

Quality Metrics in Ubiquitous Computing

Rutuja K Pensionwar, Anil Kumar Mishra, Latika Singh

Abstract— Ubiquitous computing is the latest technology that not just make computer as a tool, but helpful and calm device which is one of the main part of human being in his day to day life. The purpose behind this paper is that to share some valuable quality metrics that help us in our near future that help us to improve the quality of our project. In Software engineering Software quality metrics is one of the research areas. In this paper we will see some quality metrics that one can use in ubiquitous projects. As we know that ubicomp is one of the different techniques with some different methods, design guidelines so we can say that there may be different quality metrics for the same. As well as we will see what is meant by ubiquitous, ubiquitous computing and also some new devices in them.

Index Terms—Quality, Software Metrics, Quality Metrics, ubiquitous computing, ubiquitous.

I. INTRODUCTION

The ‘father’ of ubiquitous computing, Mark Weiser, who headed Xerox PARC as their chief technologist, coined the term in 1988 and introduced it to the public in a now seminal computer science article(Weiser, 1991). Ubiquitous computing (also known as pervasive computing) which is a simple concept that describes a human environment containing many communicating computing devices that serve to reduce the tasks of the humans in that environment. Before going to next step let’s see what is meant by ubiquitous.

Ubiquitous means existing everywhere. And ubiquitous computing is a model that helps to create such devices that are combination of human and the computers. The purpose of ubiquitous computing is to develop more intelligent technology such that humans and computer models comes in to existence in to their everyday activities and tasks.

But beyond this quality is one of the main aspects in ubiquitous environment. Lets first see what is meant by quality, so quality helps us to measure the software is all set with its design guidelines and also gives information about product ,is that product fulfils all needs and requirements of customer or not. And so to produce such reliable software we need to have some quality metrics with the help of which we get reliable software product.

II. RELATED WORK

A. Quality metrics

Before going directly to quality metrics let’s see what is meant by quality and metrics first:

Quality is defined by International organizations as follows: According to **ANSI Standard (ANSI/ASQC A3/1978)**

“Quality is the totality of features and characteristics of a product or a service that bears on its ability to satisfy the given needs”.

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Metric is a standard unit of measurement that quantifies results. Metric used for evaluating the software products. Metrics is used to improve the quality and productivity of products and thus achieving Customer Satisfaction, also provides improvement for current process. E.g., Number of errors found per person hours expended.

So let’s define the quality metrics:

Quality metrics defined as the standard of measurement with the help of which one can able to assessed the performance, quality, efficiency, correctness, portability, maintainability, reliability, & progress of any product . Quality metrics help to measure whether the process producing the right product or not.

There are three main types of quality metrics are as follow:

- *Product quality metrics:*

This metrics helps us to understand about the product & describe characteristics of product with respect to size, complexity, design features, performance and quality level. By using this one can easily produce affordable and quality product.

- *Process quality metrics*

This type of metrics used to improve the development and maintenance process of software. E.g.: testing, response time, defect arrival and effectiveness of product.

- *Project quality metrics*

This type of metrics helps us to describe the characteristics of any project. E.g.: Staffing, cost, schedule, no. of developers need.

Before going to next topic i.e.: quality metrics in ubicomp projects let’s see what is meant by distributed software engineering & ubiquitous computing.

B. Distributed software engineering

A distributed system consists of multiple autonomous computers that communicate through a computer network and middleware, which enable computer to interact with each other in order to achieve a common goal.

A distributed system is a piece of software that ensures that: A collection of independent computers that appears to be a single coherent system to its users. For ex: Network of workstation, network of branch office computers.

Common characteristics of DS that can be used to assess the distributed systems:

Table1: Characteristics of DS

Characteristics	Meaning
Resource sharing	Client server model
Openness	Interoperability
Concurrency	Share & update resources
Scalability	Good speed & response time

Fault Tolerance	Maintain availability
Transparency	Location access at any time but valid person.

There are three main types of Distributed systems:

1. Distributed computing systems: Many systems are configured for high performance computing. E.g.: Cluster computing, Grid computing, Cloud computing.
2. Distributed information systems: Many systems are configured as information system E.g.: Transaction, which is a collection of operations on the state of objects (database) that satisfy ACID property.
3. Distributed pervasive systems: Next generation of systems in which nodes are small mobiles, smart phone, PDA's etc that are embedded in a system into user's environment.

Distributed pervasive systems having three types:

1. Ubiquitous computing systems: Present everywhere.
2. Mobile computing systems :Present everywhere with the help of devices
3. Sensors network: Network that sense or track those devices.

From above we came to know that ubiquitous computing is one of the main types of distributed systems. Software engineering carried out some of the basic characteristics to form distributed systems. No matters that they are information systems, or any other system. Right now we are in globalized environment so we need such system that supports us to keep in touch with new possibilities. With this we can able to add some more and new aids to or life and awareness of new technologies are possible with this aid.

C. Ubiquitous computing

What is ubiquitous computing: - 'Ubiquitous' is a Latin word meaning 'anytime and anywhere' or 'exist simultaneously' [3].

Computers everywhere. Making many computers available throughout the physical environment, while making them effectively invisible to the user. Ubiquitous computing is held by some to be the Third Wave of computing. The First Wave was many people per computer; the Second Wave was one person per computer. The Third Wave will be many computers per person [4].

There are three main characteristics or we can say key attributes of UbiComp as follows:

1. Mobility: Anyone or at anytime one can able to carry or wear those devices and move from one place to another (from home to office or vice versa) is possible in case of mobility.
2. Interconnectivity: Right now we use so many devices like mobile, PDA's, tabs etc. those having less interconnectivity but they are capable to connect to each other. They also know how to exchange and pass that data to one another.
3. Context Awareness: Such devices capable of adapting any kind of behavior to the environment as possible to them. Devices can recognize the possible networks, software, hardware, and any other resources and interact to one another.

There are so many development areas including smart homes, smart appliances, smart beds, automated kitchens, healthcare, pollution monitoring systems, Weather forecasting models as weather beacons, sentient city survival kit.

And for such ubiquitous products and devices we need to have some quality metrics those helps us to improve the quality of our product.

So let's see some smart devices like cell phone (smart phones) are becoming popular device now a days, with these devices, you can be tracked by using GPS. Even more on the edge of technology is the increased use of radio frequency identification (RFID) tags. These tags, transmit unique data, and receivers collect that data which can then be used for many purposes; such as tracking of products, people, lost children in the market, etc

Also there is one example like Botanicalls which is one of the transmitters with moisture sensor which enable plants to communicate their needs to people.

Weiser explained the concept ubiquitous computing as disappearance of computing devices from human attention while providing services to users [1]. These devices interact and exchange information to provide services to user. How much personal information is acquired and exchanged between devices is a function of a device in that environment [2].

In ubiComp, person may try to communicate with each other by using many computers at a time which can be invisible to the environment and wirelessly connected to each other. In order to do so ubiComp can be classify in to two:

1. Mobile Computing

As shown in above fig.1 we can say that Its again having for main aspects .In which we have Various interface devices like smart phones, Long lasting power phones, cameras, microphones, Bluetooth devices, GSM,GPRS,RFID etc.

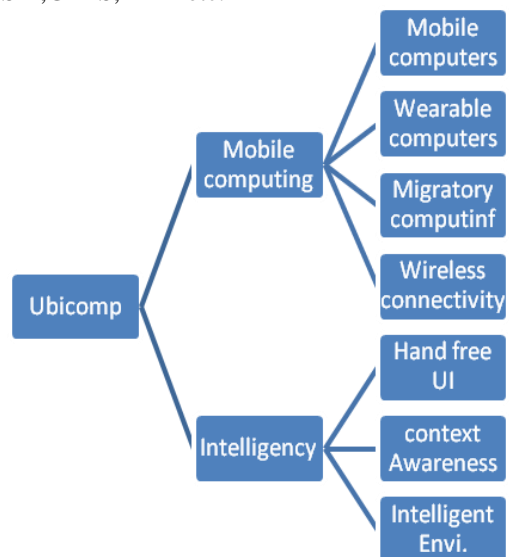


Fig1: Classification of UbiComp

2. Intelligency

In this we can have combination of elements and technologies like speech recognition, visual interface, use of sensors and use of invisible computers etc.

So all these elements having their own quality aspects and with the help of metrics we can easily manage all these elements in the future projects to build such a device which satisfy user needs and expectations.

A quality metric is a verifiable measure that captures performance in terms of how something is being done relative to a standard, allows and encourages comparison, supports business strategy. Software quality defines 5 major characteristics and as well as respective metrics are as follows:

Table2: Metrics as per the Characteristics.

SR NO.	Characteristics	Metrics
1	Adaptability	Adaptable to environment
2	Controllability	Change and Modify done by user
3	Debting	Debt ratio ,Usage of Technology, Cost
4	Failure detection	Defects found per Tested test cases
5	Fault corrected	Count total No. of faults corrected
6	Fault Detection Rate	Detect fault in a product
7	Fault Removal	No. of corrected faults/No. of total faults
8	Focus	Attention
9	Functionability	Functions in which problem detected
10	Honesty	Safe, Security and Reliability
11	Interaction	Satisfaction of user, Effectiveness and the Efficiency
12	Questionnaires with user	Ask questions to user, Interview
13	Test Coverage	Test cases executed/No. of test cases
14	Understandability	Successfully understanding

With the help of these metrics we try to build a new model for any product through which we can able to design proper product with all possible requirements of user. And ubiquitous computing is a model that helps to create such devices that are combination of human and the computers. The purpose of ubiquitous computing is to develop more intelligent technology such that humans and computer models comes in to existence in to their everyday activities and tasks. Smart devices like cell phone (smart phones) are becoming popular device now days, with these devices; you can be tracked by using GPS. Even more on the edge of technology is the increased use of radio frequency identification (RFID) tags. These tags, transmit unique data, and receivers collect that data which can then be used for many purposes; such as tracking of products, people, lost children in the market, etc.

D.Pervasive computing

Technology View Computers everywhere embedded into fridges, washing machines, door locks, cars, furniture, people, Intelligent environment (Mobile portable computing devices, Wireless communication seamless mobile/fixed) and user point of view it is invisible and implicit interaction with your environment augmenting human abilities in context of tasks. Main challenge in ubiquitous computing is to integrating large scale mobility with pervasive computing functionality to build dynamic models of environment and configure services accordingly.

III. DISCUSSION

Ubiquitous Computing Supports a world of fully connected devices, Ensures information is accessible everywhere and provides an intuitive, nonintrusive interface, feels like you are doing it. Ubiquitous Computing is NOT virtual reality as real world provides input, not computers! But it all requires extreme AI. For such kind of projects we need the above mentioned metrics to improve the quality of that product.

IV. CONCLUSION

In this I have analyzed what software quality is all about how we can able to measure software product. Metrics provide a role model for designers and also help to analyse the data for better quality. It also helps use to make future products reliable, defect free, in less cost and also help to improve the quality of future product. In this paper we have discuss about various characteristics and the corresponding metrics for them. Also we have seen some latest example of ubicomp. For the future we try to build some more metrics for other characteristics. Ubicomp is one of the type of distributed systems which consists of multiple computers that can communicate with the help of network and middleware, which enable our computers to interact with each other. In future work we try to find out various issues of this system and how metrics cope up with those issues.

FUTURE WORK

After studied of all quality metrics used in ubiquitous environment we can build a new quality metrics. To create these metrics we analyse all those corresponding metrics with one case study that depend on ubiquitous computing.

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