Software Testing Techniques in IoT Applications

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Abstract: The main goal and objective of Internet of things are control, management and co-ordination of various fields in a comfortable, effective and secure way. Another important emerging technology is Artificial Intelligence for developing automatic systems that learn from environment, can perceive the environment and make decision making using test case based reasoning. In various domains or areas of knowledge-based, vision ability, learning capability, decision making capability and analytical reasoning, the Artificial Intelligence (AI) provides a better solution for almost all automatic systems. This paper discusses software testing types for home automation systems and how these system can utilize the Artificial Intelligence techniques for test case generation so as to increase its effectiveness, powerfulness etc.

Keywords: IoT, Testing Techniques, Test case, Artificial Intelligence

I.   INTRODUCTION

The internet of things is continuously changing and evolving to emerge from initial visions to final industrial solutions, which are seen in our day to day lives. The IoT realizes machine to machine learning that can be considered as the future evaluation of the internet [9]. IoT provides lively development of these solutions that brings a number of challenges in which the objects can communicate, share information and do decision making to embed some intelligence in various types of service.

II.   THE ROLE OF AI IN SOFTWARE TESTING

Software development companies in India use AI testing. The use of AI techniques and methods in development and testing of the software product is a dynamic area of research that prompts the cross treatment of thoughts between the two fields. Assortments of AI tools and techniques are used to create test information appropriateness, advancement and examination of the scope as well as test management. A large number of assignments are automated.

2.1 The use of AI in GUI Testing

There has been a developing environment in using AI for user interface testing. There have also been some analysis and process of examination into how GUI testing could be managed with the assistance of AI.

2.2 Application Testing

Banking Application domain, deals with confidential financial data. It is essential that all the activities performed by banking software execute tasks smoothly without any error generation [2].Banking software perform various activities like transferring and depositing the funds, balance inquiry, transaction history, withdrawal and so on. Testing the banking application software assures that these activities are not only executed well but also remain protected from hackers.

2.3 Test phases in Software Testing

2.3.1 Requirement Analysis

This analysis is done by the business analyst; software requirements for a particular banking application are gathered and documented.

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2.3.2 Requirement Review

Quality analyst, business analysts and development heads are involved in this activity. The requirement - gathering document is reviewed at this phase, and cross verified to ensure that it does not affect the workflow environment

2.3.3. Business Requirement Documentation

Business requirement documents are prepared by the quality analyst by whom all reviewed business requirements are covered.

2.3.4 Database Testing

It is the most important phase of testing in application. This testing is done to ensure loading of data, stored procedure and function verification, validation, etc.

2.3.5 Integration Testing

During this type of testing, all the software components are integrated and validated.

2.3.6 Functional Testing

The usual software testing activities like test case planning, test case generation and test case execution are done during this phase

2.3.7 Security Testing

This testing ensures that the software does not have any security flaws .During test case preparation, QA team needs to include both negative and positive test case scenarios so as to break into the system and report it before any unauthorized individual accesses it. To prevent unauthorized access and hacking, the bank should also incorporate a multilayer access validation like a onetime password.

2.3.8 Usability testing

It ensures that differently abled - people should be able to use the system like normal user.
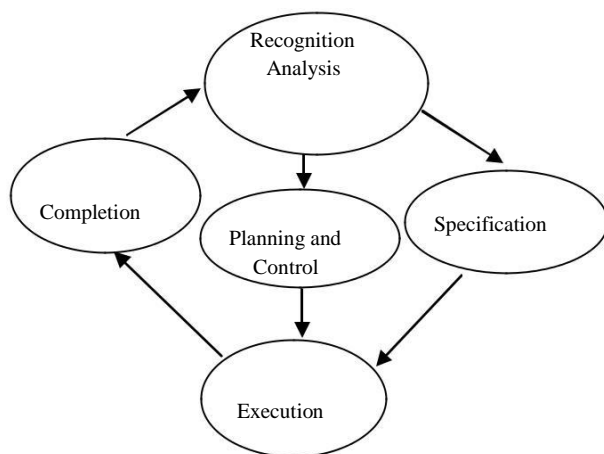
II.   RESEARCH WORKPLAN

Fig. 1: Lifecycle of IOT Application System Testing

Table: 2 Negative Test case for Fund Transfer in Banking Application

S. No.	Test Case	Pre condition	Expected output	Actual Output	Status
1	Check Account Balance	if Account <1000	Transfer is not allowed	Transfer is not allowed	Fail
2	Enter Authorization code	Asfdsdf213232	Code is invalid	Code is invalid	Fail
3	Enter Account Number	23sdfsfds4345	Invalid Account Number	Invalid Account Number	Fail
4	Enter Transfer Amount	If Account <max Limit	Amount cannot be transferred	Amount cannot be transferred	Fail

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In Fig 1: Testing is carried out in all the aspects of software development lifecycle. Various Categories of Embedded system using IOT application are required before testing [3]. The black box testing is carried out on the application that checks the input and output of the system in order to compare the safety critical character of the embedded system. Research plan begins with different smaller experiments to study how an IOT application testing is carried out using Artificial Intelligence approach to test it

[10]. In this approach, the characteristics of the application in the devices are monitored, analyzed and tested.
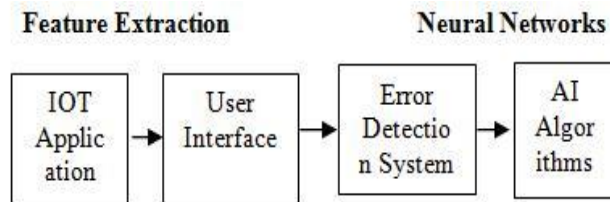

Fig. 2: Block diagram of Artificial Intelligence Testing

The test cases are often written for test types called functional testing and GUI testing in which the test case design techniques are applied such as equivalent partitioning, boundary analysis, constraint analysis, state transition and condition combination to design the test cases [4].

IV. TEST CASE GENERATION

Table 1: Positive Test case for Fund Transfer in Banking Application

S.No.	Test Case	Precondition	Expected output	Actual Output	Status
1	Check Account Balance	If Account >1000	Transfer is allowed	Transfer is allowed	Pass
2	Enter Authorization code	435345345435	Code is valid	Code is valid	Pass
3	Enter Account Number	67657676732	Valid Account Number	Valid Account Number	Pass
4	Enter Transfer Amount	If Account> max Limit	Transfer Amount Successfully	Transfer Amount Successfully	Pass

In an IoT project, it is necessary to assure that the device is difficult to hack. i.e., it is necessary to assure that the firewall and virus protections are functioning correctly or that there is no way that a hacker can affect or divert the operation of the device [9].

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V. APPLICATION OF AI IN HEALTH CARE

Testing is very much essential in case of medical imaging for diabetic retinopathy and in dermatology.
In this application, early diagnosis or treatment is very much essential to prevent a possible vision loss and blindness among the increasing population of diabetic patients [5] .AI is required to find other eye disease and also to identify indicators of cardiovascular diseases. It analyses quantitative retinal image and creates a demand for expert analysis Validation of such images require skilled readers and may be performed with assistance of remote specialists.

VI. APPLICATIONS OF AI IN HOME AUTOMATION

A. In case of Remote Controlling System, AI can be applied in the knowledge - based database, which should be learnable for the system to be more comfortable [1]. The cost of the system is high with the AI tools, but makes the system truly comfortable, flexible, easily upgradable etc.

B. Use of AI in analyzing the performance of Resource In this system AI technique can be used to create knowledge - base for previous systems and for Analyzer, as it makes it more efficient in performing the assigned task. However, if analyzer is learnable from its experience, then it will make the system more optimal and efficient. B. Use of AI in Secure Systems

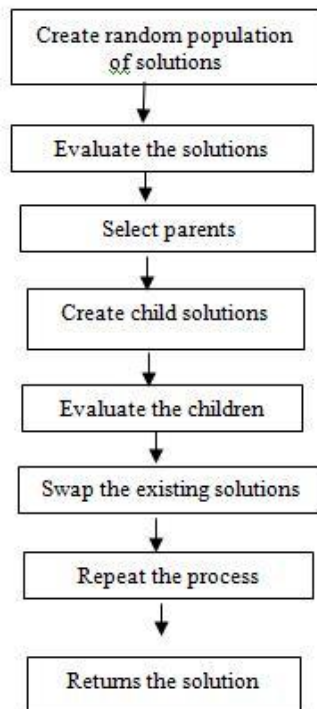The biggest use of AI is in these systems. AI tools can be applied for various applications:

1) Video Processing tool for security threat analysis

2) Image Processing tool for security threat analysis

3) Audio processing tool for security threat analysis

4) Knowledge based technique for Security system database

5) Case based analyzing and reasoning technique for analyzer and synthesizer.

6) Decision - making system in Security Checking and Decision making

So, these systems use the AI exhaustibly. At present, even though different technologies are used for implementing these systems, but in the near future, AI will be the only implementation technique behind these systems as it is proved to be more a sophisticated and effective tool for listed applications.

VII. ALGORITHM FOR TEST CASE GENERATION

The genetic algorithm is an empirical approach that has the capability to arrive at solutions for optimization problems. The genetic algorithm involves the process of creating solutions randomly and evaluating them. After the process of selection the better solutions are identified and used to generate new solutions [6]. These values can be replaced with other lesser members of the population. The revaluation process is carried out for generating new values until the final solution is determined.

Genetic algorithm is a very effective and the most efficient way of quickly finding a feasible solution to a critical problem. It can be used to create solutions that are not easy to test and analyze. This algorithm is mainly used for test environment and can derive quick solutions to the problem. The parameters are to be identified in this case in order to build an efficient function and bind them into a binary string. These algorithms mainly focus on a single objective search and optimization algorithm. Common to most Genetic algorithms is the use of a chromosome, genetic operators, selection mechanism and evaluation mechanism. Thus, to increase the efficiency and process time of Software testing, Genetic Algorithms are being used to provide us with the means of an automatic test case generator. The evolutionary generation of test cases is applied, and it proves to be more efficient and cost effective than Random Testing [7].

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VIII. CONCLUSIONS

In this research paper various factors responsible for the classification of techniques have been reviewed and discussed. This paper has also evaluated IoT implementation techniques along with Artificial Intelligence technique. The test cases are generated for various applications to check their functionalities. Genetic algorithm is one of the most efficient algorithms that can be used for test case generation.

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