

## **A Model Based Approach for the Development of Consistent User Interfaces Ensuring an Enhanced User Experience**

Muhammad Ilyas<sup>1</sup> and Aisha Tehreem<sup>2\*</sup>

<sup>1,2</sup>*Department of Computer Science and Information Technology, University of Sargodha, Sargodha, Punjab, Pakistan*  
<sup>1</sup>*m.ilyas@uos.edu.pk, <sup>2</sup>aishatehreem\_88@yahoo.com*

### **Abstract**

*User interfaces are the most important part of interactive software applications; being the entities which serve as a communication bridge between users and applications. Furthermore the user experience provided by any software application is the only factor to measure its success. Therefore an application can only be successful if besides having a worthy user interface, it also provides a pleasant user experience. Design of a good user interface suffers a lot recently with a rapid increase in the number of electronic devices as each device has its own constraints and capabilities that force the same application to run in multiple ways on multiple devices, thus generating the problem of inconsistent user interfaces. This situation also prohibits the provision of a good user experience as user interface is a very important aspect among many other aspects of user experience. In this paper; a framework is proposed that makes it possible to design multiple but consistent user interfaces of an application and also provides a wonderful experience to the end users. The proposed framework is validated by developing two different versions of a single interactive software application for two different devices. The development process is done by following the proposed framework. Final user interfaces of both versions are then compared to check consistency. This comparison shows that both user interfaces are consistent to each other and thus the proposed framework is validated.*

**Keywords:** *User interfaces, user experience, user experience design, consistency, interactive software applications, multiple electronic devices*

### **1. Introduction**

The work presented in this paper focuses on the development of consistent multiple user interfaces and provision of great user experience of any software interactive application. Consistency makes sure the same visual appearance and interaction mechanism for different versions of a single interactive application while user experience design is related to the development of any application in such a way that it just not only accomplishes user tasks but also provides them a delightful, pleasant and amusing experience. User Experience Design is about effectively addressing the needs and circumstances of your users, to produce an interface that is comfortable and even joyful to use [10].

User interfaces (UI) have their history back to the invention of computers. User interface design is an important component of HCI system [7]. Generating a great user interface design is becoming difficult with the increase in the number of interacting and computing devices. As the devices are increasing they are posing serious challenges for user interface design and development. Reason is that now user interfaces have to run on multiple platforms ranging from powerful workstations to tiny cellular phones. Recent introduction of a large number of electronic devices such as desktops, laptops, mobile phones, notebooks, PDAs, electronic white boards and smart phones has forced user interface designers to design multiple interfaces for a single interactive application because

different devices have their own very different capabilities and constraints and a single interface is not capable of running on all these devices perfectly while accommodating their different features. To cope with this situation an easy solution of designing different interfaces for a single application each suitable to a particular device is adopted. But this solution results in many inconsistent representations of the same concepts at different platforms and devices thus damaging “consistency” which is a vital factor in design of a good user interface. Users find it very difficult and uncomfortable to use these different versions of same application while using different devices.

Besides the importance of consistent user interfaces for multiple platforms, a great user experience also accounts a lot in the generation of a perfect user interface design. In fact consistency comes under the vast umbrella of user experience. Achieving a pleasant user experience is dependent on many other factors besides consistency. Some of these factors are; to support user’s basic tasks and goals, acknowledge the strengths and limitations of people and technology, to fit into user’s big picture, to fulfill business constraints, to consider different social and security issues, to be easily accessible and should take care of design’s cultural aspects [11]. Briefly it can be said that user experience encompasses much more than traditional user interface issues, rather it is a broad collection of user-centric issues that are applied to the full extent of a project.

Many approaches are provided by different researchers to cope with this consistency issue but their major limitation is that they consider only the factor of consistency, while totally neglecting the fact that achieving a great user experience is the most important factor of user interface design process. In this situation a solution is readily required that not only produce consistent interfaces but also pay attention to achieve an enhanced user experience. Therefore in this paper we present a framework which not only helps in the development of consistent multiple user interfaces but also ensures a great user experience.

The organization of the rest of the paper is as follows: In Section 3, we have proposed a conceptual framework for the development of consistent multiple user interfaces. The proposed framework also ensures the provision of a good user experience. In Section 4, the results have been discussed and the last section concludes our work with directions for future research.

## 2. Prior Literature

Research on user experience design is limited because it is relatively a new field but a number of different approaches have been proposed for the development of consistent user interfaces. Ying *et al.*, [1] suggested an ontology based mechanism. He used ontology and CPN model based approach to 3D multiple user interface design. The research of Shahzad *et al.*, [2] focuses on the model driven development of graphical user interfaces using the approach of user interface ontology (UIO). A structured and standardized user interface development environment based on UIO is proposed.

Eisenstein *et al.*, [3] proposed a set of model based techniques to aid user interface designers to build user interfaces across several platforms while preserving consistency and usability. Special focus is on mobile computing and multiple context of use. A unifying reference framework is proposed by Calvary *et al.* [4] which classifies those user interfaces that support multiple target devices and different contexts of use. Instead of suggesting a model for the development of user interfaces, a unified understanding of context aware user interfaces is attempted to provide.

Goetz Botterweck [6] described a model driven approach naming MANTRA for the development of multiple consistent user interfaces of single application. In the first step common features of these user interfaces are captured using an abstract user interface model which is then annotated by constraints posed by different platforms. With this annotated abstract UI model as input, transformations described in ATL (Atlas of

Transformation Languages) are used to derive concrete and platform specific user interfaces.

### 3. Research Methodology

In this research a framework naming ACUTE (A model based Approach for development of Consistent User inTerfaces ensuring an Enhanced user experience) is proposed which is presented in Fig. 1. ACUTE is composed of two fragments; Application Interface Development (AID) and user experience design (UXD). AID deals with the issue of inconsistent user interfaces providing a model (AID model) for the development of consistent user interfaces and UXD encompasses all factors required for a perfect user experience. UXD runs along with AID model, providing information necessary to achieve a great user experience at different particular stages of the model. Thus in the end, a user interface is generated that is not only consistent for different platforms but is also capable of providing a great user experience. Both fragments of ACUTE framework are illustrated next.

#### 3.1. Application Interface Development (AID)

This fragment of ACUTE framework provides a model (AID Model) for developing consistent user interfaces for multiple platforms. AID model consists of following phases.

**3.1.1. Application Description:** This phase of model collects basic information about the application which is going to be developed. This information includes the main objectives or aim behind the application's development. Elementary functionality of the application is provided and a brief description of all functionalities desired to be performed by the application is provided.

**3.1.2. Task Modeling:** In this phase modeling of tasks intended to be accomplished by the application is done. All tasks are represented in a structured way. Main tasks are divided into their sub tasks and a complete hierarchy of all tasks is defined. UML (Unified Modeling modeling) diagrams are used in ACUTE framework to generate a task model of desired application.

**3.1.3. Abstract User Interface:** Abstract user interface is a general user interface having general interaction elements necessary to support the tasks identified in the previous phase. This phase generates an abstract presentation of the user interface consisting of number of abstract windows and each abstract window is composed of number of abstract interaction elements. These abstract windows are arranged in a proper sequence to provide the first mockup of the final user interface.

**3.1.4. Mapping:** Mapping is not an actual phase in the sense that it does not generate any new entity. It just integrates the information received from user model, platform model and abstract user interface and pass it on to the next phase of AID model.

**3.1.5. Concrete User Interface:** This phase receives the integrated information from previous phase and uses it to generate multiple platform dependent concrete user interfaces for multiple target platforms and devices. It modifies the abstract user interface according to the information provided by user model and platform model and generates several platform dependent user interfaces; one user interface for each platform.

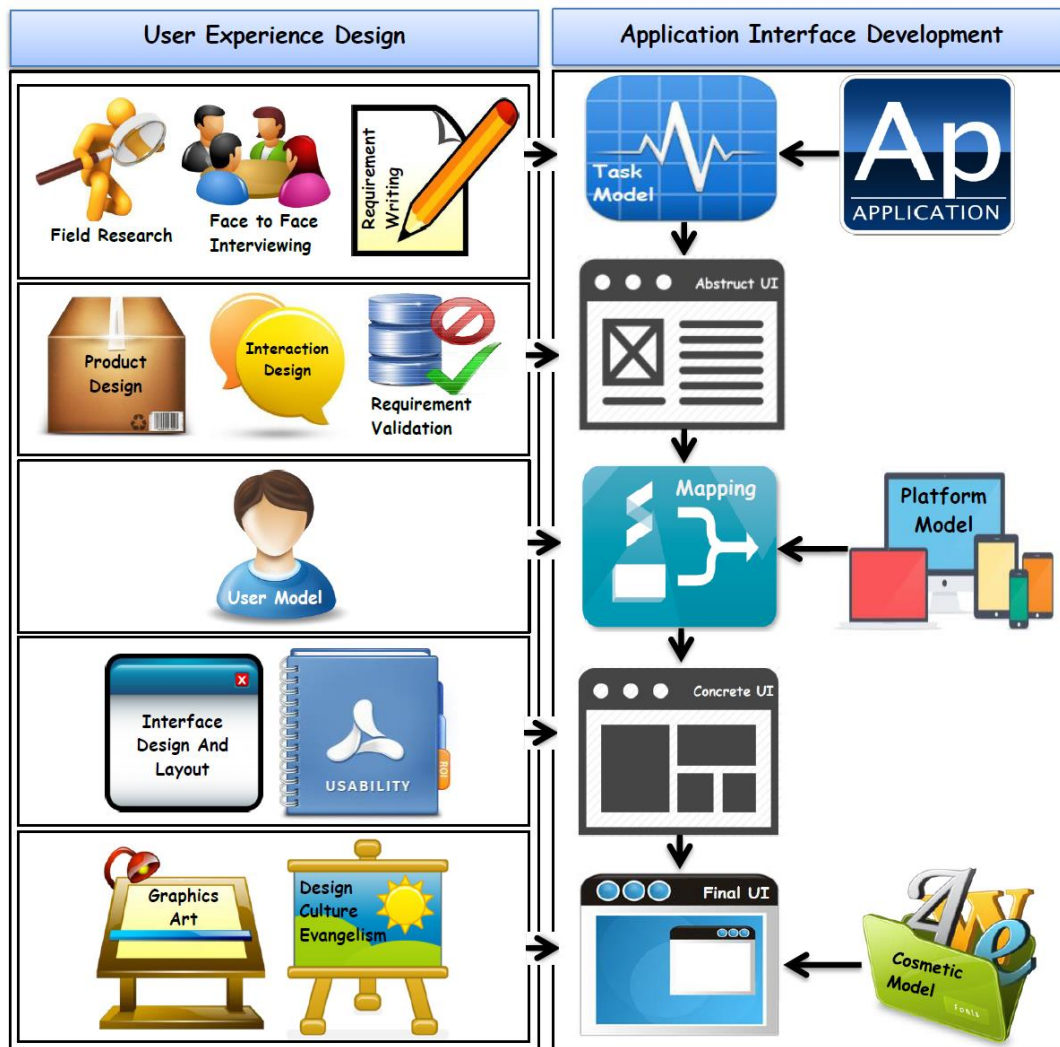


Figure 1. ACUTE Framework

**3.1.6. Final User Interface:** It is a two-step phase. In the first step, the information received from cosmetic model is exploited to generate the final visual appearance of each concrete platform dependent user interface. In the second step these concrete interfaces are translated into interfaces defined by a specific software language and source code is generated.

**3.1.7. Platform Model:** A platform is a target device on which the developing application has to run. A platform is a combination of hardware and software resources with each platform with its own hardware/software specification. This model describes the features and constraints of all target devices.

**3.1.8. Cosmetic Model:** This model provides the information necessary for the consistent visual appearance of the final user interfaces for all target devices. This information includes the type of font, size of font, terminology used, foreground/background colors and decoration images.

### 3.2. User Experience Design (UXD)

User experience design is the second fragment of ACUTE framework. It attempts to achieve an enhanced overall user experience by adding different factors in the framework which are necessary for providing a great user experience.

**3.2.1. Field Research:** Field research is the collection of information regarding the domain of to be developed application. It includes what kind of work has been done and what type of systems had already been developed in the particular domain of interest. It also includes learning the recent trends flourishing in the domain of interest

**3.2.2. Face to Face Interviewing:** This phase involves talking to the customers and understanding their problems and requirements in order to achieve a great user experience. Face to face interviewing is a good technique for having direct communication with the users while understanding their problems and reckoning what they actually want.

**3.2.3. Requirement Writing:** Basically, requirements are statements that indicate what a system needs to do in order to provide required functionality. In the phase of requirement writing user flows and stories are made by using the information passed from two previous phases and iterated on until the major problem and the required behavior and functionalities of application is made clear. Considering the identified functionalities required to be accomplished by the application, the requirements are established and documented in a formal way.

**3.2.4. Product Design:** Product design is basically the creation of a new thing or a process which results in something innovative or novel. In this phase designers understand the major problem statement and basic requirements using the knowledge produced by previous phases and generate some efficient and effective ideas for the development of new system; a system that will solve the problem faced by users and fulfill their requirements.

**3.2.5. Interaction Design:** Interaction design is a user centric process and is actually about the behavior of users including what motivates them, how do they think and behave. It is the understanding that how users and technology communicate with each other. Interaction design must be intuitive and predictable. Purpose of interaction design is to define the reactions of system when user uses any of the given interaction modes. For example it is defined here that how system will react when user clicks, taps or types in a command.

**3.2.6. Requirement Validation:** Requirement validation ensures that the right system is being built, as correct and complete requirements are the foundations of system's quality. The process filters out and resolves ambiguous, inconsistent and conflicting requirements. During requirement validation it is checked that whether the inputs, performed activities and generated outputs are according to the collected requirements or not. In the ACUTE framework, prototyping is used for requirement validation.

**3.2.7. User Model:** This phase of UXD attempts to capture all relevant information about the target users of the system. It provides information regarding who are the target users, what they need, what they value, what are their abilities and limitations. Identification of different groups of users based on their preferences, abilities, privileges and roles is also a part of this phase. It also lists the cognitive, perceptual and physical disabilities of the users. If a single interface is unable to accommodate the needs of all user groups then multiple interfaces are generated each suitable to a single user group.

**3.2.8. Interface Design and Layout:** Main focus of Interface design and layout is the anticipation of the actions users need to perform in order to accomplish their tasks. It also

ensures that the interface has necessary elements to facilitate those actions and these elements are easy to access and understand. Interface design is a determining factor between a successful and failed product. Enhanced user experience does not require a simple design that just brings clarity to the presented information. An interface design will only be a successful one if it provides its users the experience that is delightful and enjoyable.

**3.2.9. Usability:** Usability is the ease of use and learnability of any system e.g. software applications, websites and tools. In the context of user experience design, usability is the quality of user's experience while interacting with a system. It is the overall satisfaction of the user regarding every aspect of the system he is using. Usability is the pivot point of a great user experience design. This phase of UXD tries to make sure that the developed user interface provides a higher level of usability.

**3.2.10. Graphics Art:** This phase of UXD ensures the proper choice of colors, fonts, textures, different contrasts and images used in interface to make it attractive to look at. It focuses on ensuring an aesthetically pleasing interface that will provide user a fantastic experience.

**3.2.11. Design Culture Evangelism:** In the case of user experience design, the term design culture evangelism characterizes the modifications in design according to the culture of specific target users. As user experience design is all about the comfortable and pleasant experience at the user end, so the culture of target users must be considered during system development.

## 4. Discussion of Results

In this section we make effort to validate the proposed ACUTE framework with the help of a case study. For the sake of validation a software interactive application is developed following the ACUTE framework. Developed interactive application is a reading assistant for blind people naming Blind Persons Supporter (BPS) to assist them in reading text and identifying objects. There are three modules of BPS, first one is to read the pdf documents, second one is to read the text that is in image for and the third one is to detect and speak the shape of objects.

BPS is developed for two different platforms by two different teams. First platform is a mobile phone (Android phone) and the second platform is a laptop computer. BPS is developed by following the ACUTE framework and as a result two versions of a single application for two different platforms with consistent interfaces are developed. Both measures of the proposed model i.e. usability and consistency are applied to BPS. Each and every phase of ACUTE framework is used during the development process and as a result the developed application is a complete package fulfilling all requirements. The look and feel of both the versions of BPS is same despite some small differences due to the different resources of two different devices (Laptop and Mobile Phone) and it provides a great user experience to its users thus validating the ACUTE framework. The complete design process of BPS is out of the scope of this paper but some screenshots of final user interfaces of both versions are presented next.

### 4.1. Final User Interface of Mobile Phone BPS

This section includes some windows of final interface of Mobile Phone version of BPS.



Figure 2. First and Second Window of Final UI of Mobile Phone BPS

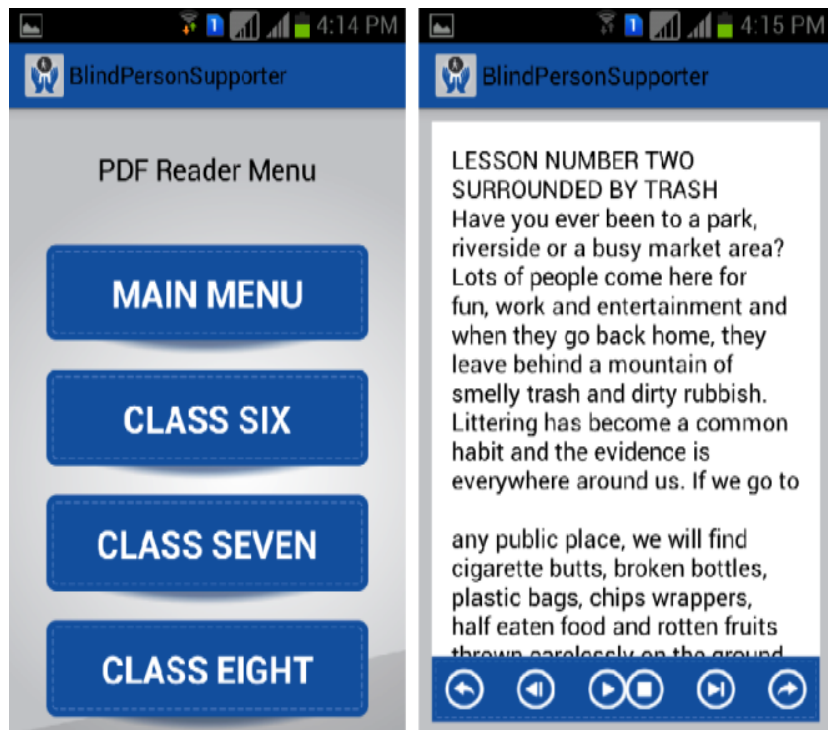


Figure 3. Third and Fourth Window of Final UI of Mobile Phone BPS

#### 4.2. Final User Interface of Laptop BPS

This section includes some windows of final interface of laptop version of BPS.

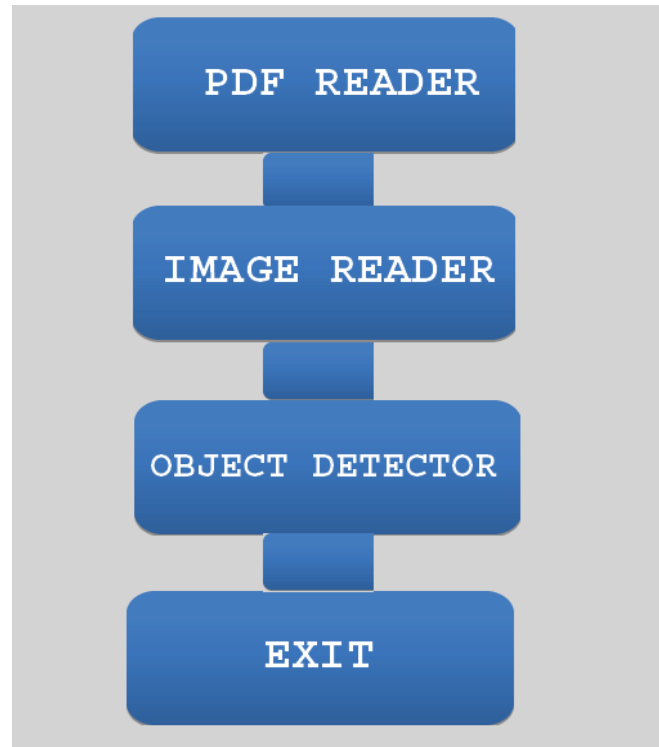


Figure 4. Second Window of Final UI for Laptop BPS

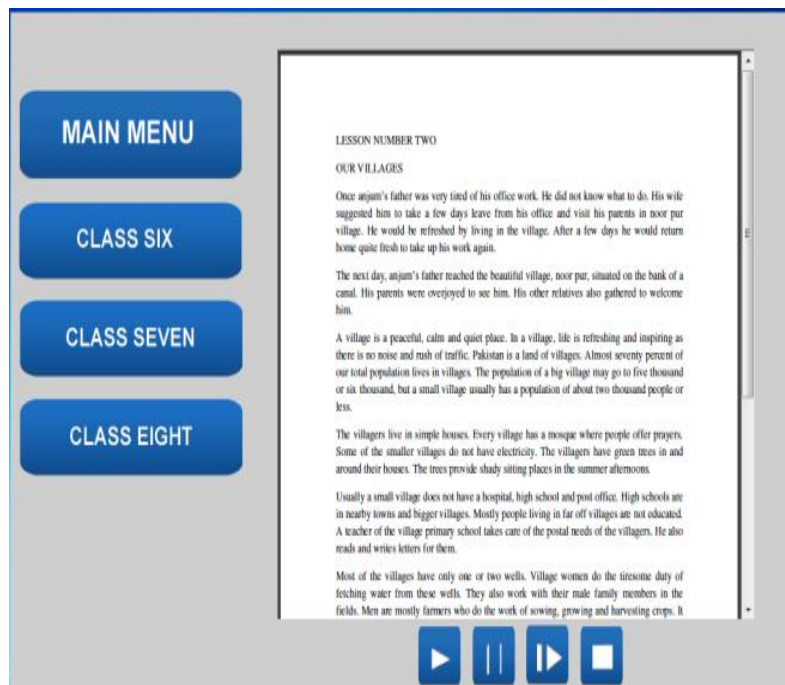


Figure 5. Third Window of Final UI for Laptop BPS

#### 4.3. Comparison of BPS Versions

Both versions of BPS are tried to design in a way that they are consistent to each other. But due to the constraints posed by devices (Mobile Phone, Laptop Computer) there are some differences in both versions. These differences are listed in the following table.



**Table 1. Difference between Two Versions of Blind Person Supporter**

| <b>Constraints</b>    | <b>Differences Caused by Constraints</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Screen size</b>    | <ol style="list-style-type: none"> <li>1. An additional interface element “tool bar” is used in mobile phone version due to the constraint of small screen. Four additional buttons are used in laptop version instead of using toolbar.</li> <li>2. Total number of windows in the final interface of mobile phone is greater as compared to that of the laptop.</li> <li>3. More interface elements are placed in a single window of final interface of laptop version as compared to mobile phone version.</li> <li>4. Pagination is used in mobile phone version to divide a pdf document in number of small pages to accommodate small screen size.</li> </ol> |
| <b>Memory</b>         | <ol style="list-style-type: none"> <li>1. Pagination is used in mobile phone version because there is not enough memory to load a complete big pdf document.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Generic design</b> | <ol style="list-style-type: none"> <li>1. “Exit” button is used in laptop version to exit the application, while there is no exit button in Mobile Phone version because they always have a button for this purpose in their built in design.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                            |

## 5. Conclusion and Future Work

In this paper we have presented an approach for development of multiple but consistent user interfaces of a single application as well as for enhancing the overall user experience of that application. A framework naming ACUTE is proposed in this paper for the development of consistent user interfaces which also takes into account all the factors necessary for attaining a delightful user experience. An interactive application naming BPS is developed following the ACUTE framework. This application is a reading assistant for blind people which helps them in reading text. Two versions (laptop and mobile phone) of BPS are developed by two different teams and their consistency is analyzed by comparing the final user interfaces of both versions. The comparison shows that both versions of BPS are totally consistent to each other despite some small differences that occurred due to different constraints and features of both devices (laptop and mobile phone).

In future, besides the consistency we would also like to analyze the user experience of developed application by performing some kind of empirical study. We would also like to enhance the ACUTE framework from mere development of user interfaces to coding and testing of applications. A great improvement can be achieved by developing a tool for the whole framework which helps automatically at every phase by taking information required for each phase and then automatically generating the desired user interfaces.

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## Authors



**Muhammad Ilyas** is an assistant professor in the department of computer science and information technology at university of Sargodha, Pakistan. He has received his Master degree in Software Project Management in 2004 from National University of Computer and Emerging Sciences, Lahore and a Doctor of Informatics from Johannes Kepler University, Linz Austria in 2010. His research interests include Software Engineering, Design Pattern and knowledge base systems.



**Aisha Tehreem** is a Post Graduate student of Computer Science in the department of Computer Science and Information Technology at University of Sargodha. She is also a software engineer and received her degree of software engineering from Fatima Jinnah Women University, Rawalpindi. Her research interests include software engineering, network security, user interface design and user experience design.