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USER-CENTRIC CONTEXT-AWARE LOCATION-BASED SERVICE FOR ATM'S USERS

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Abstract
The article discusses a context-aware system designed to help Automated Teller Machine (ATM) users quickly locate a working ATM with cash. Many people rely on ATMs for quick cash withdrawals, but often waste time searching for a working machine. The proposed system takes into account the user's environmental context, such as their activity, the availability of cash in the ATM, the on/off status of the machine, and the presence of a line or crowd at the ATM booth. The objective of the system is to enhance the ATM locator according to the user's specific needs, utilizing advanced features to recommend the best option for ATM customers based on their current situation. This user-centric approach aims to provide a more efficient and effective system for ATM users.

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1 Introduction
The concept of pervasive computing [1] aims to provide user-centric services that meet the user's needs and demands with minimal or no intervention. This computing environment consists of context-aware systems that gather information from devices and offer services or recommendations based on user preferences, focusing on what is nearby from a user-centric perspective. As the number of smart devices, including mobile and other devices, increases in the environment, they will be able to communicate with each other to fulfill the ever-changing needs and desires of users with little or no intervention. One of the research challenges in this vision of computing is the provision of banking and ATM services. Research aims to bridge the gap and deliver desired services to end-users based on their preferences when using ATMs.

2 Literature Review

The first parameter of a user-centric context-aware ATM locator is the user's activity for cash needs. There are methods developed in smart mobile phones to obtain activity from intent [2]. Our activity history is saved in our Google account when using the internet or system [3]. The research "The Influence of ATM Location Characteristics on ATM Usage in Vietnam" [4] discusses the user's intention to use an ATM, ATM location, and the user's ATM usage behavior. Tapia, E. M. proposed a sensing system that uses cameras and microphones to detect user physical activity in the home environment [5]. The paper "Speech Technology for Automatic Teller Machines: An Investigation of User Attitude and Performance" [6] investigates user intent and attitude from ATM speech.

Figure 1: Closed ATM and crowd at an ATM booth

The second parameter of a user-centric, context-aware ATM locator is the machine status: is it networked and in running condition or not? Various research has been discussed about it, and an application or sensors are installed to report on ATM status. In the research [7], an adaptive error detection framework for ATMs is presented. The third parameter of a user-centric, context-aware ATM locator is cash status information. There are mechanical sensors installed in the ATM that provide information about cash level, network accessibility, etc. If an error occurs, the system generates an alert [8]. In the research [9] , the monitoring status of ATMs on a real-time basis and the system to notify the server about downtime status and cash levels are discussed.

The fourth parameter is crowd context, which refers to the crowd information gathered at an ATM through cameras or other devices. Monitoring and counting the number of people is crucial for various reasons. The camera plays a significant role in monitoring all activity and the flow of incoming and outgoing people. Different places utilize various crowd monitoring techniques, including manual mechanical clickers, turn gates, infrared counters, overhead stereo lenses, and more [10].

The common issues and challenges with the existing ATM service provider and application include the inability to deposit checks, the absence of specific ATM or bank-oriented marketing screens, consistent transaction failures from a specific card bin range, occasional slow transactions at old and government ATMs, cash failure, malfunctioning card readers, and non-functioning bank applications. The literature available on the topic of banking and financial services for customers is not context-aware for the area of the ATM, as most resources require manual searching and limited service parameters such as country, city, district, or bank name.

The literature primarily consists of studies, with 19 percent published in research papers. The remaining studies focus on application-based services, with 23 percent being web-based and 58 percent being mobile-based. These application-based services are further categorized into desktop-based and web-based services provided by the banking or financial sector, offering static location information for banks, ATMs, and addresses [11] [12]. While there are some internet-based applications available, they are not context-aware and only provide navigation and address services based on user and ATM locations. As a result, they do not fully meet the requirements of ubiquitous computing, as promised by the idea.

AdriaGuide [13] is a versatile travel guide application that operates by sorting places and distances manually. It supports pictures and animations, and clicking the direction button will take you to the Google Maps website. However, there is an issue with the application crashing after selecting a language.

Adria ATM [14] is a helpful tool for finding ATMs and banks, and sorting them by order. Virtlo World Around Me [15] allows users to find nearby places in over 200 categories, including ATMs and banks in Serbia, using Augmented Reality (AR) live street view. This AR-based application provides virtual services and shows what is nearby you as you walk around.

The application offers services in selected countries, but there are instances where the ATM may not be available, the database is outdated, and the information provided is incorrect [16], [17], [18].

Available cash is shown in icon, an orange icon for crowded ATMs, and a red icon for ATMs with no cash. A microfinance-based app designed to locate operational ATMs across India, analyzes your text messages to categorize your expenses. When we make a money transfer through the app, it provides suggestions based on our spending habits. The app uses a green color to indicate that the ATM is currently active, orange to show that it was recently active, and grey to indicate that it has been inactive for a few days. Additionally, the app sends alerts about incidents at nearby ATMs and notifies users when a nearby ATM has received cash based on updates from other sources[19].

Integrates intention and activity context to send users a notification message, similar to a short message service (SMS). This message includes real-time latitude, longitude, altitude, speed, and location names to the user's mobile for better options. Similar to how ATMs send status information about cash and crowd information, the system in a context-aware environment will update itself and provide service accordingly [20].

2.1 Comparative Study

The comparison tables provide a summary of the comparative analysis. Existing apps have several disadvantages, including a lack of context awareness, failure to acquire and utilize user context, failure to specify the working condition of ATMs, failure to use CCTV camera context in the apps, failure to provide multimedia information for new users, and failure to specify whether cash is available at a particular ATM. Additionally, the limited mobile apps that offer ATM location search options are designed only for specific cities.

3 Methodology

The research methodology involved gathering primary data from 140 ATM users using a convenient sampling method and 23 statements related to various aspects of ATM services. Secondary sources included bank annual reports, relevant research papers, articles, theses, and so on. Data analysis was conducted using techniques and tools, with a 5-point Likert scale used for measurement. The study took place in Jamshoro City, with instruments and techniques including the map services API and an application developed in PHP and JavaScript. The study ran from December 2021 to February 2022, with a total of 140 ATM customers participating.

3.1 Block Diagram

If user activity indicates a need for cash, the user-centric system will send an SMS to the user with the best available options. Users can receive text messages about the nearest ATM from their current location in case of an emergency. The system will gather information about the user's cash needs, check their account balance, and then consider other factors such as ATM availability, crowds at ATM booths, and ATM locations to suggest nearby ATMs.

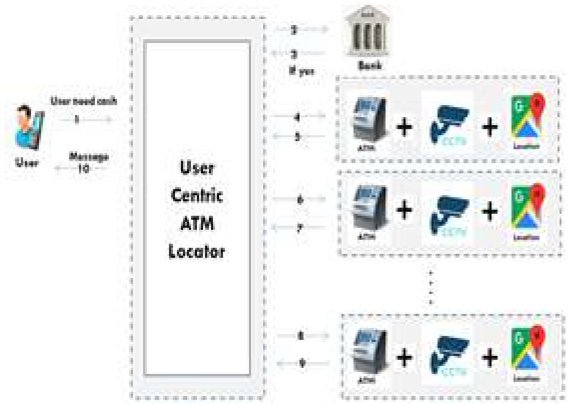

Figure 2: Block diagram of the system

If user activity indicates a need for cash, the user-centric system will send an SMS to the user with the best available options. Users can receive text messages about the nearest ATM machine from their current location in case of an emergency. The system will gather information about the user's cash needs, check their account balance, and then consider other factors such as ATM availability, crowds at ATM booths, and ATM locations to suggest nearby ATMs.

3.2 Algorithm

The system programming algorithm is divided into three phases: variable declaration and initiation. This involves creating variables and assigning values to them. The first variable is "cash intent," and the second is the user's bank account balance, which should be greater than the required amount. The third variable is "ATM status," which should be in an ON or OFF state. The fourth variable is "cash in ATM," and the fifth variable is "rush or crowd of people at the ATM."

Phase two involves searching for the aforementioned variables, some of which are accessible in the context-aware environment, while others have been created by us to evaluate our proposed system. In phase three, we filter all contextual information based on user needs to enhance service delivery.

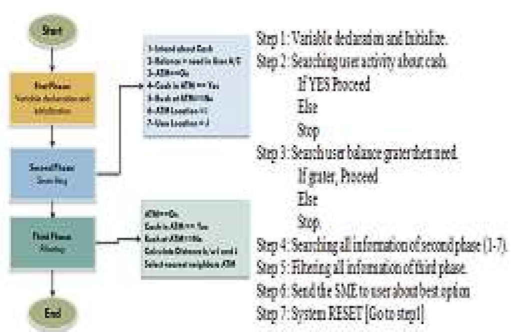

Figure 3: Flow diagram of the system

An ATM should be open, have cash, and be close to the user's current location. (Algorithms for the shortest path)

3.3 Calculating Distance Formula

The formula for calculating the distance between two points in a two-dimensional coordinate system is:

$$d = sqrt((x2 - x1)^2 + (y2 - y1)^2)$$

where:

$$(x1, y1)$$

are the coordinates of the first point

$$(x2, y2)$$

are the coordinates of the second point
sqrt is the square root function

This formula can be extended to three-dimensional space as well, using the coordinates

$$(x1, y1, z1)$$

and

$$(x2, y2, z2)$$

for the two points, resulting in:

$$d = sqrt((x2 - x1)^2 + (y2 - y1)^2 + (z2 - z1)^2)$$

The formula you provided appears to be the Haversine formula, which is a formula used to calculate the great-circle distance between two points on the surface of a sphere, such as the Earth.

Distance =

$$acos(cos((90 - User_{lat})\cdot\frac{\pi}{180})((90 - ATM_{lat})\cdot\frac{\pi}{180}) + sin((90 - User_{lat})\cdot\frac{\pi}{180})\cdot sin((90 - ATM_{lat})\cdot\frac{\pi}{180})((User_{lon} - ATM_{lon})\cdot\frac{\pi}{180}))\cdot 6371$$

In this notation, variables are represented with subscripts indicating their corresponding values. The formula calculates the great-circle distance between two points in kilometers, using the radius of the Earth (6371 kilometers) as a constant. The distance between two points on the surface of the earth is an arc, and calculating the length of which will usually involve the application of trigonometric functions. Input the value of latitudes and longitude.

4 Implementation and Execution

A. System Add new ATM, Setting Page, and interface: We discussed the design, and now we have developed the system using the case study. The system to get contexts from the environment then offers better information. The test case operates dynamically.

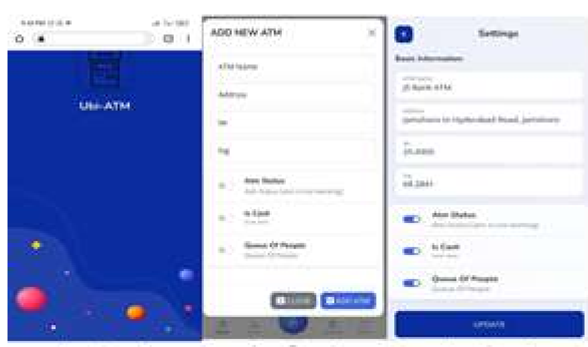

Figure 4: System Start-up interface, Add new ATM and Setting panel

B. We've identified essential services that need to be integrated, including activities, location, ATM status, cash, and CCTV cameras. Due to the lack of real-time access to the banking system's cash inside an ATM booth and the status of its CCTV camera, we've developed a conceptual scenario to test our proposed case study. To facilitate testing, we've created an "Add New ATM" section where new ATMs can be added by entering the ATM name, address, location (longitude or latitude), ATM status (on or off), and indicating whether cash is available based on the last crowd or queue of people. Once an ATM is added to the system, it reflects the updated data.

C. System setting panel interface: The system interface displays various icons such as add new, ATM status, cash status, system status, edit, and delete on the admin/system interface in the Admin Panel setting page as shown in the figures. These icons represent the working condition of nearby ATMs that have been added to the system. The system acquires real-time data from the context-aware environment and updates it accordingly, with the bank being responsible for the updates. Whenever a user requires it, the system provides the best recommendation for the given situation.

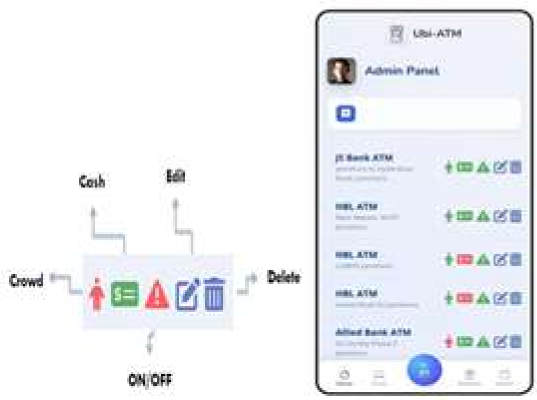

Figure 5: Icons of the system and admin interface

The green color of the icon indicates that the functions are operational, while the red color indicates that the functions are not operational. For example, the cash icon is green to indicate that the ATM has sufficient cash available, but the system is not operational due to a crowd of people.

D. System Execution: This section shows how the system works, including the user interfaces of the client and resource applications. The system checks the user's bank account balance and verifies if it's enough for shopping. The server retrieves ATM locations, working status, cash availability, and crowd information, then filters and sifts the data.

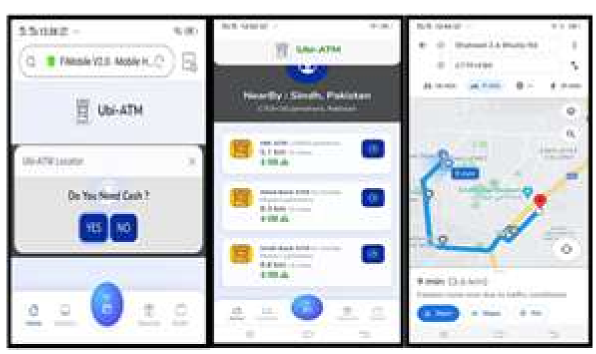

Figure 6: Pop-up message, suggestion, and suggestion results of the system interface

4.1 Usability Testing

Usability testing evaluates a product or service by having representative users complete typical tasks while observers take notes. User feedback provides quantitative data about their impressions, likes, requests, and dislikes. The testing aims to identify issues that may impact the system's usability and improve the user experience. The goals are to identify problems, improve the product or service, and learn about the target user's behavior and preferences. Major metrics ensure that the system is easy to use and that users are satisfied.

4.2 Participant Response

A random sample of 140 ATM users was collected through a post-demonstration questionnaire to gather demographic information and answer research questions. The data was collected from December 2021 to February 2022 and represents a purely random sample from all accounts with the bank that made at least one transaction during that period. The questions on the application form were updated, and users provided feedback after testing the application. Unique data was collected from each customer, and the population from which the sample was collected is unknown. The study focused on a sample of 140 ATM users from Jamshoro City, using a convenience sampling method. Data was analyzed using a chart to determine customer satisfaction.

The participant information provided is crucial for targeting users based on gender. The survey results show that only 8 percent (11) of the participants were female, while 92 percent (129) were male. Additionally, the majority of users fell into the 31-40 age group at 44 percent (62), followed by 21-30 years at 37 percent (51), 41-above years at 12 percent (17), and below 20 years at 7 percent (10). In terms of occupation, 41 percent (58) were government employees, 36 percent (50) were students, 12 percent (16) were self-employed or business owners, and 9 percent (13) worked in private organizations.

The participants provided feedback on the questionnaires and answered general questions about ATMs, usage, and the proposed system. To test the system's usability, we visited an ATM in Jamshoro city, briefed ATM customers on our proposed system, and offered to open the system on the web link www.baloch.me/atm.php upon the user's request. After receiving confirmation from the user, the Ubi-ATM system determined the user's current location and recommended the best ATM options. Users were able to easily locate ATMs with cash availability and minimal or no queues nearby. The app suggested a location based on the user's current position and led them to the selected ATM. Following this, we invited users to provide feedback on our proposed system.

1. After completing the posttest of CAATMS and using the application, ATM respondents were asked the first question: "Are you satisfied with the proposed system and application?" The results showed that 45 percent (63) of respondents were satisfied with the services, 40 percent (56) were strongly satisfied, 12 percent (17) were neutral, 1 percent disagreed, and 2 percent (3) strongly disagreed with the statement.
2. The second post-testing question asked, "Has the proposed system met your needs and requirements?" 48 percent (67) of respondents strongly agreed with the question, 33 percent (67) agreed with the statements, 11 percent (16) were neutral, and 4 percent (5) disagreed or strongly disagreed with the statements.
3. The participants were asked if the system was functioning properly and if the application provided the necessary information about nearby ATM locations. In response, 78 percent (119) of users agreed or strongly agreed, 3 percent disagreed, and 19 percent were neutral.
4. When asked whether this application provides the necessary information about the availability of ATMs, 72 percent (101) of users agreed or strongly agreed, while 19 percent (27) did not agree.
5. When asked if the application provides the necessary information about cash in ATMs, 78 percent (109) of users strongly agreed or agreed, while 10 percent (14) disagreed.
6. When asked if the application provides appropriate information about queues or crowds at ATMs, 53 percent (74) of users strongly agreed or agreed, while 36 percent (51) did not agree.
7. When asked if they would recommend this application to others, 65 percent (92) users strongly agreed or

agreed, while 23 percent (32) did not agree.
8. The question is: Do you agree with the proposed implementation of real-time services in the banking sector? 80 percent (113) of users strongly agreed or agreed that this application should be implemented for general ATM users, while 5 percent did not agree with the question.
9. Would you consider visiting this application to support our idea? 78 percent (109) of the users strongly agreed or agreed with the question, while 14 percent (20) did not agree.

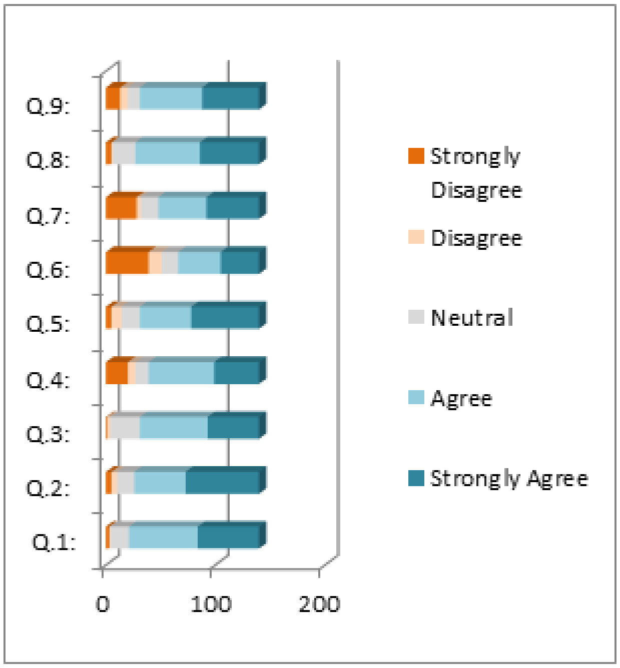

Figure 7: Summary of the response to Usability testing

The average satisfaction score from usability testing for the system was 74.60 percent, indicating that the system or product is considered acceptable and satisfactory. The testing results revealed that participants were satisfied with the system's ability to support user involvement in the development of CCATMS (Ubi-ATM) pervasive applications. The findings also indicated that the system was easy to use and provided sufficient features for user involvement, leading to increased satisfaction. Additionally, performance evaluation showed minimal and acceptable performance overhead in pervasive computing settings.

5 Conclusion

The contextual information is readily available in the environment, but the challenge lies in how to effectively locate and utilize it. A user-centric ATM locator with access to user activity, cash availability, on/off status, and crowd information is essential for ensuring a better experience for ATM customers. This system provides valuable insights into the user's cash needs and demands. The user-centric ATM locator prototype is designed to efficiently integrate activity, cash availability, on/off status, and crowd context. The overall system delivers efficient results, allowing users to withdraw cash from the ATM without having to wait in line, waste time, or make multiple attempts at different ATMs.

6 Future Work

Future work may involve adding necessary parameters to the current User-Centric ATM locator algorithm. This can be achieved by incorporating new parameters based on user needs, such as face recognition, pattern recognition, and crowd sensing through mobile devices to detect crowds at the ATM booth.

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Author Contributions

Abdul Rehman Baloch: Requirement Analysis, System Design, Literature Review, and Writing Original Draft **Prof. Dr. Kamran Taj Pathan:** Supervisor **Prof. Dr. Azhar Ali Shah:** Co-Supervisor **Dr. Mujeeb-ur-Rehman Jamali:** Evaluation and Results Comparison **Muhammad Ali Baloch**: Implementation (Coding) and Data Curation

Compliance with Ethical Standards

It is stated that all authors don't have any conflict of interest. Furthermore, informed consent was obtained from all individual participants included in the research work.

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