TELKOMNIKA, Vol. 11, No. 4, April 2013, pp. 2131~2135
ISSN: 2302-4046

Demand Analysis of Informational Shipboard Gun Weapon System Interface Design

WANG Hui-chuan*[1], ZHAO Xiao-zhe[2]
[1,2]Dept. of Training, Dalian Naval Academy, Dalian, China 116018
*Corresponding author, e-mail: wanghuichuan_1984@163.com

Abstract

According to development demand of informational shipboard gun weapon system, design concept of shipboard gun weapon system interface is proposed. System composition is put forward and function demand of interface is analyzed from combat, training and detection aspects. General principle need to be followed in design process. A new concept is provided for development of shipboard gun weapon system interface.

Keywords*: shipboard gun weapon system, interface designing, demand analysis*

1. Introduction

Informational shipboard gun weapon system interface is the medium and communicational interface of transfer and exchange information between men and weapon [1-2]. It is the consolidated operating environment of using the machine. And its design level and quality can affect the operational effectiveness by impacting the strength of the system functions, the reaction time and ease of use directly. The necessity of designing informational shipboard gun weapon system interface are: firstly, full expansion of combat functions of Shipborne Gun equipment needs the corresponding man-machine interface; secondly, designing informational shipboard gun weapon system interface is an urge need for the research of shipboard gun equipment; thirdly, universal and standardized informational shipboard gun weapon system interface research is also an urge need for training and use of the personal for shipboard gun operational use; and the last, systematical design of man-machine interface is an urge need for improving the operational capability of shipboard gun weapon system [9-10].

Starting from the consistence, function module, design and implementation of informational shipboard gun weapon system, the design requirement of informational shipboard gun weapon system man-machine interface is studied and analysed. Meanwhile, a new idea of the study and future direction of informational shipboard gun weapon system man-machine interface is also proposed.

2. System Component Requirement

Informatization naval gun weapon system consists of data acquisition device, data displaying processing and control device, the guns and informatization ammunition (which is shown in the Figure 1).

Data acquisition device contains external and internal data acquisition devices. External data acquisition device is comprised of gun embedded task system, reconnaissance satellite and individual amphibious reconnaissance system. Those devices provide the video of the long-range target/shellburst and the target audio for the gun system or controls the guidance ammunition via the wireless data link, satellite telephone(or short-wave communication), target/shellburst observation-location device, or the guidance ammunition control device. Internal data acquisition device is comprised of gun launched TV reconnaissance missile, photoelectric tracker, tracking radar, projectile velocity radar, electronic navigation chart and military topographic map database. Those devices provide the target coordinate, shellburst

Received January 15, 2013; Revised February 26, 2013; Accepted March 6, 2013

location, projectile trajectory and damage effect information for the combat decision making or the ballistic control.

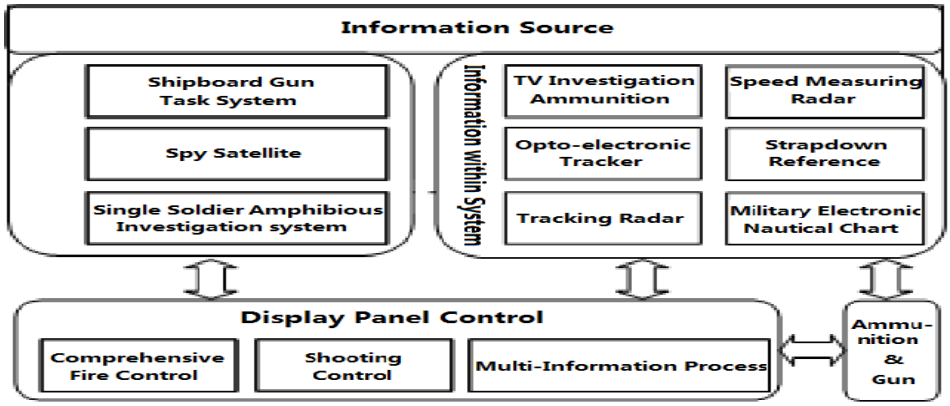

Figure 1. Components of Informatization Shipboard Gun Weapon System

Data displaying processing and control device contains integrated fire control station, firedirector and various information processing station. Integrated fire control station can capture and track the target coordinate by the search radar then the fire control computer can collect the target coordinate, calculate the firing data, control the gun and display the system status on the terminal. Firedirector can display the target vision information, system status, system mode, ammunition type, collimation, effect observation and decision-making plan. Various information processing station can handle and integrate satellite images, airborne task system or TV reconnaissance missile conveying videos or images information to extract target location, shellburst offset, shellburst coordinate and damage effect. The guns receive the commands of fire-control equipment to fire and report the running status to the control system. Informatization ammunition is comprised of the projectiles and propellants and that is able to control the projectile flight path, make the correction on demand and hit the target.

3. Component Function Requirement

Informatization naval gun weapon system GUI has the abilities to support thebattle, the training and the maintanance (those functions are shown in the Figure 2).

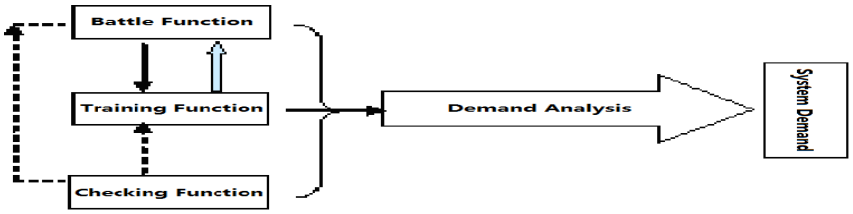

Figure 2. Logic Map of Function Demand Analysis

3.1. Battle Function Requirement

Battle Function is the bottleneck to the whole system. Thus, the primary task to develop gun equipment is the system requirements analysis. Based on the different target location, the system battle function can be divided into surface battle function, anti-air battle function and ground battle function.

(1) Surface Battle Function

Surface battle function requires the weapon system to be always intended for surface combat mission from the standby mode and creates the maximum demage effect.

Surface battle function GUI supports the following 3 typical scenarios.

Scenario 1: Manned Attack. In this scenario the GUI should support combat marine targets with guided munitions.

Scenario 2: High Speed Small Target Attack. In this scenario, the GUI should support combat marine high speed small targets with guided munitions, unguided munitions in the fire-control system working or outage condition.

Scenario 3: Military Operations Other Than War (MOOTW). In this scenario, the GUI should support warning shots or barrage fire on the specific targets.

(2) Warfare-to-air Function

Warfare-to-air function of informatization shipboard gun weapon system is based on aerial defence combat mission of surface warship, which demands effective strike towards air targets in the range of shipboard gun .

Non-control shell with fire-control system uses radar observation to accomplish closed-loop tracking shooting towards air targets, promotes shooting effect through real-time measuring targets' coordinate and trajectory diviation, and forecasts shooting emendation. It is supposed to be met by interface design that operation request of open-loop tracking shooting towards air targets using photoelectricity and radar observation of non-control shell with fire-control system. It is supposed to be met by interface designing that operation request of man-in-loop shooting towards air targets of guided shell. It is supposed to be met by interface designing that operation request of open-loop shift-fire shooting towards air targets using radar virtual amending of non-control shell with fire-control system. In above-mentioned shooting methods, it is also supposed to be considered by warfare-to-air interface designing that operation request of working mode and state transition of shipboard gun weapon system which brought by electronic interfering, wicked weather, equipment trouble etc.

(3) Warfare-to-shore Function

Warfare-to-shore function of informatization shipboard gun weapon system is based on combat mission and condition towards targets on shore. Aiming at characteristics and requests of warfare-to-shore, warfare-to-shore function demands of interface designing of shipboard gun weapon system is put forward. Considered combat conditions and methods show as follows:

First, when no former results can be utilized, efficacity shooting could be carried through after test-fire commonly.

Second, when using non-control shell shooting to shore, it is available that making use of shift-fire shooting after virtual shooting towards sea or shore, and it is supposed to be met by interface designing of shipboard gun weapon system that operation request of shift-fire shooting after virtual shooting towards sea or shore.

Third, when efficacity shooting needs to vary character or dimensionality targets using non-control shell, it is divided to pressing shooting, stopping shooting, annihilating shooting according to shooting mission section, and raid shooting, surveillance shooting according to fire intensity, and area shooting, direction echelon shooting, distance echelon shooting, same distance shooting according to backsight section.

Fourth, in the future, imformational shell of shipboard gun, which is used of exact shooting towards shore targets, is not non-control shell after shooting, but man-in-loop shell on the whole[3]. Whose marked characteristic is that instead of test-fire, man-in-loop guarantee is need.

3.2. Training function demand

The purpose of training is to win the war. The way of training is based on the way of fighting a battle. Making training in accordance with battling is the basic demand principle and of military training. So, first, the most important demand of the training ability of shipboard gun weapon system interface is that making it could simulate all of shipboard gun weapon system combat function training. Second, the training course and subject should be able to fulfill the training syllabus, this means it could create training subject not only under general conditions but also under complex conditions, so it can give the handlers a thorough training. The control of shipboard gun weapon system in training should be in accordance with the control in battling, so this demand the training conditions created by shipboard gun weapon system be in

accordance with the real conditions, and the simulated visual information and combat control information be in accordance with the real one. So,the design demand of the training function of shipboard gun weapon system is to give setting and selecting of the training subject strong support,and creat training subjec and implementation to satisfy training demand and function.

3.3. Checking Function Demand

From the demand that informational shipboard gun weapon system should always keep usefull and reliable, this paper studies the maintenance and inspecting mode of shipboard gun weapon system, and builds up an inspecting function system of shipboard gun weapon system, in order to provide the basis for the checking function design of shipboard gun weapon system interface.

The first function is self-checking. Interface design should be able to provide display of self-checking command and result of single machine or a system, in order to alow the handlers master the status of single machine or a system.

Second, static accuracy and dynamic accuracy checking. Interface design of shipboard gun weapon system checking mode should be able to provide installing and selecting of checking subject of static accuracy and dynamic accuracy, and display the checking command and result,in order to alow the handlers master the status static accuracy and dynamic accuracy.

Third, checking with artillery. It requires interface design of shipboard gun weapon system checking mode to provide fixed-point and uniform and sinusoidal velocity and running state checking,in order to alow the handlers master the servo performance of shipboard gun.

Fourth, zero-deviation checking. In order to ensure the consistence between the tracker axis and the gun barrel axis, the consistence should be checked,so we set up zero-deviation checking function on shipboard gun weapon system checking mode interface to provide checking methods.

Fifth, amending of calibration parameter. The inconformity of levelness interval and zero position between shipboard gun and observer could be achieved by software-revised. The amending function of calibration parameter should be provided in shipboard gun weapon system checking mode interface,in order to satisfy the amending requirement. When calibration parameter need to be amended, the interface provides authentication and authorization function to prevent illicit modification.

Sixth, records reappearance.

It can record the running processes,and reappearance the record at time be required for further analysis. The records reappearance function should be provided in shipboard gun weapon system checking mode interface ,in order to satisfy the analysis repeating requirement.

4. Demand of Design and Implementation

Manipulation device of informationised naval gun weapon system typically use a new generation of standard display and control console, each hardware module has a unified standard [4], which can be used based on the performance. In this case, the man-machine interface design select the hardware modules based on the system composition and manipulation requirements, focus on the expansion key, touch-screen buttons and the display page design. For such constraints, the in the design and implementation process of man-machine interface need to follow the principles below:

4.1. Principle of Consistency

Including the consistency of color, operation area, text and term definition. On one hand, the interface color, shape, font, and national or industry-wide standard are consistent [4]. On the other hand, the interface color, shape and font are self-contained, different equipment, the same design and the color of the same design state should be kept consistent. The consistency of the graphic design of the interface details can make operator concentrated and feel comfortable. Consistency of term definitions and in accordance with industry standards can reduce the training time and memory burden for operator, to facilitate naval gun handling staff positions interchanged from different models, different systems, reduce operational errors caused by different understanding to term [3].

4.2 Principle of Partition Comprehensive Highlight

The consistence of informatization shipboard gun weapon system is complex, and it is demanded that the console could display large amount of information. Information needed to be displayed must be classified by the level of urgency and importance, while the displayer should also be divided into different parts to separately show the information of image, status, decision, operation feedback and faults. When deal with urgent information, the media best combination principle[6] should be followed, and the highlight technical means (such as font or background color, sound, light, voice alarm, etc.), suggestion and help tips should be used, in order to shorten the manipulation of response time and improve control accuracy [6].

4.3. Principle of Safety

Naval gun weapon system man-machine interface design must take the security of the system operation into account. The design of man-machine interface mainly consists of two aspects:

(1) Operational safety

Due to the wartime tension or ships' bumps and other reasons will cause the controllers mistakenly hit misuse, such as mistaken hit work model, working status and other key. The mistaken operations above will cause system convert work model or change the running state, to take further steps "confirm" to eliminate misuse. Another example is the data input over a range of values, the pop-up text prompt dialog box will be prompted to re-enter [7].

(2) Data Security

Owing to a long voyage at sea, swing and weapons' impact cause structural deformation of the ship, which will lead to gun weapon system observation equipment, guns installation levelness change, zero inconsistent changes. All the parameters above affect the firing data accuracy. Firstly, man-machine interface design of gun weapon system must provide the corrected input function; Secondly, we have to be provided with modify password authorization, to agree to modifications after being approved. Thirdly, setting reasonable modifications value range to prevent modify unreasonable.

5. Conclusion

This paper systematically analyzes the human-computer interface design needs of information-based naval gun weapon system, provides a basis for the development of man-machine interface. In the process of implementing the concept of user-centered design, we also need to continue to find the problems, sum up experience, improve and further optimize the design of man-machine interface.

References

[1] Yan SY, etc. *Man-machine engineering of weapons*. Harbin: Publisher of Harbin Institute of Technology. 2009; 11.
[2] Liu WH, etc. *Modern man-machine-evironment system engineering*. Beijing: Publisher of Beihang University. 2009; 3.
[3] Yuan XG, Zhuang DM. *Man-machine engineering*. Beijing: Publisher of Beihang University. 2002; 3.
[4] Ding YL. *Science of man-machine engineering*. Beijing: Publisher of Beijing Institute of Technology. 2004.
[5] Chen X, Yuan XG. *Pandect of man-machine-environment system engineering*. Beijing: Publisher of Beijing Institute of Technology. 2000: 8-10.
[6] Xia HC, Zhang SL, Mao JZ. *Self-adaptive man-machine interactive frameworks of shipboard commanding system*. 2009; 32(2): 21-24.
[7] Li LS. Man-machine interface design for user cognition. *Spatial Design*. 2004; (7): 68-74.
[8] NFN Linawati, Gede Sukadarmika, GM Arya Sasmita. Synchronization Interfaces for Improving Moodle Utilization. *Indonesian Journal of Electrical Engineering*. 2012; 10(1): 2012.
[9] Fatimah Arofiati Noor, Ferry Iskandar, Mikrajuddin Abdullah, Khairurrijal khairurrijal. Numerical Simulation of Tunneling Current in an Anisotropic Metal-Oxide-Semiconductor Capacitor. *Indonesian Journal of Electrical Engineering*. 2012; 10(3): 2012.