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Context-aware Architecture Using Mobile Phone Simulator: a case study of an institution

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***Abstract*— Mobile phones nowadays are ubiquitous with our daily activities and the sensing ability of the device inspired us to propose context aware services to users in the academic environment. This paper presents the concept of a context aware solution using a proposed architecture from a theoretical perspective. The context-aware solution is a notification that delivers a text or call about certain information dissemination on events or activities that occurs as a result of unforeseen circumstances or situational changes in the institution on their mobile phones. The process is activated by a pop-up from the proxy server through the mobile portal database. This is followed up by a reminder from the server when necessary. This paper offers solution to a perennial problem that normally occur from traditional method of bill board or notice board placement of event such as examination time table or course schedule, as means of information dissemination to lecturers and students in the institution. The approach was simulated with phone simulator, and results shown to lecturers and students as presented in the paper were satisfactory.**

Keywords - Context-aware service, context-aware architecture, examination time table, mobile phone simulator.

I. INTRODUCTION

Context-awareness, an instance where the device is aware of the situation in which it is used. It is a domain that has gained an increasing amount of attention in recent years. A context-aware device can assume the use condition, and adapt its behavior according to the state of affairs. Mobile handheld devices, which have been highly adopted by large user groups, especially in the form of mobile phones, constitute a stimulating platform for context-awareness [1].

The vision of ubiquitous computing is generally about having computing presence, embedded in our environment, always available and always with us [2]. Nowadays most mobile devices and sophisticated phones with affordable prices are embedded with set of sensors such as GPS, Digital compass etc. The sensing nature of these mobile devices gives them power to enrich applications with relevant service related to user's context. Context awareness is concerned with the acquisition of context information, the abstraction and understating of this information, and application behavior based on the recognized context information [3-5]. Currently context aware applications are also becoming location aware. This trend has gained research emphasis and bringing location awareness in conjunction with context-awareness into a limelight.

Location awareness reveals environment and time, while context fetches contextual data and information in conjunction with the location-awareness. Context-aware applications are now equipped with knowledge of what is happening around this particular user (of mobile device), where he/she is headed, what actions he/she has performed and what are the related sources of data mined with this information. For instance, mobile users may not be able to decide instantly for an unknown number incoming-call, receiver sometimes have few options to undergo like rejection of the call, accepting it or let the answering machine handle it (depending upon situation and location) but a very prompt decision is required, which may lead to further wastage of time. This is the opportunity for a voice aware mobile application with context and location knowledge to decide whether to interrupt user (he/she may be in hospital) with bell or inform caller with pre-recorded message also sometimes it could be a call from sales

advertisement, product or goods promotion; and the application may decide to reject it totally. Similarly the paper proposes architecture for a context-aware Mobile College Portal (*MCportal*) to sensitize academic activities in an institution. Fig. 1 is a diagrammatic illustration of Mobile portal Internet transaction with desktop computer. The aim of this study is to present how context-awareness can be used as a solution to the problem(s) highlighted above and similar ones, which may occur in an academic environment inside portal services also available to mobile users.

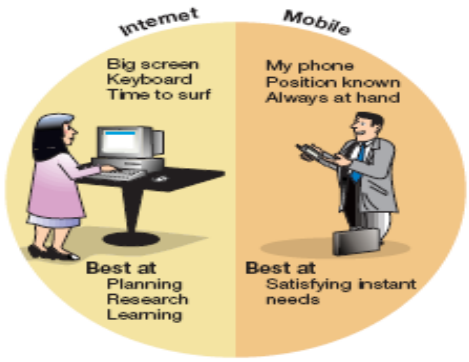

Fig.1. Relationships between Internet and Mobile Technology [7], as cited in [8].

In this paper, three research questions were formulated based on a postgraduate research going on. Answers to these questions were generated from the respondent's responses, which would justify the aim of this study and will lay future research directions for the research.

II. Problem Definition

Designing and deciding means of information dissemination [6] is very important especially in case of an institution, specifically Ambrose Alli University, (AAU) Ekpoma. This institution presently circulates critical information through bill board/or notice board, circulars by hands to the concerned person (student and staff) in the faculty for instance meeting announcements, examination timetables and invigilation roasters. This method has few default problems like duty roasters (printed) could be misplaced, circular could be unread and email is again offline medium and did not force user to check when a critical information arrives. This can cause the student to miss the examination, a faculty member to neglect the invigilation duty and a staff to miss meetings. These problems can be tackled by an alternative way of incorporating a prompt reminder system for important notices, announcement of meetings etc. Any change in previously propagated information through a context-aware application execution on mobile phone of the users. This will occur with the portal database by activation from the proxy server. Similarly another component of this application would be running on a mobile phone for voice and data filtering, this would also have voice-aware capability to allow certain calls to reach user while rejecting or delaying unnecessary calls and data while popping out for urgent messages and calls.

III. Related Work

Mobile computing is a novice area, and is one of the fastest growing technologies in information era; the concepts are widely used in the banking sectors [9], higher education [10], telecommunication industry [11], sale and marketing sector [12] of the economy. Using this concept many context aware solutions are proposed, researches are implemented in the area of education [13] embedded systems [11] computer forensic [4] and many more. Mobile and wireless devices particularly mobile phones are increasingly common amongst younger generation and as a result provide new possibilities, opportunities and challenges for educational communities.

Already a Mathematics Cellular Phone Learning Communities system has been proposed [13], another Web-based M-Learning System for Dual Screen Handheld Game Console is being researched [14], and another research is trying to improve educational processes [8]. Context-awareness computing is the key enabling technology to pervasive computing [15]. Context may be seen as anything that may be used to adapt user interface to the current needs and situation of the user [5]. Fig. 2 shows the interface proposed for the MCportal described in this paper. In the area of context awareness solution's proposed, other research are already implemented in the area of education as well [8, 13-16]. The MCportal features new portable services or features, which include the following:

a. Unconventional means of payment.
b. Opportunity to run the proposed application on any java enabled phones while connected with the portal.
c. Few services would be offered in off-timings of organizations/institutions like universities, banks, offices, faculty and hospital etc.
d. SMS would be another feature for offline notifications when and where active call/data connectivity with portal would not be possible.

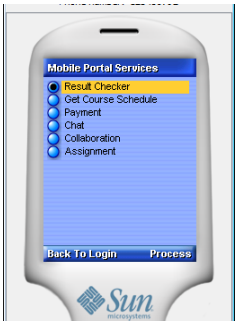

Fig.2. Screenshot demo for Mobile College Portal [8]

MCportal would depend a lot for information dissemination on the resident component (on mobile device) of this entire software. These services will cater for the environment change while on the move provided there is an active and suitable connection link. MCportal would be capable of displaying students lecture time schedule, venue

and name of lecturer that will teach a course, provide result checker for students, examination timetable or course schedules and allow collaboration between students and the institution on the go. A simulator was used to demonstrate the portal usage with unconventional payment methods being proposed employing Short Message Service (SMS) like recharge of mobiles with balance with the software deployed on the mobile phone. One scenario of critical advantage of this portal would be in a perennial problem that often confronts the environment; like armed robbery attack on a bank inside institution that would lead to total closure of the Institution. The portal is developed with Java Micro Edition (JME) for the interface and MySQL was used at back end. This similar architecture has already been presented [8] but it lacks in few things like the ability to sensitize the users with the events likely to occur around them and handling ever growing number of users. In another study, a middleware is proposed having an abstract layer offering contextual information from proxy server and other external services linking the mobile users with e-learning portals/devices, giving birth to m-learning and extending e-learning. This becomes possible due to the availability of context-aware services [17].

A. Existing Techniques in Context aware

Context awareness architectures available in existing literature are classified in three areas i) sensors ii) users and iii) devices. Table 1 summarizes techniques used in previous work [2, 18-24].

TABLE I. EXISTING TECHNIQUES IN CONTEXT AWARE

Reference	**Study**		
	Techniques	***Classification***	***applicability***
[18]	Context awareness used for mobile learning with hypermedia in the wild		
	Hypermedia	User	Learning
[19]	The Stick-e Note was used as bases for extending the Interface beyond User. It is essentially meant for online system and does not address mobility for those concerns		
	Stick-e Note	User	Academic community
[20]	The Context that aided development of Context-Enabled Applications. It offers freedom to developers that handles low-level of detail context acquisition and permit them to attend to higher level application specification behaviours		
	Toolkit	User	Learning environment
[21]	The Mobile Informal learning kit collaboration for the design of SMS questions and answers style for transaction between students and teachers in a desired learning environment		
	Milk	User	Learning environment
[22]	An Infrastructure Approach to Context-Awareness for Human-Computer Interaction. It offers context service infrastructural model to users		
	CHCI	User	Academic environment
[24]	A Context-aware for integrating different service domains and diverse devices into a unifying environment		
	CADBA	User	Unifying environment
Wang.	A context-aware for mobile application for University		
[18]	Context awareness used for mobile learning with hypermedia in the wild		
et'al .[2]	campus maps. It provides context service to newly arrived students on how to identify location of Hostels, bookshops, Faculties by showing indication through maps available on the students mobile phone		
	UNINAV	User	Academic environment

Most of the techniques in the Table 1 are employed in academic domain and this paper is following the footsteps too. Each listed technique provides context aware solution for one service or another in higher education institution. None provided timetables, schedules or other timely announcements of this type like examination updates for students, lecturers and non-teaching staff; this is also covered in proposed architecture.

Awoyelu and Ojo [25] targeted an issue of congestion in cybercafé as a major setback of depriving students in academic environment from timely payment of fees, registration of courses and many other student transactions such as access to transcript, time table etc; thereby proposed a Mobile portal Architecture that will solve the mentioned problem using a WAP based approach to be made available on students cell phone. This portal service serves as an alternative to conventional university portal where large number of students possessed a mobile phone. The system design in this study include; i. A front end of the system comprises web-interface through WAP on a mobile device; ii. The WAP gateway acts here as the middleware; iii. The web server have a PHP application running; with Obafemi Awolowo University (OAU) as a case study.

B. Weaknesses

The timetable option in the portal is static, because students or lecturers will always check whenever they need it from there. The portal is not context based.

The architecture proposed in this paper support java enabled phones. And is capable of providing context aware services that can sensitize lecturers/students using SMS or phone calls alert with the available portal on their mobile phone. With java enabled the service performance on mobile devices is much better.

Fig. 4 indicates an enhanced architecture with the inclusion of context aware feature, which was not part of [8], that will popup message as a reminder to students or lecturers in case of any change on examination timetable or course schedule, and other updated information right on their personal mobile devices

IV. METHODOLOGY

The methodology employed in this paper is in three folds: 1) Structured questionnaires were distributed to two hundred and forty (240) students in *AAU,* Ekpoma out of which one hundred and eighty (180) questionnaires were retrieved and analyzed. The questionnaire was designed to gather

information about the impact of incorporating Context-aware application into the Mobile College Portal used by the students. This study was carried out at *AAU* - Ekpoma using *Key Informant Interview Method (KIIM) method* to gather key information from the stakeholders of the portal. The application being proposed in this study would be using *Global Positioning System (GPS)* enabled device that would be connected to the proxy server to collect data. The data would be uploaded into Google Earth from the server through an active link [26]. Finally, it would be made accessible to the users via their mobile phones as depicted in Fig. 3 and Fig. 4.

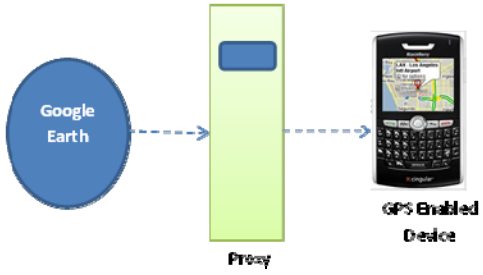

Fig. 3. Context Data Gathering Flow Diagram [26]

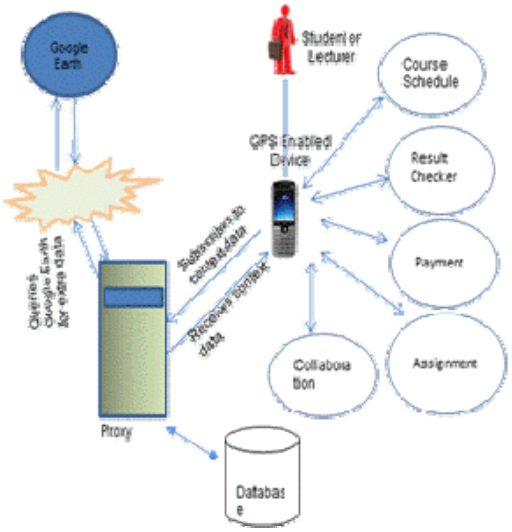

Fig. 4. Proposed Context-Awareness Architecture

V. System Architecture

A cellphone is assumed to be deaf and blind; it mostly relies completely on the user for management of its state, configuration and mode of operation. Providing users better tools to manage the state, configuration and mode of operations at their cellphones; tools which requires less of their attention, like context aware, that can do more of the jobs automatically. The architecture in Fig. 4 shows how MCportal can be more useful by adopting the concept of context-awareness. The context data initially chosen in this case include:

- Student
- Location or the university environment

The architecture consists of three vital components, the student's mobile device (cell phone or mobile phone), the proxy server and Google Earth. The proxy server provides access to every available context data and connects to Google Earth when there is need for additional data than what it has. The mobile device will be used for GPS data through software "Magellan".

With this scheme, the system now have access to students context data, it now knows the time, location and environment of the student, for instance, he/she is in the examination hall, or in the lecture hall, and can therefore ensure (by auto reject call feature) that student's mobile phone does not ring out (loudly) in this situation. Also, the knowledge of the student's school fees payment status can help the system to remind the student of payment deadlines and the implication of late payments etc.

VI. Discussion Of Results

The demographic characteristics of the respondents in percentages are presented based on gender and the response of the questionnaire distributed in faculties that took part in the study in Table II.

TABLE II. Response of the Respondents By sex, Age, Faculties

Respondents demography	**Response**	
	Category /types	***Percentage (%)***
Sex	Male	122(67.8)
	Female	58 (32.2)
	16-24	126 (70.0)
Age	21-31	54 (30.0)
	Natural sciences	96 (53.3)
Faculties	Engineering	49(27.2)
	Arts and humanity	35(19.5)

Table II shows that out of the 180 respondents who took part in the study 122(67.8%) were male and 58 (32.2%) were females. Three faculties took part in the study, with 96 (53.3%) Natural Sciences, 49(27.2%) Engineering and 35 (19.5%) was Department of Arts and Humanities. The respondents that took part in the study are within average age of 20 years with total =126 (70.0%) and rest were close to or above 26 total = 54 (30.0%). The interview mentioned was mainly conducted for fifty (50) academic staff at different time intervals in March, 2013.

The response of staff indicated that, there is no such service available in the institution and if provided, staff showed a lot of eagerness, especially about the possibility of reminder with context awareness solution for the events or activity already highlighted.

Conventionally, courses offered by university for undergraduate students are scheduled and announced via time tables (course schedule) based upon availability of lecture halls in the faculties, using different time slots depending on each course with their description/code. The faculty time table officer dispatches the printed copy of this time-table or course-schedule to different concerned departmental representative, who will then prepare final departmental course schedule by integrating all timetables or course-schedules and distribute both to lecturers and students for their daily lectures. The same process is repeated for examination and copies made available to lecturers with invigilation roaster and pasted on the noticed board for students. The course schedule described is being done manually so far. The methods of course schedule preparation are cumbersome and time consuming as presented in this paper.

In cases when there is a public holiday announced by the Government, (federal or state) or any other event occurring beyond the authority of the school's administration, which may alter course-schedule or examination schedule would brought change in course-schedule (by shifting it to a new date) or in examination roaster. The change will take effect and another timetable will be circulated.

Copy of it will be sent for paste on the notice board for student's perusal and check. This may cause communication gap and all the concerned may not be properly informed. In the past practicing this manual system, have made lecturer(s) failed to conduct examination invigilation, many students also missed their examination. The response in Table III presents the reaction of the students based on their past experience on these issues. These discussed problems motivated this study and the formulation of three research questions: with the responses presented in Table III. The study showed that previous method of timetable communication to students is not effective.

TABLE III. RESPONSE'S OPINION BY RESPONDENTS (%) ON THE PROPOSED CONTEXT- AWARENESS SOLUTION VIA A MOBILE COLLEGE PORTAL

S.No.	Research questions		
	(%) Positive	Negative (%)	Undecided
RQ1	Have you witnessed a change in examination table/course schedule that make you miss your examination before?		
Response	159 (88.3)	21 (11.7)	0
RQ2	Would you like to have a portal service that will remind you of your examination time table /course schedule or other school activities through your mobile phone whenever the time draws nearer?		
Response	140 (77.8)	40 (22.2)	0
RQ3	Have you come across such services that remind you of school activity such as examination time table/course schedule in this campus before now?		
Response	0	177 (98.3)	3(1.8)

However, the architecture proposed for the context awareness solution resolves the issues with simulation of the MCportal using the portal database as shown in Fig. 4. The feedback result for the simulation can be found in Fig. 5. Since the output from this study is based on the simulation process using Sun Microsoft Phone Simulator is the reason to classify the approach used in this paper "theoretical". Improvement is hoped using real life experimental approach to further ascertain detail results.

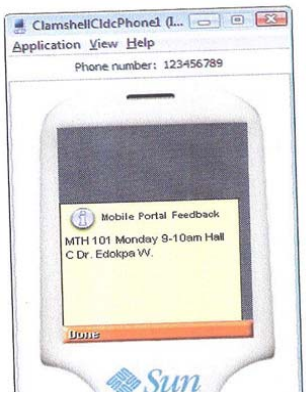

Fig 5: Context Awareness Solution Feedback

A. *Feedback*

The simulation was demonstrated to some students. Their response with the simulation result in Fig. 5 was satisfactory. The proposed application if implemented is capable of eliminating the problems arising from missing of examination due to sudden change in examination's timetable in the institution. This type of problem(s) has caused carryover and spillover in the past among students. Fig. 6 presents respondent's opinion on the proposed context awareness solution with the MCportal in a graphical form.

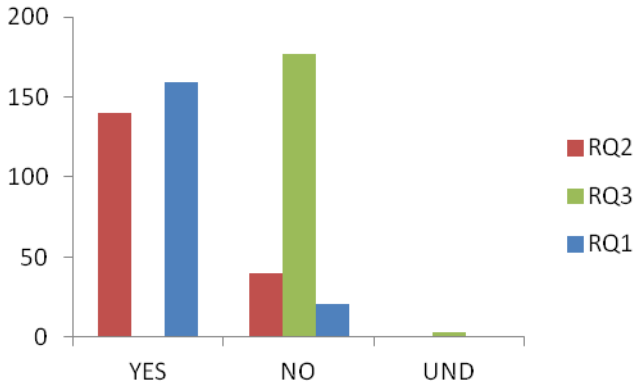

Fig 6: Analysis With Bar Chart

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Horizontal: Opinion of respondents on the proposed context- aware. solution via *MCportal*. Vertical: No of response from respondents.

VII. Advantages Of The Proposed Architecture

It is an improvement on the mobile portal because it offers context aware solution to the users via mobile device. The context aware information dissemination used SMS /CALL alert to deliver critical information at anytime, anywhere irrespective of the location. The application is java enabled, hence scalable without disrupting performance on mobile devices. It is an innovation in academic environment in the area of problem solving approach in context aware domain.

VIII. Comparison With Other Techniques

From the questionnaire received for the evaluation based on the feedback, 27 out the 29 participants indicating (93%) satisfaction.

Comparing this architecture with other techniques in Table 1, only UNINAV [2] with the simulation prototype used for the study, featured a similar architecture for context awareness using campus map navigation with mobile application. The application assists new students to locate hostels, departments, faculties, and cafeteria on arrival to campus ones they have normal android phone that capable of using the application. Their evaluation was carried out with 14 out 21 participants. Majority of 92% show certain level of acceptance. With this our study shows a slight improvement than their own even when the issue addressed differs but similarly concept used in the same domain. Also, Milk [21] presented game event and SMS path for questions and answers with simulation based. Results from their trial indicated that the teachers found the event builder easy to use with only minor recommendations for improvement and most of them reported an increase in confidence in using mobile phones for learning by the end of the workshop. The proposed approach is realized with a mobile phone simulator by popup message or call alert as a reminder to be deliver through mobile phones/devices of the lecturers and students in the institution. The study also contributed to other research work in context aware domain and ubiquitous computing in general. Though, it does not feature how the concept can be implemented using algorithm to query the mobile portal database prior to information retrieval which prompts the theory perspective idea in this paper.

IX. Contributions

The main contribution of this paper is the review of the context-aware techniques, and the unique proposal of the automatic message or call reminder service that will be offered to both lecturers and students (special case of university), through the context-aware solution with the mobile portal database in the proposed context awareness architecture.

X. Conclusion

The paper presents an information reminder (context awareness solution) to eliminate the problem of miss-communication of courseschedule and examination notices dissemination in AAU, Ekpoma. It is achieved through context aware solution presented in this paper with the simulation result's feedback in Fig. 5, showing the satisfactory acceptance by lecturers and students in the university. The context awareness architecture fetched the data via the mobile portal with the information of students' data already available in the mobile portal database. The analysis in Table III, is a confirmation of the outcome that prompts the idea of theoretical approach as suggested in this paper. The context aware solution is a mobile application delivers in text or call messages send with the help of database query that will automatically post it to the concerned students and lecturers, two days before depending on the closeness of the examination's dates, using the context data of students or lecturers on the proxy server as shown in Fig. 3. If a change occurs in course schedule or in date or time of examination, a follow up reminder or notification from the context aware unit under ICT office in charge of information dissemination, will post message(s) using query, to deliver information on the user's phone, this will be repeated at appropriate time intervals to avoid delivery failure.

XI. FUTURE RESEARCH

Context aware application's delivery and response time in practical environments need to be looked into to minimize congestion in such service(s). Suitable algorithm techniques are required for context aware information retrieval service in the area of mobile computing. Query recommendation of information retrieval using mobile portal database.

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