Int. J. Advanced Networking and Applications
Volume: 16 Issue: 01 Pages: 6270– 6274 (2024) ISSN: 0975-0290

Context-Aware Tourist Guide: A Rule based Approach

Sanjida Ara Mousumi
Department of Computer Science and Engineering, Islamic University, Kushtia, Bangladesh
Email: sanjida.cse.iu@gmail.com
A. O. M. Asaduzzaman
Department of Computer Science and Engineering, Islamic University, Kushtia, Bangladesh
Email: azaman_s@yahoo.com
Md. Mojahidul Islam
Department of Computer Science and Engineering, Islamic University, Kushtia, Bangladesh
Email: m_mojahidul@cse.iu.ac.bd
M. Robiul Hoque
Department of Computer Science and Engineering, Islamic University, Kushtia, Bangladesh
Email: robiul@cse.iu.ac.bd

ABSTRACT

Due to the blessing of human computer interaction (HCI) technologies people are experiencing different types of personalized service in their daily life. By this motivation, a context-aware tourist guide system has been designed to enhance user experiences through personalized services. Leveraging smartphone sensors, including GPS for location tracking, accelerometer for mobile gestures, and smartphone time for precise timing, the system effectively gathers and analyzes different contextual data. A rule-based algorithm governs decision-making, allowing the system to provide relevant information tailored to users' interests and preferences. In addition, flexible architecture of rule-based reasoner facilitates the addition of new service rules for seamless expansion. For performance evaluation, a case study is conducted in three different spaces within a university campus that demonstrate the system's accurate location identification and its ability to deliver essential information about places of interest while respecting user privacy. By offering an automated and intelligent tourist guide, the proposed system showcases the transformative impact of technology in various domains, extending its benefits beyond tourism.

Keywords - **Context-awareness, Tourist guide, Location, Service, Rule-base, Rete algorithm.**

Date of Submission: January 27, 2024 Date of Acceptance: May 22, 2024

I. INTRODUCTION

In today's rapidly evolving technological landscape, context-aware computing has emerged as a fascinating area of research, captivating the interest of scholars and practitioners alike. This novel concept envisions systems capable of not only sensing their surrounding environment but also adapting and reacting intelligently based on the contextual cues they perceive. Context-aware systems hold the promise of providing tailored services and seamless user experiences by harnessing data from various sources and applying predefined rules [1], [2], [3], [4]. The essence of context awareness lies in the ability of a system to interpret information about its environment and make informed decisions accordingly.

This research endeavors to explore and create a context-aware system, focusing on its implementation and evaluation in the domain of a tourist guide. The proposed context-aware tourist guide system aims to replicate the prowess of a human guide while incorporating computational intelligence to discern user preferences. By intelligently sensing user activities and locations, the system strives to provide relevant and timely services tailored to individual interests. Given the significance of context awareness in numerous applications, this study delves deeper into location awareness and activity recognition as key research areas. The proposed context-aware tourist guide holds immense potential for implementation in diverse settings, from tourist destinations to university campuses and beyond. The overall system design is depicted in Fig. 1.

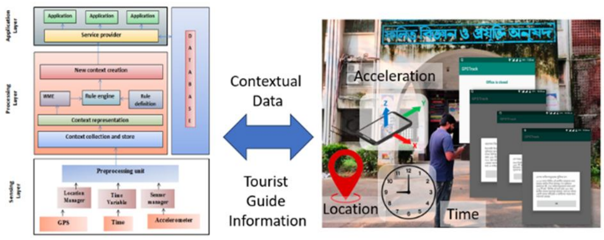

Fig.1. A Context-Aware Tourist Guide System.

The primary goals of this research are threefold: firstly, to acquire context information from smartphone sensors; secondly, to process and reason with the gathered contextual data; and finally, to provide dynamic services based on context changes. The ensuing sections of this paper elaborate on related terms, the technology employed in the system's design, the system architecture, and the methodology applied for evaluation, culminating in a comprehensive analysis of the research findings and potential future directions. Through this work, we seek to contribute to the rapidly growing field of context-aware computing, coupling the transformative power of technology to revolutionize user experiences in various domains and lay the groundwork for innovative and intelligent systems of the future.

II. RELATED WORKS

An activity-based retrieval system, where data on the user's activity are gathered automatically to support retrieval by, for example, browsing through an autobiography of work episodes and also discusses some of the difficulties with this approach, and presents the results of three experiments in which autobiographical episodes were reconstructed by means of automatically collected activity data [5]. It concludes with some comments on the technical feasibility and social acceptability of such an approach to information retrieval.
A project entitled Cyber Guide that builds a prototype of a mobile context-aware tour guide. Knowledge of the user's current location along with the history of past locations provides more of the kind of services that are exactly expected from a real tour guide [6]. Chen and Kotz examined context-aware systems and applications, types of contexts used and models of context information systems that support collecting and disseminating context and applications that adapt to changing context [7]. Mobile application based tourist guide system helps people to explore a place in many dimension [8], [9].
Context-aware features, including contextual sensing, contextual adaptation, contextual resource discovery, and contextual augmentation, enable systems to provide seamless and personalized interactions by understanding user needs, adapting to varying situations, and offering timely and relevant services based on the user's context. These capabilities make context-aware systems valuable tools across various domains and applications, enhancing user experiences and optimizing system performance [10]. Middleware architecture for a context-aware system in a smart home environment shows that the middleware provides a more accurate and faster reasoning outcome compared with the traditional rule-based reasoning method [11]. To build a context-aware tourist guide system, in this research, we have integrated contextual sensing, rule-based processing, and provide services according to the contextual adaptation.

III. SYSTEM ARCHITECTURE

This paper presents a context-aware system that harnesses smartphone sensors, including the accelerometer and GPS, in conjunction with system time, to attain precise contextual information for localization purposes. Utilizing default sensors available on Android smartphones and considering smartphone time as system time, the system is implemented and evaluated within the context of a tourist guide. The results demonstrate the system's remarkable ability to deliver logical conclusions regarding the user's location, catering especially to individuals keen on discovering more about specific places. By effectively collecting and analyzing contextual data, the context-aware system provides relevant and personalized information, elevating the overall tourist experience.
The context-aware system is structured into three fundamental layers: the sensing layer, the processing layer, and the application layer as shown in Fig. 2. Each layer plays a crucial role in the system's overall functionality, contributing to the effective delivery of context-aware services. Context aware tour guide uses GPS position sensor, Accelerometer sensor, which is built-in on a smartphone and system time also takes as an input. Preprocessing unit transforms sensed data into linguistic form. For example, system time is 10am then it will be converted into "open" means, now the tourist site is open for visitors. Similarly, if the time passes 5pm then it is converted into "close". This layer passes sensing data to the upper layer for further processing with the data format given in Fig. 3.

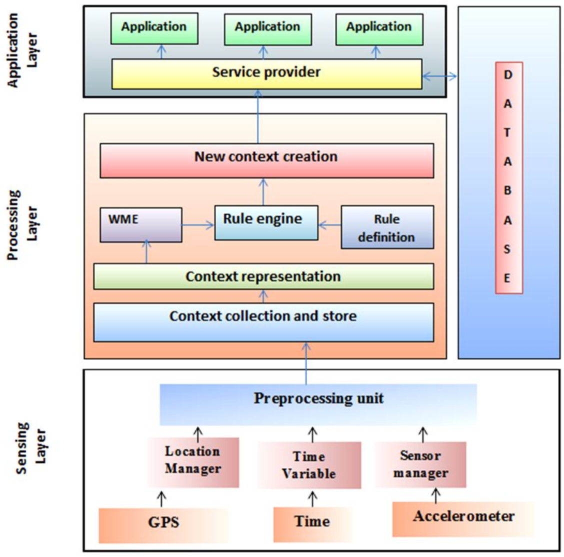

Fig.2. Context-Aware Tourist Guide System Architecture.

Data Format	Description
{"B1", "open", "portrait"}	• 'B1' represents the building name • 'Open' represents the office time • 'Portrait' represents the orientation of the

Fig. 3. Data Format and Description.

The nearest building from the user's current location is found using GPS position data according to the following algorithm as shown in Fig. 4. Hence, the Euclidean distance formula is used to find the distance between two buildings in the campus.

Algorithm : Calculating distance between user and Buildings
begin
(1) Lat_user : Latitude of users current location
(2) Lon_user: Longitude of users current location
For each building in the campus
  (i) Lat_building : Latitude of a building location
  (ii) Lon_building: Longitude of a building location
  (iii) Distance= √((Lat_user-Lat_building)2 + Lon_user-Lon_building)2)
(3) If min(Distance)<threshold
  (i) Bname ← Building name with minimum distance
(4) return Bname
end

Fig. 4. Minimum Distance Calculation Algorithm.

Volume: 16 Issue: 01 Pages: 6270– 6274 (2024) ISSN: 0975-0290

Processing layer has four major parts: context collection and store, context representation, inference engine and context creation. The context collection and store are responsible for acquisition of sensed data and placing them in the working memory (WM) through context representation.

The context representation employs First-Order Predicate Logic (FOPL) to represent the relationships between various facts, which are essentially tuples of sensed data. For example, if a user is detected in front of the science building, it can be represented as “building (science)” in FOPL. The inference engine serves as a specialized module responsible for generating new contexts based on the available current contexts. This module utilizes a user-defined rule-based decision-making technique to achieve its functionality. Each time a new context is added or updated in the current context list, stored in the working memory element along with the sensed data, the inference engine is triggered.

When a change is identified in the current context list, the inference engine loads the rules from the rule base and proceeds to find matches with the current context list. This process allows the system to make decisions as well as creates new contexts by applying relevant rules to the available data; the process is depicted in Fig. 5. In summary, the FOPL-based interface facilitates representing relationships between facts, and the inference engine, employing rule-based decision making, dynamically generates new contexts by matching the rules with the current context list. This mechanism enhances the system’s context-awareness and enables it to respond effectively to changes in the user’s environment.

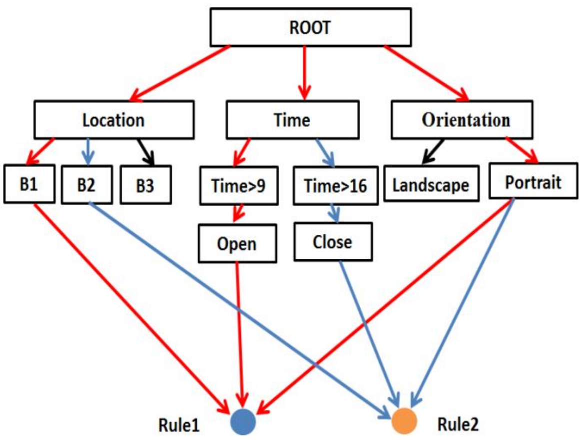

Fig. 5. Rule-based Inference System.

Every rule contains variables, and each variable will be replaced by instances of some concepts according to the context representation. We describe this process considering the rules presented in Fig. 6 as follows.

In the rule, for showing information to the user, let *location(x)^time (open)^orientation(portrait)* be defined as part of the rule. Here, the variable ‘x’ is mapped to the building name; the variable ‘open’ is mapped to the office time. Moreover if the user’s device orientation is portrait then new context *info(z)* will be created. Here the variable ‘z’ mapped to the provided services.

SN	Rule
1.	If location<x>^time<open>^orientation<portrait> Then info<z>=new context<x>
2.	If location<unknown>^time<open>^orientation<portrait> Then info<z>=message<a[1]>
3.	If location<x>^time<close>^orientation<portrait> Then info<z>= message<a[2]>
4.	If location<x>^time<open>^orientation<!portrait> Then info<z>= message<a[3]>
5.	If location<x>^time<close>^orientation<!portrait> Then info<z>= message<a[4]>

Fig. 6. Rule For Creating New Context.

A rule-based service selection engine is developed to provide the desired service. The newly created context acts as an input of this rule-based selection engine. Service may include information about a building; notification during prayer time, lunch time; any specific restricted place can be defined as mentioned in Fig. 7.

Context	Service definition
New-context(x)	Provide necessary information about building ‘x’.
Message a[1]	Unknown place (Show default message).
Message a[2]	Office time is closed (Show default message).
Message a[3]	Please take your phone in portrait (Show default message).
Message a[4]	Check time and orientation of your phone! (Show default message).

Fig. 7. Illustration of Some Services with Corresponding Important Functions.

IV. EXPERIMENTAL RESULTS

The objective of this work is to devise a context aware system and implement it as a tourist guide. We have created a context-aware tourist guide by following all procedures of the context-aware system. This location-based context-aware tourist guide can provide the exact location of the user and also can provide information about that location. If the context becomes changed then the given information will also be updated. The screen shot of the developed android application is illustrated in Fig. 8.

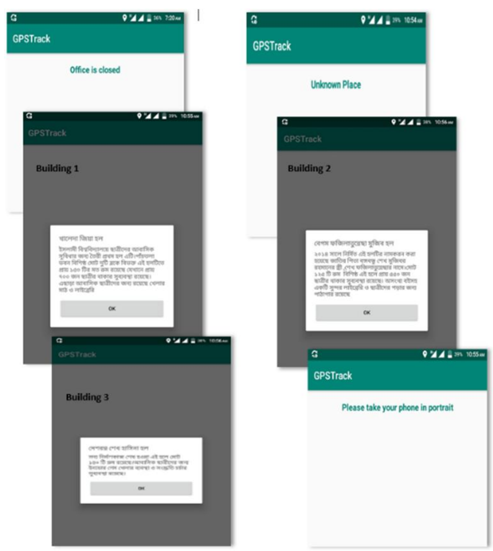

Fig. 8. Output of the Context Aware Tourist Guide System.

Volume: 16 Issue: 01 Pages: 6270– 6274 (2024) ISSN: 0975-0290

This location-based, context-aware tourist guide possesses the capability to accurately determine the user's location and provide relevant information about that particular place. Additionally, it continuously updates the provided information to reflect any changes in the context. We have checked the performance of the proposed rule based context-aware system for five days. The performance results are presented in Fig. 9, Fig. 10 and Fig. 11.

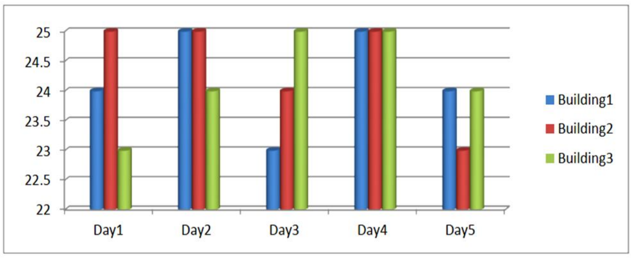

Fig. 9. Location Determination.

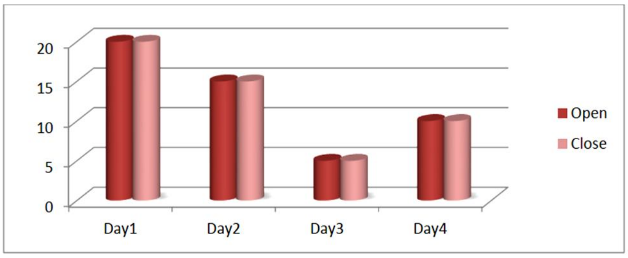

Fig. 10. Time Determination.

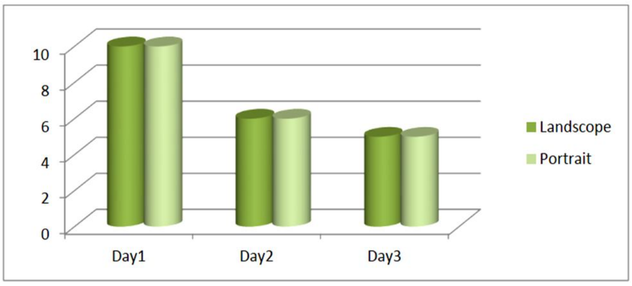

Fig. 11. Device Acceleration Determination.

V. CONCLUSION

Our context-aware tourist guide revolutionizes the way tourists explore and learn about new destinations, empowering them with personalized, contextually relevant data and enhancing their overall travel experience. This study contributes to the knowledge base on context-aware systems, shedding light on their potential to revolutionize user interactions.

As part of future work, the developed architecture can be extended to other smartphones and regular phones, enabling its implementation in various locations beyond the current scope. While the prototype relies on GPS for outdoor tourist navigation, it's acknowledged that GPS accuracy is limited indoors. Hence, future endeavors may involve integrating alternative location support systems tailored for indoor navigation.

REFERENCES

[1] M. Humayun Kabir, Kim Hyun-Wook and Yang Sung-Hyun, The development of a modular type platform for home network service, *2012 International Conference on Informatics, Electronics & Vision (ICIEV)*, Dhaka, Bangladesh, pp. 582-587, 2012.

[2] M. R. Hoque, M. H. Kabir, H. Seo, S. H. Yang. PARE: Profile-Applied Reasoning Engine for Context-Aware System, *International Journal of Distributed Sensor Networks. 12*(7), 2016.

[3] M. R. Hoque, M. H. Kabir, K. Thapa, and S. H. Yang. Ontology-based Context Modeling to Facilitate Reasoning in a Context-Aware System: A Case Study for the Smart Home, *International Journal of Smart Home*, *9*(9), pp. 151-156, 2015.

[4] Navod neranjan thilakarathne and et. al. Internet of Things(IoT) Security: Status, Challenges and Countermeasures, *Int. J. advanced networking and Application, 14(03)*, pp 5444-5454, 2022

[5] M. G. Lamming and W.M. Newman, Activity-based information retrieval: Technology in support of personal memory, *In Proceedings of IFIP-92*. IFIP Congress, 1992.

[6] D. Abowd, G. A. Christopher, J.Hong, S.Long, R. Kooper, and M. Pinkerton, Cyberguide: A mobile context-aware tour guide, *Graphics, Visualization and Usability Centre Wireless Networks, 3*, pp. 421–433. 1997.

[7] G. Chen, D. Kotz, A survey of context-aware mobile computing research, *Dartmouth: Dartmouth Computer Science Technical Report*; 2004.

[8] W. Y. Meng, A. S. B. Shibghatullah, K. Subaramaniam. Go. Travel- A Smart Tourism Guide Mobile Application, *Journal of Advances in Artificial Life Robotics, 3(2)*, PP. 92-101, 2022.

[9] N. B. Nugraha, E. Alinudin. Mobile Application Development for Tourist Guide in Pekanbaru City, *The 2nd International Conference on Computer Science and Engineering Technology, Journal of Physics: Conference Series 1430*, 2020.

[10] J. Pascoe, Adding generic contextual capabilities to wearable computers, *In Proceedings of the Second International Symposium on Wearable Computers*, Pittsburgh, Pennsylvania, October 1998.

[11] H. W. Kim, M. R. Hoque, H. Seo, and S. H. Yang, Development of Middleware Architecture to Realize Context-Aware Service in Smart Home Environment, *Computer Science and Information Systems*, *13*(2), 427–452.

Volume: 16 Issue: 01 Pages: 6270– 6274 (2024) ISSN: 0975-0290

Biographies and Photographs

Sanjida Ara Mousumi has completed her B.Sc and M.Sc in Computer Science and Engineering from Islamic University, Bangladesh. Her area of interest in research is Context-Aware System, Smart Space, Sensor Network, and Robotics.

A. O. M. Asaduzzaman is an Associate Professor in the Dept. of Computer Science and Engineering, Islamic University, Bangladesh. He has completed his B.Sc and M.Sc in Computer Science and Engineering from University of Rajshahi, Bangladesh. His research interest includes Computer Networks, Artificial Intelligence, Smart Space, and Sensor Network.

Md Mojahidul Islam received the B.Sc. and M.Sc. degrees in Computer Science and Engineering from the Islamic University, Bangladesh. He is currently an Associate Professor in the Department of Computer Science and Engineering, Islamic University, Bangladesh. His research interests include computer vision, speech signal processing, object tracking, pattern recognition, multimedia analysis, and machine learning.

M. Robiul Hoque, is a Professor in the Dept. of Computer Science and Engineering, Islamic University, Bangladesh. He has completed his PhD in Electronic Engineering from Kwangwoon University, Seoul, Korea in 2016. Before that he completed his B.Sc and M.Sc in Computer Science and Engineering from Islamic University, Bangladesh in 2000 and 2001 respectively. His research interest includes Context-Aware System, Smart Space, Sensor Network, Image and Speech Processing.