

Testing of Embedded System, An Issues and Challenges

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ABSTRACT

The process of Testing of Embedded Systems contains distinct methodologies, modern techniques and innovative mechanisms. They are evolved continuously in order to match with rapidly changing industrial environment. In the case of Embedded Systems, Testing is very complex and critical job for testers. Testing of software is not enough, as parallel Testing of hardware is also required. Testing of all combinations of interfaces is usually not feasible in practice, because of large manufacturing cost. This paper proposes issues and challenges related to Testing of Embedded Systems. The main objective of paper is how to allocate the Testing techniques to Embedded System based on its characteristics and design.

Keywords: Embedded System Testing, Techniques, verification, validations, Artificial Intelligence.

1. INTRODUCTION

In the rapidly changing technology there is a need of electronically controlled computers to perform application specific functions. from toy to laptop, from cruise controller to satellite, variety of products are available in the market. The Embedded System is developed with variety of computing devices, digital signal processors, application specific integrated circuits and microcontrollers. A key requirement for the request, the service must be activated in the real time environment. Developers of an Embedded System have to measure and ensure safety and performance throughout the lifetime of the product. There is a need of a technique which identifies fault during normal operation of the product. The evaluation parameter for Testing may be is error coverage, error latency, space and time redundancy. Software Testing is the mechanism where computer program is executed number of times intend of finding of bug or error.

1.1 Embedded Systems

Embedded Systems are divided into two sectors, namely the Technical Scientific Algorithm based and the safety critical Embedded System. The former are traditional computers covering ordinary PCs, servers and super-computers. Their common property is that they can be programmed by a user and can be deployed for a large number of different applications. But nowadays, new applications come into being which demand characteristics that cannot be provided by safety critical systems for technical reasons. To meet the requisites, special-purpose systems were developed. They are programmed once and provide service for a specific task without any further interaction with the user. Due to the demand of new and more efficient applications, Embedded Systems gain in importance. The Testing of Safety critical Embedded System is more difficult job.[8].

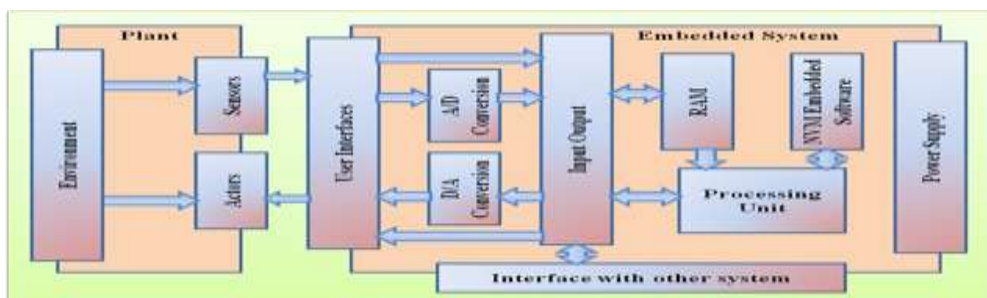


Figure 1. Development plant of Embedded System

2. CLASSIFICATION OF EMBEDDED SYSTEMS

The embedded Testing environment presents unusual challenges to a tester. As we are dealing with heterogeneous Embedded Systems each Embedded System is developed as application specific one and having different approach for Testing. The resource, performance, and timing constraints of real time Embedded Systems suggest that significantly more powerful Testing techniques should be applied during the final and ending stages of program development. very first task have to conduct is separation between the execution platforms and application development. Embedded system testing depends upon the differential execution platforms. It depends on the cross-development environments, It also depends on wide range of deployment architectures, Coexistence of various implementation paradigms like the tight resources and the strict timing constraints on the execution platform, Lack of clear design models, Emerging quality and certification standards.

3. ISSUES AND CHALLENGES IN EMBEDDED SYSTEM TESTING

Several difficulties occurs while Testing of Embedded Systems. Manufacturing of Embedded Systems are very costly amongst all of the systems, as they are the combination of software and hardware. In a normal life from morning to night there is a requirement of such systems, which are electronically controlled by the software and hardware. System must behave intelligently. Embedded Systems are complex and critical, which are not easy to repair. And the Testing process of the system is very complex, critical and expensive. For this reason continuous monitoring detection and diagnosis is essential for the systems. We know that the hardware is manufactured not developed. Due to the environmental factor corrosion, erosion occurs in hardware and no chance of repairing we have to just replace them.

Embedded System sometimes can be used for storage, computing or to perform few dedicated or specific functions. It is an electronically controlled device with an integrated computing facility. It is embedded, as a part of complete device often including hardware and mechanical parts. There are various tools available in market for Testing software and for Testing the hardware. Some of the Embedded Systems are tested on the basis of their platforms, where they are developed, methodologies, which are used to test them, evaluation parameters, on which they are tested. For Testing of Embedded System certain life cycle is required. Design and development of Embedded Systems can be performed parallel. Individual development life cycle required for development of software as well as for hardware. The Testing is required from planning to turn over phase. In the case of Embedded System it is a dual job as we test software parallel with hardware

In order to develop and conduct hardware and software Testing in Embedded Systems, developer and testers have to face several issues and challenges. System failure occurs only because of interaction between hardware and software. It is important to understand the importance of Testing of Embedded Systems ,as all of its functions are very complicated. While defining Embedded Systems we can say software is embedded in the hardware in order to perform dedicated and specific task. For the Testing of Embedded Systems there is a need of specialized compiler and development software, which offer means for debugging. Verification and validation techniques are required in order to test the system. Verification process is carried over in the design phase to ensure that the manufactured design will behave as expected or not. The great difference between verification and Testing is the Testing perform in manufacturing state to ensure that the device which is manufactured is defective or not.

The embedded Testing environment presents unusual challenges to a tester. As we are dealing with heterogeneous Embedded Systems each Embedded System is developed as application specific one and having different approach for Testing. These systems are characterized by life cycles infrastructures, techniques, organization which can be treated as basics of approach, aggressive and particular microprocessors, performance sensitive devices, and real-time applications. Testing techniques are failed to satisfy either the accuracy or performance requirements, and the tester must program separate code for Testing of each Embedded System. The rapid growth in the Embedded Systems suggests that not enough automated Testing tools are solving Testing problem of Embedded Systems.

4. CHATEGARISATIONS OF EMBEDDED SYSTEMS

Techniques can be allocated depending on some important factors on the basis of how Embedded System was developed. First is Lifecycle, Second is infrastructure, and last is organization.

A. Testing based on Life Cycle.

Research plan begins with Embedded System's Testing life cycle, were all of Testing requirements are analyzed, test plans are designed and coded. Life cycle gives information of by what and when the Testing will be conducted. The verification and validation techniques are used.



Figure 2. Life Cycle of Embedded System Testing

The clean room software engineering concept is to start Testing from very early phases of life cycle, so that at the last we get error free system. Planning and control process for test cases are carried out for all over the system. First phase is Recognition analysis where requirements are identified. The next phase contains conversion of requirement to technical specification. Third phase contains coding and execution of test cases. Last phase contains completion and turnover. The basic idea behind the lifecycle is to try to do as many activities as possible as soon as possible, away from the critical path of the project. When the system to be tested is delivered to the tester in the execution phase, it would be a waste of precious time if the tester only then starts to think what exactly the test cases should look like. This could, and should, have been done in the previous phase, specification. It would be equally annoying if the tester could not start specifying test cases during the specification phase because it still has to be figured out which design techniques to choose and how they can be applied to the system specifications just received. This should have been done in the previous phase, preparation.

Although the lifecycle may explicitly show more activities than the test organization primarily thought of, it does not necessarily add extra activities. It merely makes a clearer distinction between the things that must be done and arranges them more efficiently and effectively. When applied wisely, the life-cycle is a powerful mechanism for saving time when it matters most, on the critical path. Testing is performed in all of development processes of Embedded Systems. Planning and control is provided to Recognition analysis, Specification, and Execution and completion phase. Different Embedded Systems are identified before considering under test. If we will take ten numbers of Embedded Systems and we have to test them under one platform, first we have to identify their type. In order to test them via one tool as it is a very difficult task. Embedded System is the application specific one and each Embedded System contains its specific Testing tool. It contains hardware as well as software, so there is a need to test hardware as well as software.

B. Testing based on Infrastructure

Infrastructure is responsible to give information by what the Testing is going to be conducted. Infrastructure provides platform for Testing. It is responsible to generate test environment. It also provides test execution and test automation and other facility for staff and workers. Infrastructure contains Test structure planning and execution, which plays very important role. The infrastructure contains technical as well as non technical items in Technical part hardware software and in non technical management, staff worker are considered. Testing based on infrastructures is basically used to test capability of system.

C. Testing based on Organization

Organization is responsible to give information by whom, Testing is going to be conducted. It gives the roles of expertise customer developer and tester in Embedded System development. Organization gives information about the persons who are in picture. Organization divided into non technical and technical way, non technical contains staff, their training, their roles and responsibilities and technical means Test organization, test structure, test products and so on. In the organization section platform is developed to conduct test mechanisms for Embedded System Testing. Testing of set top box is obviously not similar to Testing of whether forecaster.

5. DIFFERENT TECHNIQUES FOR EMBEDDED SYSTEMS TESTING

verification and validation are the most popular techniques used for Embedded System Testing. Testing is detective and verification is corrective measures of quality. Verification is performed via simulation, hardware emulation and formal methodologies, which is responsible for design quality. Testing is a two phase process, where test generation and application are performed. In the test generation software processes executed ones during design. In the test application electrical tests are applied to hardware and perform on every manufactured device. Testing is responsible for quality of

devices. In the rapidly changing technology there is a need of electronically controlled computers to perform application specific functions. from toy to laptop, from cruise controller to satellite, variety of products are available in the market. The Embedded System is developed with variety of computing devices, digital signal processors, application specific integrated circuits and microcontrollers.

A key requirement for the request, the service must be activated in the real time environment. Developers of an Embedded System have to measure and ensure safety and performance throughout the lifetime of the product. There is a need of a technique which identifies fault during normal operation of the product. The evaluation parameter for Testing may be is error coverage, error latency, space and time redundancy. Software Testing is the mechanism where computer program is executed number of times intend of finding of bug or error.

Some algorithms used popularly to test the Embedded Systems. First one is Heat and Jump algorithm. For component Testing is Hit and jump algorithm is used. Memory Testing uses March Algorithm. Test case automation can be performed via March algorithm[14]. For input and output signal Testing neural network approach that is Levenberg Marquarate algorithm is used. Pseudo code algorithms are used in some language related built in Embedded System Testing . For Technical Scientific algorithms based Embedded Systems Testing evolutionary algorithms are used. An evolutionary algorithm uses mechanisms inspired by biological inspired evolution, such as reproduction, mutation, recombination, and selection. In optimization problem Candidate solutions plays an important role of individuals in a process of population, and the fitness function used to determines the quality of the solutions. Artificial evolution describes a process involving individual evolutionary algorithms[13].Black Box and White box Testing are conducted in order to test embedded hardware and embedded software. Now a day Host based or Target based Testing is used for Testing of Embedded System Testing.

6. CONCLUSION

In this research paper we have studied different types of Embedded Systems and there Testing techniques. rather than finding Testing mechanism, if we will more focused on its type and categories them in broad range , we can solve their Testing problem. this paper discusses different issues and challenges of Testing of Embedded Systems as well some techniques with the help of which Testing of Embedded System can become easy. For minimizing high cost related issues some simulator also developed on host and Target side. For Complex designing some Tools can be used to automated test cases. In this paper we have seen how to solve the embedded system testing related problems ,we also seen how to categories embedded systems based on its lifecycle ,Infrastructure and organization.

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