It is expected that this research improves the situational awareness and reduces the user's task load.

Keywords

Anti-Air Radar Screen, Air Defense Weapon System, Human Interface, Ergonomics, Situational Awareness, Task Load

1. Introduction

It will be expected to lead to major changes of mission operation environment for air defense mission in the future shown as **Table 1**. According to dramatically improvement of missile target detection range with the development of radar detection technology and missile propellants, ballistic missile's flight speed and accuracy are also improved. Thus, it is necessary to quickly and effectively exhibit the enemy missiles that fly at rapid speed because ballistic missile will fly at Mach 3 to 10 in the future. Future integrated battlefield environment is required exhibition of various elements such as atmosphere, climate, terrain, enemy/friendly information factor [1]. Therefore, the study of the radar screen configuration suitable for mission operation environment condition is required. **Table 2** shows direction of design for anti-air radar screen. As a result, effective handle is possible, grasp the trajectory of ballistic missile three-dimensionally [2]. Applying a touch-screen with a zoom-in function that can be observed a particular area of the wide range of attacks and it must be able to obtain detailed informa-

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Table 1. Major changes of mission operation environment.

Changed Situation	Requirements
Increase in detection range and missile propellant range	<ul style="list-style-type: none"> • Development of radar detection and missile propulsion technology • Target detection range is dramatically increased • Missile range, flying speed, accuracy are improved • Expansion of scope for battle field
Short time of the battle by the fast flight speed of ballistic missile	<ul style="list-style-type: none"> • The speed of the ballistic missile is faster than normal aircraft speed • The high-speed combat will be occurred • Quick and liquidity of certain capability will be required
Increased probability to engage with an number of target	<ul style="list-style-type: none"> • Clear situation awareness of commanders is required • Fast and precise command decision is required

Table 2. Direction of design for radar screen.

Direction of Design in Changed Situation	Description
Zoom-in/out function through the touch-screen	<ul style="list-style-type: none"> • Ability to see wide range of attacks quickly using zoom-function • Display detailed information that does not degrade the overall situational awareness when zooming
Switch function/ Simultaneous display function 2D, 2.5D, 3D (dimension)	<ul style="list-style-type: none"> • Determine the trajectory of the ballistic missile in 3D as well as 2D • Determine efficiencies for various radar screen's component layout
Rapid and accurate situational awareness	<ul style="list-style-type: none"> • Utilization of agronomical symbol for component of radar screen • Representation of friendly/enemy/missile/asset with high readability • Quick and accurate threat analysis through rapid situational awareness
Expression of intensive information through the large screen	<ul style="list-style-type: none"> • Apply high-resolution LCD touch-screen • Minimize the time to load information • Prevention of essential missing information

tion to that area. In addition, represent assets of enemy and friendly using the symbol based on ergonomics of the radar screen's elements and then it should be designed to allow rapid situation awareness. Through a large screen like a 30-inch LCD touch-screen allows broad sense representations of information, further it must be minimize the time to import battlefield information [3].

2. Case Study

Air Defense Weapon System Radar Screen

- Case study for 12 kinds of radar screen for air defense weapon systems.
- Attack range/altitude, mission, intercept altitude, operating country etc.
- Threat information, friendship information, tactical situation information, the operation of the tactical map equipment, the type of air defense weapon system components etc.
- Air defense weapon system radar screen's configuration and layout.
- Major Air defense weapon systems are shown as **Table 3**.
- **Tables 4-7** show results of analysis for radar screen.

3. Results

This study analyzes the common characteristics and flow of air defense weapon system's radar screen. Also features of each radar screen elements are analyzed as a graph.

3.1. Radar Screen Shape/Location/Background/Color

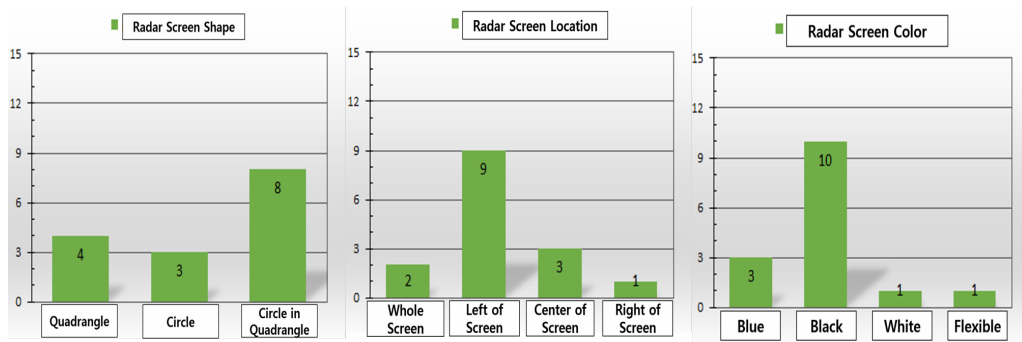


Figure 1. Analysis results of shape, location, color for radar screen.

3.2. Radar Screen Text Information and Tactical Map

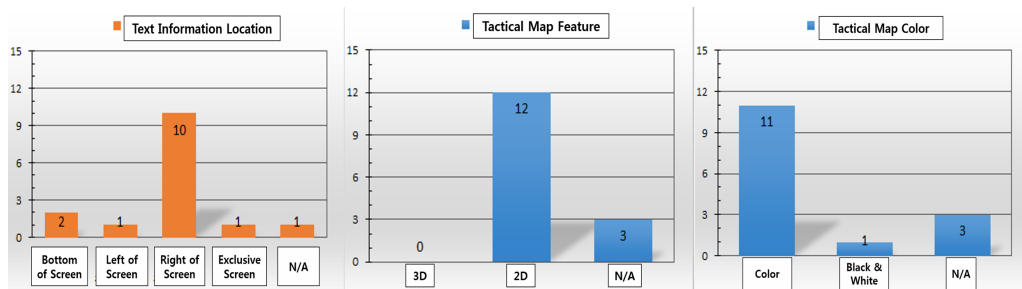


Figure 2. Analysis results of text information and tactical map for radar screen.

Table 3. Major air defense weapon systems.

Air Defense Weapon System	Nation	Attack Range/Altitude
THAAD	USA (Lockheed)	200/100
Patriot (PAC-1, 2, 3)	USA (Raytheon)	160/24
Arrow-2, 3	USA + Israel	100/50
MEADS	USA + Germany + Italy	30 (Detection Range)
PANTSIR-S1	Russia	32/15
Tor M-1	Russia	25/12
OSA	Russia	15/12
S-300/400	Russia	25/70
Polyana d4m1	Russia	2400 (Detection Range)
SAMP/T	France	40/15
MCDS	Italy	30/15

4. Conclusion

Radar screen which form is circular shape onto a quadrangle screen taking the largest proportion. Position of radar screen mostly is displayed on the left side of its screen. Its background's color is usually dark color such as black, blue, indigo. Text information of radar screen is normally on its right side. Recent radar screen system has evolved into free-form with adapting its components to user's convenience. Recent trend of radar screen is including Tactical map into its components. Previous trend is using 2D color Tactical map. In the future warfare, radar screen will need 2.5D, 3D Tactical map. Most of radar screens have 4 monitor up down left right side. The number of user will be 2 or 3, and their assignments are detecting radar screen, management of arm and total control. **Table 8** shows results.

Table 4. Radar screen layout analysis (1).

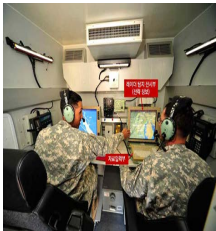

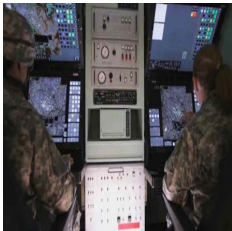
Name	THAAD	Patriot PAC-1, 2 (old type)	Patriot PAC-3 (the newest)
Radar Screen Layout			
Radar Screen Shape	Quadrangle	Circle	Circle in Quadrangle
Radar Screen Location	Whole screen	Center of screen	Center of screen
Radar Screen Color (Background/Symbol)	Blue/White	Black/Green	Black/Various color
Text Info. Shape	N/A	Text type	Text type
Text Info. Location	N/A	Bottom of screen	Bottom of screen
Text Info. Color	White	Green	White
Tactical Map (Available/Resolution/Color)	Available/2D/Color	N/A	Available/2D/Color
Number of Operator	2	3	3
Role	Radar detection, Targeting and Fire operation	Radar detection, Targeting and Fire operation, Whole situational awareness	Radar detection, Targeting and Fire operation, Whole situational awareness
Total Display	2	2	4

Table 5. Radar screen layout analysis (2).




Name	Arrow-3	MEADS	Pantsir-S1 MD
Radar Screen Layout			
Radar Screen Shape	Circle in Quadrangle	Quadrangle	Circle
Radar Screen Location	Left of screen	Left of screen	Left of screen
Radar Screen Color (Background/Symbol)	Blue/White	N/A	Black/Red, Yellow
Text Info. Shape	Window Box type	Window Box type	Window Box type
Text Info. Location	Right of screen	Right of screen	Right of screen
Text Info. Color	N/A	N/A	Various Color
Tactical Map (Available/Resolution/Color)	Available/2D/Color	Available/2D/Color	Available/2D/Color
Number of Operator	2	2	2
Role	Radar detection, Targeting and Fire operation	Radar detection, Targeting and Fire operation	Radar detection, Targeting and Fire operation
Total Display	4	4	2

Table 6. Radar screen layout analysis (3).




Name	Tor M-1 (old type)	Tor M-1 (the newest)	OSA-2
Radar Screen Layout			
Shape	Quadrangle	Circle in Quadrangle	Circle
Radar Screen Location	Whole screen	Left of screen	Left of screen
Color (Background/Symbol)	Black/Green	Black/Blue	Black/Red, Yellow
Text Info. Shape	N/A	Window Box type	Window Box type
Text Info. Location	Exclusive Display	Right of screen	Right of screen (Flexible layout)
Text Info. Color	Red	Various Color	Various Color
Tactical Map (Available/Resolution/Color)	N/A	Available/2D/Color	Available/2D/Color
Number of Operator	2	3	3
Role	Radar detection, Targeting and Fire operation	Radar detection, Targeting and Fire operation, Whole situational awareness	Radar detection, Targeting and Fire operation, Whole situational awareness
Total Display	4	4	3

Table 7. Radar screen layout analysis (4).




Name	S-300	Polyana D4M1	SAMP/T
Radar Screen Layout			
Shape	Circle in Quadrangle	Quadrangle	Circle in Quadrangle
Radar Screen Location	Left of screen	Left of screen	Left of screen
Color (Background/Symbol)	Black/Various Color	White/Black, Red, Blue	Black/Various Color
Text Info. Shape	Window Box type	Window Box type	Window Box type
Text Info. Location	Right of screen (Flexible layout)	Right of screen	Right of screen
Text Info. Color	Various Color	Black	Various Color
Tactical Map (Available/Resolution/Color)	N/A	Available/2D/White & Black	Available/2D/Color
Number of Operator	2	7	3
Role	Radar detection, Targeting and Fire operation	Radar detection, Targeting and Fire operation, Whole situational awareness	Radar detection, Targeting and Fire operation, Whole situational awareness
Total Display	4	7	5

Table 8. Radar screen layout analysis results.

Division	Analysis Results	Case of Air Defense Weapon System
Radar Screen Feature	Circle Radar Screen	Patriot series, S-300, Tor M-1, Arrow-3
Radar Screen Location	Left of Display	Arrow-3, Pantsir-S1 etc.
Radar Screen Color	Black	SAMP/T, MCDS, OSA etc.
Text Information Location	Right side of Radar Screen	Pantsir-S1, Arrow-3 etc.
Tactical Map Feature	2D Tactical Map	THHAD, the Newest Patriot etc.
Tactical Map Color	Color Type	THHAD, the Newest Patriot etc.

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