

A Survey Paper - Mobile Applications Testing: Challenges and solutions through Automated Techniques

Heema Goratela|| Dhruvi Kakadia|| Krushi Panchani|| Hetanshi Darbar

Student|| B.Tech-Indus University

Mentor: Sejal Thakkar, Indus University

ABSTRACT:

Due to immense development of mobile devices, mobile applications have engrossed a large market. Due to rapid increase in number of users of mobile applications, it is concern for researchers and software professionals to devise appropriate software techniques to ensure the unfaltering quality of these mobile applications. As the development life cycle of mobile applications is small-scaled, the developed apps tend to be malfunctioning due to negligence in ensuring the quality of app. The purpose of our research is to mainly investigate the general methods and tools used for mobile application testing in different software companies, challenges faced by that companies and analyze solutions to those challenges. Mobile application testing techniques are categorized either as manual or automated techniques. But more emphasis is given to automated approach due to its assorted advantages. This paper discusses the various automated techniques used for testing mobile apps along with comparison of manual and automated testing approaches. It investigates new conducts in research on the type of testing and skills required for mobile application testing

KEYWORDS:

Mobile application testing, automated testing, software testing, systematic literature review, testing techniques, literature review method.

INTRODUCTION:

Mobile devices are swiftly acquiring over desktop computers and are becoming a very essential part of our lives. With the increase in use of mobile devices, necessity of ensuring the application quality is also surging. Testing is one of the prominent factors in increasing application quality. Mobile app testing is different from testing of desktop applications, as apart from regular functional and UI requirements we also have to consider factors like device hardware, screen size, platform, connectivity issues and many more.^[1] There are certain limitations that need to be considered while performing mobile app testing like Performance Factor, Power Factor, Band Factor, Connectivity Factor, Context factor, Graphic Interface Factor, Input Interface Factor.

1. *Mobile application testing*

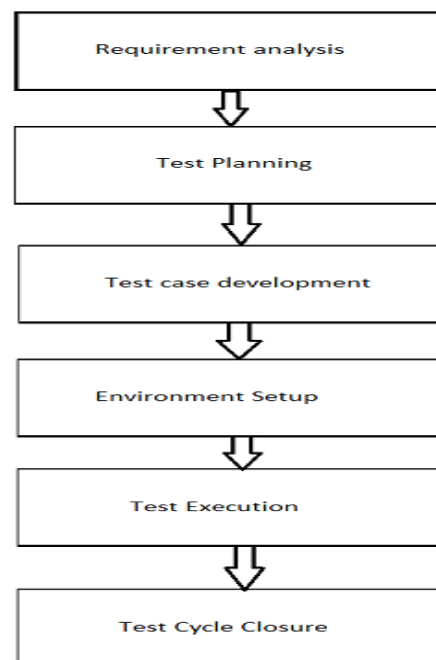
Mobile application testing is a process by which application software developed for hand held mobile devices is tested for its functionality, usability and consistency^[1]. Software testing of applications is not an insignificant task due to various factors such as variability of inputs required by mobile devices and the heterogeneity in technologies used to execute them. Our main focus is to investigate various characteristics of mobile apps and how they further impact the testing technique which will affect the quality of application.

1.1 Characteristics specific to mobile applications

- Limited energy: All mobile devices are powered by battery, so applications must be programmed in such a way that it requires minimal amount of resources, as more the no. of resources greater will be the use of battery power.
- Graphical Interface: Due to the reduced screen size, the interface design is limited.
- Input interface: It describes the form in which the user will interact with application, whether it will be touch screen, stylus or keypad.
- Limited Performance: Due to its size and technological advancement all mobile devices, even the most advanced in its class, have limitations of specific resources such as processing power, memory and connectivity. Because of this, the performance is limited.
- Reduced memory: Due to limited hardware size, less memory is available.
- Connectivity: Mobile applications can developed to support several types of connectivity like 3G, 5G, Bluetooth, Wi-Fi etc. In addition, a single application can also support multiple connectivity's simultaneously.
- Constant interruption of activities: Mobile applications should be prepared for various scenarios and should be able to work in offline and online mode. Low network connectivity, calls, low battery are some interruptions that the applications should overcome.
- Portability: It is of two types: Hardware, application should be able to run on huge number of devices. Software, applications should be compatible with all types of operating system.

1.2 Testing life cycle of mobile application

The testing life cycle of mobile applications contains various activities that help in mending the testing of mobile applications. The below figure shows the different phases of life cycle.



- Requirement analysis: Identifying the testing environment and feasibility of the testing approach used, also the details and priorities of the test.
- Test planning: Test strategy is prepared, various testing tools are analyzed and roles and responsibilities to individuals in team is assigned.
- Test case development: Here test cases are prepared, if automated testing is used, then then scripts are created for test data.
- Environment setup: Software and hardware are planned for testing.
- Test execution: Here test cases are executed as prepared.
- Test cycle closure: Test cycle completion is evaluated based on criteria like test coverage, time spent and a report is made for the same.

2. TYPES OF MOBILE APPLICATION TESTING METHOD

2.1 Automated app testing

It is used in order to test features that require a high load of tests to be executed simultaneously, as well as those that require a large amount of data^[3]. It is an approach that uses tools and methods without human intervention to find defects and access the performance of product. Here the QA specialist will write different scripts which will automatically test the product.

^[1]Various advantages of automated testing:

- 1) Time Saving
- 2) Defects are identified
- 3) Higher quality software
- 4) Accuracy is high
- 5) Test cycles are also fast
- 6) Lower cost even though initial cost is high but they are compensated with long term use.

2.2 Manual app testing

It relies on human supervision only. This approach presumes that the QA specialist will execute the test on his own from beginning to end without using automated tools, extensions, or scripts^[3].

2.3 Manual Vs Automated testing

Manual testing is performed by a human(QA analyst) while a computer performs automated testing using scripts, code, automated automation tools. Automated testing is quicker than manual testing. Both the testing requires adequate amount of investment. Manual testing is less reliable than automated testing due to high risk of human mistakes. Hence automated testing approach is mostly used to ensure effective quality of mobile application. Also automated testing uses different frameworks to support tools.

2.4 Tools for automated testing

- AndroidRipper: It is an automated tool for GUI testing. It is operated by ripper interface that automatically travels the apps GUI aiming at implementing a given app in structured way.
- Monkey: It is a test framework released and maintained by Google, the official maintainer of Android. It generates and sends pseudo-random streams of user/system events into the running

system. This functionality is exploited in the literature to automatically identify defects of ill-designed apps.

- **RERAN:** It is a record and replay tool for testing Android apps. Unlike traditional record-and-reply tools, which are inadequate for Android apps because of their expressiveness on smartphone features, RERAN supports sophisticated GUI gestures and complex sensor events.
- **Robotium:** It is an open-source test framework, which has full support for native and hybrid apps. It also eases the way to write powerful and robust automatic black-box UI tests of android apps. It executes its generated test cases.
- **Robolectric:** It is a unit testing framework, which simulates the Android execution environment (either on a real device or on an emulator) in a pure Java environment. The main advantage of doing that is to improve the testing efficiency because tests running inside a JVM are much faster than that of running on an Android device.

3. TESTING ENVIRONMENTS

3.1 *Real device*

Here testing is done in real android device and it can be used to test apps with respect to compatibility aspects and poor responsiveness issues. Unfortunately, using real devices is not that efficient and useful as it cannot scale in terms of execution time resources.

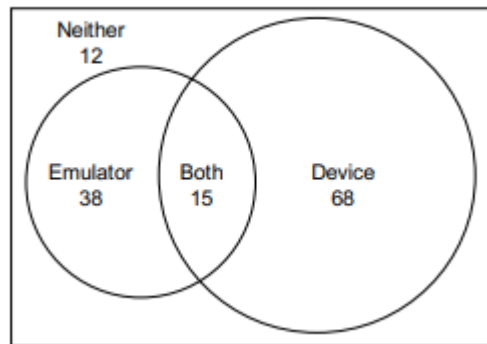
3.2 *Emulator*

It is a type of virtual device where we can test mobile apps. An emulator provides a real time environment and same features as the real device. On contrary to real device, an emulator is scalable. When deployed on the cloud, using the emulator can grant a tester great computing resources and carry out parallel tests at a very large scale^[4]. Unfortunately, emulators are ineffective for security-relevant tests, since some malware have the functionality to detect whether they are running on an emulator. If so, they may decide to refrain from exposing their malicious intention. Emulators also introduce huge overhead when mimicking real-life sensor inputs, e.g., requiring altering the apps under testing at source code level.

3.3 *Emulator + Real device*

The combination of these two can be leveraged to test android apps. For example, one can first use an emulator to launch large-scale app testing for pre-selecting a subset of relevant apps and then resort to real devices for more accurate testing.

As can be seen from figure below, real devices are largely used by 68 publications in our final list. Only 38 publications used emulators, despite the fact that they are cheap. 15 publications chose both environments to avoid disadvantages of either. Deducing these 15 publications, we then concluded that 23 publications focused solely on emulators, where 53 publications selected real devices as the only environment.



Venn diagram of testing environment

4. FUTURE CHALLENGES AND SCOPE IN MOBILE APPLICATION TESTING

4.1 Challenges in testing mobile applications

- 1) Fragmentation: Multiple devices in the market with different versions of OS.
- 2) Testing on multiple devices: Due to enormous availability of mobile devices, it is not possible to get new device everytime and simulators are also not reliable.
- 3) Time to market: Marketing time is reduced and the release cycles are very short.
- 4) Newer Versions: The upgraded version which means there is new release of android version every 6 to 8 months.
- 5) Multitasking: Because of the small screen size, it is hard to show many applications at same time. With multiple applications open and running in background consumes a lot of battery.
- 6) Form Factor: There are different form of Mobile devices such as phones and tablets. Developing the apps for different forms is related but designing apps for them is very different.
- 7) Diversity: The diversity of handsets in terms of screen size, OEM, operators.
- 8) Emulator Vs. real device: Testing on emulators is cost effective as testing can be done quickly and efficiently. While testing on real devices helps to understand the application activities in real-life setups.
- 9) Manual Vs. Automated: Automated testing is cost effective, fast and more but it requires a large amount of initial cost.

4.2 Scope of mobile app testing

- 1) Unit Testing: It is performed to check app code structures to find bugs and errors.
- 2) Integration Testing: It is performed to verify that the interfaces between components works as expected.
- 3) System Testing: It is performed to ensure that the entire system of the mobile application meets all the specification specified by the application.
- 4) Regression testing: It is performed to ensure that the basic functionality is not affected due to any changes made and new features works fine as expected.
- 5) Compatibility Testing: It is performed to assure that application works as intended with the selected device,

operating system, screen size, display and internal hardware.

6) Performance Testing & Stress Testing: It is performed to load and stress test the mobile application and database servers.

7) UI Testing: It is performed to ensure that the end user's experience is efficient, effective and satisfactory for user application.

LITERATURE REVIEW TABLE:

S r. n o	Paper title	Refere nce	Publis hing year	Author	Descriptio n	Challenges	Result
1	Automated Testing of Android Apps: A Systematic Literature Review	Research Gate	2016	Pingfan Kong, Li Liξ, Jun Gao, Kui Liu, Tegawende F. Bissyand'e, Jacques Klein	A systematic literature review is conducted highlighting the challenges that Android testing researchers should strive to address in future. Also a few research directions are proposed to solve current issues in app updates, continuous increase in app sizes, Android ecosystem fragmentation.	1.Satisfying Fastidious Pre-conditions. 2.Modelling Complex Events 3. Bridging Incompatible Instruction Sets 4. Evaluating Testing Approaches Fairly. 5. Addressing Usability Defect	A detailed taxonomy of research has been concluded exploring several dimensions and future challenges in the field of Android app testing.

2	Review of Mobile Applications Testing with Automated Techniques	IJARC EE	2015	Anureet Kaur	This paper describes the characteristics specific to mobile apps along with comparing various automated techniques for mobile applications .	1) Fragmentation 2) Testing on multiple devices 3) Time to market 4) Newer Versions: 5) Multitasking 6) Form Factor 7) Diversity 8) Emulator Vs. real device 9) Manual Vs. Automated	Through this paper we have concluded that, Manual testing for mobile apps is time consuming and due to short development life cycle of mobile apps it is difficult to use manual techniques. Various automated testing techniques has replaced manual testing .
---	---	----------	------	--------------	--	--	---

3	Mobile Application Testing and Challenges	Citess erX	2013	Ravi Ramchandra Nimbalkar	This paper describes basic idea of mobile application testing and their challenges in future.	<ol style="list-style-type: none"> 1. The major challenge in Mobile App Testing is the multiplicity of mobile devices with different capabilities, features and restrictions 2. These extra hardware elements in mobile apps place additional demands on the tester, particularly in terms of isolating a bug to hardware or software. 3. Good usability testing, carried out in conjunction with key users, in their own environment, is essential. 4. The developers need to focus on developing applications that are easy to use on a mobile and consume less power. 	We have concluded that we can design and develops better quality of mobile apps by testing each aspect of mobile apps such as functionality, usability and consistency. Our analysis shows that, that we can never use the same testing methodologies as we have been using on the conventional web and desktop applications. We have to devise a new strategy and methodology,
---	---	------------	------	---------------------------	---	--	---

4	Mobile Application Testing – Challenges and Solution Approach through Automation	IEEE	2013	B. Kirubakaran Dr. V. Karthikeyani	This paper wants to investigate new directions in research on the type of testing and skills required on mobile app testing by analyzing the current trends in mobile application development and testing, and by proposing my view on the topic.	The need of automation in testing mobile applications is exacerbated by two orthogonal aspects: i) Cost of testing: the common perception on mobile applications is that they must be cheap, and cost much less than traditional applications. On the other side, they must be performant, reliable and correct. Automation is certainly among the most important means for keeping the cost of testing low, while guaranteeing an adequate degree of dependability. ii) Testing through the layers: current bugs are due to interoperability problems that exist today among the application	This short paper has tried to provide an overview on what testing mobile applications is and can be in the next few years. This paper concludes that performance, security, reliability, and energy are strongly affected by the variability of the environment where the mobile device moves towards
---	--	------	------	---------------------------------------	---	---	---

5	Automated testing of mobile applications: A systematic map and review	Research Gate	2015	Abel Mendez Porras, Marcelo Jenkins, Christian Quesada-Lopez	This paper reports on a systematic map and review. Automated testing approaches for mobile applications, testing techniques, and empirical assessment are identified, mapped, and characterized. We investigate the major challenges in automated testing of mobile applications. An analysis and synthesis of these studies is conducted.	For future activity we would like to set up a search engine unit to achieve more coverage courses in systematic book reviews. In addition, we would like to do a comprehensive analysis of each strategy described in the lessons. And, we will do it like to do a test study and compare tools available according to the revised studies.	In latest age, number of suggestions for automatic mobile software testing requests abound. In 40% of subjects, testing strategies use application-based GUI models. More research is needed, in to improve the creation of effective and efficient models for automated testing of mobile applications.
---	---	---------------	------	--	--	---	--

CONCLUSION:

In this review paper, we have analyzed the use of different mobile application testing techniques. Also the comparison between mobile devices applications to other applications that run on desktop/laptop is done. We have discussed how automated testing is better than manual testing and described different tools used for automated testing. A comparison between these techniques is reviewed which helps the mobile app tester in choosing the appropriate method keeping in view the tool support, platform on which they want to work on and test coverage supported by the technique. Also challenges and scope in relation to automated mobile testing and comparison of various testing environments is mentioned.

REFERENCES:

- [1] <https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.682.803&rep=rep1&type=pdf>
- [2] <https://ieeexplore.ieee.org/document/6496451>
- [3] <https://performancelabus.com/manual-automated-mobile-testing/>
- [4] <https://www.diva-portal.org/smash/get/diva2:1313292/FULLTEXT02>
- [5] https://www.academia.edu/Documents/in/Mobile_Application_Testing
- [6] https://www.researchgate.net/publication/254041958_Software_testing_of_mobile_applications_Challenges_and_future_research_directions
- [7] <https://www.ijert.org/research-challenges-in-mobile-application-testing>