

“Recognizing the better technique for Context Aware Applications in Mobile Computing”

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Abstract—there is a great potential of enhancing the context aware mobile application in future. So for improving the optimization of these applications, suitable middleware services are required. The survey paper consulted fifteen (15) papers in this regard and discusses a number of techniques used for the development of context aware applications. The papers are analyze on some parameters and results show the selection criteria for choosing Pervasive framework for development, ODM model for designing and Pervaho & Artemis middleware for testing.

Keywords-Mobile context aware applications; ubiquitous computing; mobile computing

I. INTRODUCTION

Context aware applications and mobile computing are occupying a substantial part in the ubiquitous computing. These applications have the aptitude to recognize the surrounding environment. As new technology is flourishing day by day and people are moving to the wireless surroundings which include smart phones and tablets and many more. Hence it leads to the rapid development of context aware applications in mobile computing environment.

There are some important phases that are significant part of the development of context aware applications. These include some design guidelines, a model used for development and a framework which needs to be followed and lastly but not least a way to test the application. The survey paper henceforth, for this purpose consulted fifteen papers that are describing the above mentioned points. Context aware applications are more multifaceted in distributed environment as they comprise of connection among diverse software components and objects move from one node to other.

The next section focuses on the design guidelines and models which are followed by proposed frameworks, middleware used for testing. That is further followed by the performance analysis and the choice of the best technique. In the end we have conclusion and recommendations.

II. GUIDELINES FOR CONTEXT AWARE APPLICATIONS

Mobile device has turn into a broad tool in our life hence the difficulty of managing the growing feature has to be maintained. One of the papers suggests a need of design guidelines for the development of context aware applications in mobiles that are conducted in three themes. These are

- a) **Location awareness** in which location sensitive push messages were collected and uncertainties in location awareness were charted
- b) **User-defined settings** in which user ideas about context sensitive settings were studied showing performance setting according to predefined conditions
- c) **Privacy and Information sharing** in which user perception of context-dependent information sharing was investigated

These thing must be given due consideration when the context aware applications are design in mobile computing.

III. UNIVERSAL MODEL

The complex models which are employed in Context Aware Applications are still uncompleted and inadequate although they are in cooperated using a number of schemes. A study demonstrate diverse techniques which are previously used for Context aware application and in reply instructs a widespread model which can be used in such applications for mobiles.

For this **Ontology definition data model** is employed. The basic purpose of this is to eliminate the gap among the software tools specified for modeling (model driven development, MDA) and artificial techniques which are specified for ontologies (ODA) [1]. MDA will enable the easy expansion of user-centered context aware applications. ODA will provide the feature of extensibility.

The ontology model will be containing three levels of ontologies which are

- a) Generic Ontology
- b) Domain Ontology
- c) Application Ontology

It leads to provision of advantages for both the domains.

Along with that, sensors actuators are important for the connection, so in order to assess the unwavering quality of connection data, a **Connection Model** is proposed. [2] It is characterized by two parts; property assessment and proposal assessment, to offer assistance assess setting data. At the point when CM favors of the connection data, it considers both the key elements of connection data, furthermore the distinctive necessities of the connection heedful application

IV. FRAMEWORKS

Once the development of context aware application passes through design guidelines and then uses a model for its designing. Then the next step leads to the decision for the choice of frameworks. The papers that are studied in the research contain many frameworks proposed for development of context aware applications. A brief description of each framework is discussed below.

A. *Framework using Sentient Object Model*

A technique used for development of context aware applications inculcates sentient object model. The ad-hoc wireless atmosphere is employed in which event grounded communication paradigm is design. This also enables the loose coupling among sensors, actuators and application modules. The disparate sensors are used for data collection which is further fuse with representation of context [3]. The framework is providing following features.

- a) It enables low level interaction with the hardware devices by providing abstraction for sensors and actuators.
- b) For initiatively higher level context information, it uses the probabilistic mechanism in order to inculcate multi model fragments present in sensor data.
- c) There will be an event based interaction among sensors and actuators.
- d) Hierarchy of the context is used for intellectual reasoning.
- e) The visual programming tool is provided for programming.

The framework is successfully employed for a number of context applications

B. *Pervasive Context-aware Mobile Phone Application*

A study shows that a pervasive context-aware mobile phone have been proposed and developed in which context information is first collected from different sources and preprocessed to get standard metrics [4].

The proposed architecture has 4 components

- a) Context acquisition layer will collect context data (dynamic or static) from different context resources.
- b) The context preprocessing layer will represent the collected data in a standard way along with extraction of higher level information through hardware sensors.
- c) Context modeling layer will model the context according to generic ontology, domain ontology and context ontology.
- d) Context information reasoning will help to limit mobile resources

So this framework can be used for the implementation of context aware applications in mobile computing [4].

C. *IP Multimedia Sub-system framework*

One of the papers proposes an IP Multimedia Sub-system (IMS). [5]It is provided with the features of combining, amalgamating and developing the significant context data that is employed in mobile computing used in context aware applications.

Moreover the technique is being implemented on university campus community application prototype CAMCAP in order to show its usability and performance [5].

D. Develop context-aware mobile applications using a web platform

One of the papers introduces a technique for the individuals with no programming abilities by setting mindful portable administrations and applications utilizing a web stage. The engineering of the stage takes after the outline rules of the inspected setting mindful toolboxes, with a client interface that has been adjusted with a specific end goal to permit the setup of all the required connection conditions and parameters with no programming code [6]. This leads to an essential pattern in programming that increasingly applications are being composed by software engineers as well as by individuals with aptitude in different areas so that it may contain diversity.

V. MIDDLEWARE

Middleware is a software or bridge which is used between OS/Databases and applications. It is usually used for testing. The research is being carried out for the components which are required for the middleware used in the development of context aware applications. Some of the proposed middleware are discussed below.

A. Middleware for generic context aware applications

A paper during the survey discloses a technique to separate the context aware applications and the middleware in which definition of context aware application is given along with its brief explanation of its state. More or less communication protocols are present among the instances of context aware applications [7].

It employed the generic context awareness by swapping among providing and consuming software modules. The middleware was developed on Java. An understandable programming language is chosen. The object relational mapping is used for the storage of the persistent values. Usually context trigger actions are not used in context aware applications due to unaware of the content of application. The mentioned middleware also leads to more invisibility of the content used in an application.

B. Pervaho Middleware

In order to test and develop mobile context aware application, an integrated middleware is presented that is named as Pervaho built on Java ME [8].

It uses the concepts of pragmatics and integrated middleware. The testing is being made simplified by employing testing proximity based semantics consisting of

- a) Location Based Subscribe service (LPSS)
- b) Phone motion emulator (Phomo).

The mesh networks are used along with the communication protocol for the implementation of Pervaho. An application name glove is created using this service. [8]

Results display that content mapping is supplementary appropriate for the scenarios.

C. CASS - Middleware for Mobile Context-Aware Applications

CASS (Context awareness sub-structure) is a server-based middleware, supports the context-aware applications on hand-held devices has been presented.

It enables developers to manage the processing and memory constraints of small mobile computer platforms while supporting large number of context inputs and low level sensors [9]. One of its key features is to separate context based interfaces from application code which will help in reconfiguration of application by user rather necessitating for reprogramming and to provide high level context data abstraction.

D. Artemis-FollowMe: Middleware

A study shows the Artemis-FollowMe middleware for portable setting mindful applications, in which specialists go about central parts for taking care of settings as well with completing application rationales.

The tests reveals how movements of the operators will influence, exceptionally, the general system overhead and by tests we demonstrated that SMS is static and suitable for circumstances where movement is constantly required; while DMS is more versatile and suitable for circumstances where influencing parameters are obscure at the time the specialists is sent [10].

VI. CONTEXT AWARE APPLICATIONS IN COMMON WITH SOCIAL DATA

The emerging social networking technology includes network sensors are influencing to make exciting applications and computing that is fully context aware such as context aware videos screen, music jukeboxes and mobile health devices.

Social Fusion a context aware system for fusing mobile, sensor and social data to force a context aware application both for individual and group of people is presented [11]. A multi-stage architecture is defined for achieving such fusion. Some major challenges in the process are collecting and managing diverse data streams;

mining the data for context-aware inferences of individuals and groups; generating context-aware recommendations; and preserving privacy and anonymity. Context-aware video application of Social Fusion, Social Flicks is demonstrated in this context.

VII. PERFORMANCE OF CONTEXT AWARE APPLICATIONS

Performance is an important factor while evaluating the context aware applications. Since environments are highly dynamic, user and devices roam between networks resulting in CPU loading and unloading and flux in network hotspots.

One of the study show that metrics to capture software, performance attributes and resource utilization to model their impact on context-aware applications can be in cooperated. This is followed by testing using linear correlation analysis [12].

It explain the impact of software code attributes on efficiency of mobiles applications, a model of mathematical equations to show the dynamic behavior of objects at runtime in context-aware mobile applications. The model is supported by studying an application, using mobile system running on MobJex framework. Results show that applying local adaption strategies results in application efficiency in terms of performance and resource utilization [12].

VIII. ANALYSIS

Context-aware mobile computing has an extended exploration past; it is not linked generally in our day by day life. In the region of examination, there are quiet numerous mechanical complications. The above discussion explains a variety of frameworks and middleware to build context aware applications. In order to fully demonstrate the technique whether it is a framework or middleware or some model there are some characteristics that needs to be fulfilled.

The analysis of these techniques is made on the basis of some parameters that are explained in table 1 and the table 2 shows that the studied papers in the survey are either fulfilling the criteria or not. On the basis of analysis, a choice of the better model, framework and middleware is made which can be summed up in following three points.

- a) The best modeling approach that can be used is ODM based modeling as it fulfills most of the criteria for evaluation. It has an efficient algorithm using ontologies definition along with SWRL (semantic web rule language) benchmark used for testing. This modeling technique is used for developing techniques such as Booking Travel application, Presentation application and Visiting City application in-cooperating the ad-hoc environment.
- b) A better framework that can be employed might be a pervasive mobile context application which can be used widespread. A prototype application has been developed for application domain that leads to 78% accurate and optimize results. It is also using ontology based model (ODM).
- c) As far as the choice of the middleware is concerned, the analysis leads to Pervaho and Artemis-Follow me middleware. The performance is much better. Indeed both strategies lead to dependence on applicative scenario and this decision is made at deployment time.

It is reality that some novel applications in setting context-aware processing are developing in rapid so the right choices matter a lot in this regard.

IX. CONCLUSION

The context aware application needs standardization and definition of interface, when both things are present can leads to better and optimize performance.

The survey paper studied fifteen paper for the thirist of finding a better model, framework, and middleware of mobile context aware applications along with the performance analysis as well. The paper presents a number of techniques in this regard and shows that each technique leads to better performance and optimization than before. In particular analysis of each technique based on some parameters reveals that might be using ODM model, Pervasive mobile computing and Pervaho & Artemis middleware leads to better results as compared to others.

In future it is expected to grow this approach and will use it for familiarizing such applications at design and runtime. Also the software benchmarking and functional test suites for context aware middleware will be studied. The features will be extended to more complex community applications.

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TABLE I. PARAMETERS USE FOR EVALUATION

No:	Parameters	Definition	Possible values
1)	Technique/algorithms	A way or set of rules used for carrying out a particular task.	Mention name
2)	Devices	An item which is prepared or adapted for a specific purpose.	Yes/No, Mention name
3)	Benchmarks	The comparison of features against a standard.	Yes/No, Mention name
4)	Frameworks	An elementary assembly underlying a system or concept	Yes/No, Mention name
5)	Applications	A software designed for end-users	Yes/No, Mention name
6)	Environment	The surrounding in which the application is implemented.	Mention name
7)	Model/paradigm	A thing used as an example to support or developing the framework	Yes/No, Mention name
8)	Networks	The type of network in which data is transmitted among different devices	Yes/No, Mention name
9)	Middleware	A software or bridge which is used between OS/Databases and applications.	Yes/No, Mention name

TABLE II. EVALUATION OF PAPERS BASED ON ABOVE PARAMETERS

Paper Ref No:	Technique/algorithms	Devices	Benchmarks	Frameworks	Applications
[1]	Ontology Definition Meta-model (ODM) and Model Driven Development (MDA) technique	Laptop, PDA, Smartphone, Tablet PC and sensors	SWRL (Semantic Web Rule Language)	Meeting-Guide (MG) is used	Booking application, Presentation application and Visiting application. Travel and City application.
[2]	Context Information Interpreter (CII)	Actuator, Sensor	No	Property and Recommendation Analysis	context-aware application
[3]	Event based communication technique	Sensors, Actuators devices & mobile devices	No	Framework which includes the ability to fuse context fragments and deal with uncertainty	Car application and other proof-of-concept applications
[4]	SHA-1 checksum, Location checking algorithm	Mobile devices	Android smart phone with the developed application	Model for pervasive context-aware mobile phone	Yes
[5]	IMS based prototyping is used	Mobile devices	IP Multimedia Subsystem (IMS) and All-IP Networks	The design and architecture of a Context Aware Mobile Community Application Platform (CAMCAP)	University campus social community application
[6]	Semantic web technique	Context-aware toolkits	No	Web-based platform	APIs
[7]	Coarse Protocol	Interconnected devices	Cyberguide	Object-relational mapping and Google Protocol Buffer	States of context and application
[8]	Location first & match predicate and content first strategy algorithms.	Mobile devices	GMS/GPRS-enabled mobile devices and Java ME	Implementation of LPSS API.	Glove
[9]	Structured Query Language (SQL), Forward chaining	Small mobile computer	No	CASS (Context-awareness sub-structure) server based middleware	MALLET (Maintenance Assignment Listing Lightweight Electronic Tool), STONE (STart ON Entrance)
[10]	Ubiquitous and Pervasive computing	Physical and software sensors	Mobile agents	Performance analysis	Context based
[11]	K-anonymity algorithm	Mobile devices(mobile computing)	Java Standard Edition (SE) 5.0 platform, e Java Micro Edition (ME) platform, BlueCove JSR-82 Emulator tool	Social system Fusion	Social application Flicks

[12]	Linear correlation analysis	Mobile devices	Pentium IV 1.8 GHz, 256 MB, Windows 2003 Enterprise Server OS, 100 Mbps Ethernet link	MobJex framework	Taxi Dispatching System (TDS)
[13]	Interpretation algorithms	Mobile devices	Context-Toolkit, Java Context Awareness Framework (JCAF)	Common object request broker architecture (CORBA)	No
[14]	No	Mobile handheld devices	No	Design guidelines for context-aware mobile applications	No
[15]	UI design	Apple devices, Windows 7, Android, and Blackberry	No	Context aware framework	Context representation and context data storage

Table II Continued

Paper Ref No:	Environment	Model/paradigm	Networks	Middleware
[1]	Pervasive Computing	Ontological context model	No	Context-aware middleware
[2]	Experimental environment	Context Model (CM)	No	No
[3]	Ad-Hoc mobile environment	Sentient object model	No	STEAM event service
[4]	Devices, nearby people	Ontology based context modeling	Sensor networks	No
[5]	Mobile community	Context Management and Processing Architecture	Internet	No
[6]	EUD environments	Context-Data model	Sensor Network	Web
[7]	No	Context and Application Model	Ubiquitous Network	Java
[8]	Ad-Hoc mobile environment	Communication model and the testing model.	Mobile ad hoc network (MANet)	Pervaho middleware
[9]	Devices	No	Wireless networks	CASS middleware
[10]	Agent-based Infrastructure	FollowMe Architecture	Distributed Network	Artemis-FollowMe
[11]	Nearby people	Probabilistic models based on Markov chains	Sensor networks, Social networks	No
[12]	Heterogeneous Internet environment	Mathematical equations model	Yes	Yes
[13]	Ubiquitous computing	Key value pair model for interpretation	Ubiquitous network	Context-aware middleware
[14]	Devices	No	Yes	No
[15]	Context aware computing environment	Software product line engineering approach	Wireless communication	No