Self-reliance in Salvo Launch of an Article

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Abstract

Defense-related operations such as firing of torpedo, underwater mines, and submarine-launched missiles and so on can be carried out from underwater platforms. This paper focuses on the activities when articles are launched from submersible platforms. In real-time scenario, after firing of an article, it is ensured that maximum damage is caused to adversary and that the operation must be finished in prerequisite duration and the mobile launcher should flee from that area in a short period. It details the factors that are considered while implementing the schemes for salvo launch in terms of fault tolerance, automated sequences, system modular design and various communication protocols. This system has been successfully implemented and tested for warfare activities.

Keywords: *automated sequence, fault tolerance, salvo launch, underwater platforms*

1. Introduction

In recent years, there have been significant and ongoing technical advancements that have, in some cases, drastically altered our way of life. The noteworthy thing about the current technological boom is that, in contrast to what happened following World Wars I and II, most advancements came from the non-military sector. Due to the possibility of rogue states and non-state actors to acquire capabilities that might asymmetrically influence the nature of conventional combat, such technological breakthroughs have also led to an extremely complicated strategic environment. For undertaking research, commercial, and naval operations, frequently in hostile and dangerous locations, submersible platforms [1] transporting objects are frequently utilised. In order to enable the successful accomplishment of its job, articles that are launched actually need to have a particular level of fault tolerance built into them. Every technique employed to boost this level of fault tolerance will expand the article's range of operational capabilities. As control engineering technology develops, the operating requirements for commercial, naval, and scientific underwater vehicles become more difficult.

Such vehicles must be equipped with a fault-tolerant or reconfigurable control system in order to survive actuator or sensor failure during a mission. Articles launched in salvo from underwater vehicles involves lot of safety issues which have to be taken care in the development phase itself. As the design and development of an article is a complex task, it requires expertise in almost all phases of engineering, from conception to finally launch stage. While designing and implementing the salvo launch of an article some major aspects that needs to be considered are fault tolerance, timing cyclogram, automated sequence and transfer alignment. This paper covers a brief design and analysis aspects of salvo launch of an article for modern warfare.

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2. SYSTEM DESCRIPTION

With advances in technology, there has been rising demands to launch an article in salvo mode. Successful launch involves various factors, of which the prime importance is preparation of article in smaller time duration and minimum human intervention. The preparation is carried out in various phases in a systematic phase manner before launch [2]. As a case study Figure 1 below shows the basic block diagram of a system in salvo launch. This paper considers two weapons during salvo launch. System consists of two main consoles which is responsible for controlling all the subsystems following it in conjunction with remote controller.

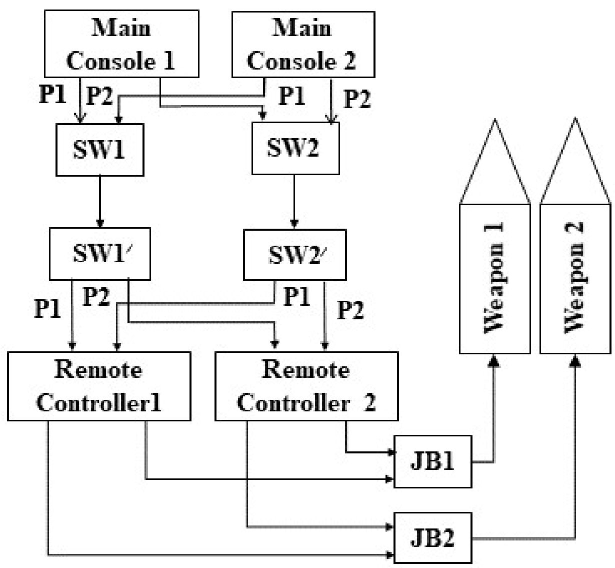

Figure:1 Block diagram of a system in salvo launch

In order to increase the reliability of the system fault tolerance is introduced in the main console and remote controller of the system. Cross connection is made via switches to check for and ensure against any system link failure. It is here whose health check and preliminary data exchange takes place. Provision is made for standby system to take up in case any failure occurs in main system. Redundancy elements have been added across all of the subsystems to account for the space constraints and to improve the whole power management [3] system's reliability and availability.

Subsystem redundancy has improved the power management system's ability to withstand faults. the arrangement of the entire system in a serial-parallel combination. A setup like that ensures the system won't operate with a single point of failure. All of the controls are GUI-based, and in addition to all primary displays, they also show the current drawn by each piece of equipment. The operator can watch both guns' operations via GUI displays prior to ultimate launch.

3. DESIGN CONSIDERATION

Provisions are made to launch the articles either in manual mode or in automated mode. Sequence of operations and launching of articles are predefined. It is ensured that the system has a series of automated phase sequences. It is necessary because for two articles in salvo launch, time scheduling is very important. Proper time delays [4][5] between the articles is ensured which should be free from any manual interventions. Operator sitting at the console has the provision to launch the second article or exit for the ongoing activities.

Fault tolerance [6] is introduced in the system in from of redundancy. Fault-tolerance as a crucial architectural feature of any systems has experienced substantial improvement over the past ten years in both understanding and application. A different approach to the fault problem is provided by fault-tolerance [6], in which the system's internal components handle fault detection and returning it to normal operation. The special quality of a digital system known as fault tolerance allows it to continue operating as a logic machine according to the program's specified behaviour even in the presence of defects. Because fault-goal tolerance's is to bring an error state back to the desired behaviour, ensuring the survival of information processing operations, it is possible to describe fault-tolerance as the logic machine's survival attribute. To reduce the danger of single point failure, fault tolerance is added to the system. Throughput and reaction times are unaffected, and the system does not experience any further changes [7]. Fault tolerance system use redundancy in both main system and subsystem. These systems continuously share the health and data information.

For people who depend on or utilise computers, fault tolerance provides important psychological support. The knowledge that fault-tolerance is being used will probably lessen the anxiety that exists when it is known that the very first component failure will be fatal [8] to the uninterrupted operation of the entire machine, even if the probability of such failure is very low. This is especially true when the failure of a system could endanger a person's safety or financial well-being.

A systematic series of design actions that includes explicitly stating the sorts of defects that are to be tolerated introduces fault-tolerance into the system architecture. Quantitative reliability goals are then set, and after that, a detailed evaluation of the dependability that the system has really reached is assumed. The purpose of recovery algorithms [9] is to restore the system to some level of normal operation or to securely shut it down. They are triggered by signals from fault detection algorithms.

Following the discovery of the defect, recovery refers to all steps that are taken. These might involve fixing errors, finding faults, excluding or changing out failed components, documenting what was done, restarting regular operation, or carrying out a safe shutdown. The failure of the system is caused by recovery algorithms that are unable to fulfil their task. Redesigning control sequences, adding spare processors or bus components, increasing storage capacity, and other changes to the original architecture may be necessary to accommodate the addition of recovery. With the use of analytical modelling, simulation, or a mix of the two, the fault-tolerance of a design is evaluated [11]. It is done to improve the design.

4. Emergency Procedures during Launch

Despite the efforts made to prevent failures, numerous systems have experienced faults while in operation. Because of this, most systems incorporate emergency procedures to identify error states that could be caused by design flaws, record them, and get the system to a place where external help could be requested to finish the analysis and restart operation. Although certain fault-tolerance approaches for physical defects are comparable to these emergency procedures, the function that is achieved is just the shutdown of all or a portion of the system.

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The entire set of hardware, software, and repetition (time) approaches that produce the initial fault signal are used to implement fault detection. Below is a useful breakdown of all these techniques based on when they were used in relation to the system's regular operation.

- Initial testing, which is done before regular usage and is used to spot defective hardware parts that may have flaws introduced during the manufacturing or assembly procedures.
- Concurrent (on-line) detection, which occurs in tandem with regular system operation.
- Scheduled (off-line) detection, which occurs when routine operation is momentarily halted.
- Redundancy testing, which is performed concurrently or at predetermined intervals and checks to see if the different defensive redundancies are fault-free in and of themselves.

5. Timing Cyclogram

To ensure timing cyclogram in salvo launch, both linear and parallel methods can be used, each with its own advantages and disadvantages. If the articles are launched in a linear manner, then it may cause delays in combat mode of operation which is not desirable in practical real time scenario. It is preferred to opt for parallel approach for operating the articles as it is less time consuming and also acknowledges the fault at the initial stage of launch. However, it makes the checkout system activities complex in nature.

6. Control and Guidance

For control and guidance, Initial Navigation System is precisely initialized prior to start of any operation. For controlling the power to the article subsystems and firing of pyros, reliability is ensured in the electrical schemes designed for article onboard and also on ground checkout system. Space optimization, redundancy and isolation among articles is ensured at the designing phase itself, GUI is made for proper identification of the weapons either in one screen or split in different pages. Both analog and digital parameters are also provided as displays on console.

7. Testing of Article

The system is tested for functional test, subsystem test, integrated test, phase checks, power consumption test, and failure mode test after design implementation. Software is developed using real time operating system VxWorks. GUI is implemented using Zinc Application framework on C++ language. Individual subsystems are tested using simulator. All protocol level validation is done and communication link failure is also tested in advance. During system level testing, actual system is tested with simulated articles instead of actuals. All ground and operational parameters are monitored and discrepancies if any is observed and tabulated. Electrical phase checks of the article are carried out in phases at subsystem and integrated levels. It is mandatory to carry out these checks before any launch operation activities.

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8. Conclusion

This paper covers in brief the design aspects and analysis of salvo launch of an article which is useful for present scenario where power and safety is of prime concern. Factors which influence the performance of the system during article preparation and launch is thoroughly verified valuated by suitable nominated committees before operating it in real-time scenario. Such study is not just confined to underwater circumstances; it may also be extended to ground-based systems.

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