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Critical Insights into Context-Aware Systems: A Literature Review

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ABSTRACT

Recently, automobile networks, health monitoring, and industrial alarm systems have used context-aware systems more. These systems make sense of environmental cues and simulate productivity gains using fuzzy logic and machine learning. They can verify machine integration into the human body and perform logical sensor data analysis to improve healthcare monitoring. They can also help to create systems that adapt to changing conditions, such as emergency vehicle communication networks. Regardless of scale, these adaptive systems have varying modularity to improve results in a wide range of application areas. They enable secure, efficient, and intelligent interaction across domains. This study investigated 20 context-aware system studies. It covers strategic shifts, challenges, and dynamics in this field in detail. Business analytics, the Internet of Things, remote care, human capital, recommendation systems, vehicle networks, human-robot interactions, smart product-service systems, and successful recruitment are covered. Consider the entire synthesis to determine the value of contextuality and system use in various sectors. Fuzzy logic, machine learning, and architectural frameworks help explain context-aware computing formation and ongoing advances.

Keywords: Context, automotive networks, sensor, IoT, business intelligence, PSS.

INTRODUCTION

Cost-effective context-oriented technology will likely drive the most notable technological advancements in the future, leading to a novel kind of human-to-human communication. The industries most affected include transportation, healthcare, and smart housing. AI, sensor technology, and computer science are key factors in the development of these products. Sensory awareness is crucial in context-related systems. It involves quickly distinguishing varied environmental situations and providing individualized services to system users based on optimal decision-making. "Contextual intelligence refers to the process of coding artificial intelligence (AI) and applications in a manner that mimics how humans gather and utilize contextual information." Contextual intelligence refers to the ability of individuals, computers in artificial intelligence systems, and some applications to understand and interpret the context in which they operate. This includes the capability to analyze and make sense of recorded images or visual data using machine learning algorithms. The essay commenced with an examination of the establishment of context-aware systems, followed by an exploration of the forthcoming advancements in these devices. The practical implementation of these systems was extensively elucidated towards the end, with the provision of a specific case study.

Context-Aware Challenges

i. Contextual Ambiguity: Contextual ambiguity refers to the inherent uncertainty in environmental occurrences that context-aware systems encounter. These systems need reliable methods to accurately interpret such events.
ii. Diverse Sensing Modalities: Context-aware systems get increasingly complex when integrating diverse sensing modalities that necessitate pre-established data fusion and interpretation techniques.

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iii. Processing Restrictions in Real Time: Given that context-aware systems primarily function as real-time operating systems, they necessitate algorithms and architectures that are both extremely efficient and capable of low latency.

This study offers a thorough examination of 20 works that focus on systems and deal with context-aware systems. Through a thorough examination of their research methodologies, findings, and final statements, we aim to emphasize the complexities of context-aware computing. We embarked on a review of those publications to discern crucial concepts that will enhance our comprehension of context-aware systems and aid in the advancement of a new trajectory in this rapidly expanding field.

Context-Awareness

The primary challenge of context-aware computing is to empower users with the ability to comprehend and interpret contextual cues, enabling them to make intelligent judgments and adapt their actions accordingly. To provide context-based suggestions, adaptive user interfaces, and tailored services, context-aware systems need to be able to effectively process and evaluate contextual information.

i. Interpreting Environmental Cues: Sensitive systems consist of distinct components that decode diverse environmental factors, such as timing, location, user preferences, and context.
ii. Adaptive Decision-Making: Indeed, this corresponds to cognitive systems having the ability to make decisions that are aware of the context in real time and being able to alter based on the interpreted context in a flexible manner.
iii. Integration of Multiple Data Sources: Most context-aware systems are meant to leverage data from several sources, such as sensor technologies, IoT devices, and social exchanges. However, this requires the use of intricate and complex methodologies for data fusion and analysis.

Sensors

Sensors are devices that observe and detect physical properties or changes around them. Context-aware systems involve different types of sensor devices such as

Figure 1: *Sensors in Mobile Computing*

Location Sensors

Sensors such as Bluetooth, Wi-Fi, and GPS tell us where the user is.

Motion Sensors

Sensor reconstruction in this category is achieved without any motion measurement or spatial discrepancies that could disrupt the process. This is because they record and assess changes in physical observable quantities such as sound, light, heat, and electromagnetic waves through measurements and evaluations. For instance, the accelerometer and gyroscope are employed to monitor the movements of the selected activity. In modern times, sensors have assumed a significant role in security systems, with gadgets increasingly incorporating them in many applications, including gaming, robotics, home automation, medical monitoring, and more. Motion sensors are superior because they are the primary means by which systems

detect and respond to activity occurring in their surroundings.

Environmental Sensors

Environmental sensors, which are crucial in a context-aware system, collect users' information to enable a smart atmosphere to gain precise knowledge about the user's surroundings through accurate telemetry data. These sensors possess the capability to engage with the climatic surroundings and accurately detect a wide range of data, such as temperature, humidity, brightness, pressure, and more. There is a wide array of environmental sensors due to their diverse properties. The comprehensive nature of each entity produces context awareness, enabling modifications to the surroundings. Typically, these sensors are accountable for detecting and displaying variations in temperature and humidity through distinct colour indicators. Context-aware computing platforms are a unique method of accurately representing the user's surroundings. These platforms rely on data-intensive processes and real-time sensors to read the user's environment and accurately depict the user's current condition. Automated guidance systems, robots, and classroom monitoring systems can adjust their behaviours by regulating measurements of elements like heat, pressure, humidity, and light intensity. This allows them to prioritize security, enhance comfort, and boost productivity.

Biometric Sensors

Devices that are inherently aware of their surroundings often rely on biometric sensors to offer two essential services: identification and authentication, as well as data gathering and analysis for health monitoring purposes. The technique establishes measurements to obtain a comprehensive understanding of the user. Her/his biometrics are used as a means of identification. The sensors mentioned, such as facial recognition, fingerprint reader, and heart rate monitor, are all instances of biometric sensors. If your device is equipped with sensors such as face(ion) sensors or fingerprint scanners, you can detect a heartbeat. These sensors are widely used and recognized as some of the most popular sensors available.

LITERATURE REVIEW

A Context-Aware Empowering Business with AI

Case of Chatbots in Business Intelligence Systems Artificial intelligence (AI) enhances business intelligence (BI) by enhancing data analysis, automating data integration, utilizing predictive analytics, employing natural language interfaces, detecting anomalies, generating tailored suggestions, and improving data visualization. Artificial intelligence (AI) systems analyze vast datasets to identify patterns or extract useful insights, while machine learning enables quicker and more effective examination of the data. They usually automate the process of aligning, transferring, and merging data between systems without human intervention. Natural language interfaces enable people to access data, while artificial intelligence predicts future patterns. This study explores the strategies for enhancing AI-based business intelligence through the application of advanced intelligence. The focus is on how AI business intelligence (AI BI), which comprises a range of approaches and tools, can enhance or even replace certain business procedures to improve decision-making. Consequently, our primary focus was to elucidate the viewpoint of intelligent business intelligence (BI) enhancement through artificial intelligence (AI), which forms the foundation of AI's use in empowering businesses (Azmi et al., 2023).

A Fuzzy Diagnostic Agent for Context-Aware Patient Monitoring

Remote healthcare monitoring, intended to offer adequate alternatives to conventional healthcare services, may serve as a feasible solution to alleviate the overwhelming strain on global healthcare systems. Regardless of your level of expertise in diagnosing a patient, it is crucial to ensure that you accurately determine their condition as well. This paper presents a fuzzy expert system that is connected to the Internet of Things (IoT) to perform medical diagnostics. The system utilizes a Body Area Network (BAN) consisting of multiple sensors that collect important health data. The system collects sensor data and uses fuzzy logic to classify the patient's responses, ranging from basic data to advanced indicators, for further study (Magano et al., 2018).

A Context-Aware Safety System for Human-Robot Collaboration

The development of synergies between humans and machines can be achieved through the newest advancements in human-machine interaction. In the industrial sector, each contributor will provide support to the other, using these inventions. The most captivating aspects of the entire procedure are consistently the removal of inefficiencies and the safeguarding of both data and function. This article proposes the discontinuation of the smart safety system invention to overcome obstacles and ultimately prevent loss of life. Technologies prioritize minimizing human intervention in data processing by computers, ensuring that desired goals are achieved only when a clever algorithm has determined it. Additionally, it will streamline the process of locating individuals, particularly about other factors that will improve comprehensiveness. This project focuses on creating a safety system for human-robot interaction that ensures optimal collaboration. Therefore, it delineates the elements, methodologies, and connections that are required (Liu et al., 2018).

Context-aware Gossip in Ad hoc Vehicular Networks

The objective of this research is to prioritize the provision of instances that examine the quantitative information-seeking behaviour of vehicular ad-hoc networks in the context of communal news guidance. The purpose of the contextual filtering function for Gossip in a traffic scenario is to be evaluated by comparing it with an unfiltered message through the simulation of two distinct scenarios. The objective is to integrate a single on-board unit into the car that has a collection of maps (layers) or named layer types (for vector layers) and allows for field selection and other similar actions, as well as the ability to set bookmark keywords. One of the main areas of our research is studying the intensity and significance of contextual filtering in life-threatening situations. Our study findings demonstrate that implementing such an idea may be done securely, without exacerbating the transient rumors that circulate inside the college environment. Contextual filters protect against a decrease in water levels by preventing the rivers from being filled with unnecessary and repetitive messages or data. When the costs of advertisements increase, the main flow of water will decrease rapidly (Bennakhia et al., 2019).

A Meta-model for context-aware adaptive Business Process as a Service in a collaborative cloud environment

Due to the significant expansion of cloud computing, the process of establishing new software through SaaS composition has become a more crucial activity compared to its previous importance. Today, the crucial demand for commercial SaaS solutions is to be adaptable and nimble, capable of transforming rapidly to meet changing conditions and requirements. Initially, a business analyst, who scrutinizes the operations of companies, designs the new business process for the SaaS. Once the SaaS composer completes the evaluation of the components, it assumes the task of choosing appropriate software that will ultimately be integrated into the process, with a primary focus on the essential parameters.

To address multiple business concerns under the cloud banner, this study develops a meta-model.

Additionally, an illustration of context-aware systems is examined, which focuses on the integration of several business activities and services to effectively handle the dynamic nature of business tasks (Hidria et al., 2019).

Detecting Bogus Information Attack in Vehicular Ad Hoc Network

A Context-Aware Approach Voluntary participatory networks can execute various functions, such as those of Fly Ad Hoc Networks (FANETs) and Vehicular Ad Hoc Networks (VANETs). These networks operate on community principles to enhance performance and deliver better services for entertainment and traffic monitoring. However, malfunctioning or misbehaving vehicles in a parking area of 10 spaces can occupy up to 8 spaces, preventing other car drivers from parking as desired. This not only compromises convenience but also poses a risk to safety and property. Therefore, obtaining accurate and reliable information about the location of vehicles sharing the area is crucial for ensuring the effectiveness of VANET. The existing detection method of a static security fence cannot prevent crimes or stop moving vehicles from breaching it. Similarly, surveillance cameras are not an effective barrier as criminals may easily cross them. Therefore, the criminals may possess the capability to effectively carry out criminal activities.

By employing this detecting technology, we are presenting a jewel that is highly attached to its surroundings, resulting in a reduced likelihood of false alarms and increased accuracy. During our investigation, we may additionally incorporate data pieces that are beneficial for maintaining the overall perspective of the vehicle. We will rely on a dendrogram algorithm to validate messages submitted to us, without any human supervision, to verify the legitimacy of these messages. Following the classification step, the system then employs Bayesian-based hypothesis testing to eliminate any inaccuracies that may have occurred during the classification process. The consequence of using this technique would be that it is suitable for encouraging the identification of attacks on bogus information, resulting in an efficient application (Stitini et al., 2021).

Designing a context-aware recommender system in the optimization of the relief and rescue.

Context awareness is an essential tool for addressing many problems, as it enhances cognition and facilitates the identification of environmental elements and dynamics. Given that Iranians and people from all parts of the world reside in areas with numerous seismic faults, the occurrence of an earthquake poses a significant challenge for relief and rescue operations. This study tries to determine the incorporation of context awareness into various types of endeavours.

At the forefront of the research topic is the examination of elements such as the specializations of humanitarian workers and the environmental and operational challenges they face. Additionally, the study aims to evaluate the locations that have similar characteristics in terms of rescuers, groups, and environment. One of the important duties involves developing a precise algorithm and improving it to detect areas that have been affected and assigning relief workers to specific locations and tasks.

The emphasized context-aware strategy has been shown to have the best performance in improving relief measures, demonstrating positive results in the enhancement of relief measures. Speed improvement is quadrupled compared to the current state. This study demonstrates that by closing the gap in catastrophic response, the maximum achievable outcome is facilitated (Ghose & Rehena, 2019).

A Mechanism for Air Health Monitoring in Smart City Using Context-Aware Computing

Smart sustainable communities strive to enhance the quality of life by implementing innovative solutions that foster economic growth and guarantee overall social well-being. These cities are focused on creating a secure, clean, inexpensive,

and dependable environment for all residents. The core concept of this approach revolves around constructing environmentally friendly areas that provide a healthy living environment for the occupants. In this study, we propose a methodology for monitoring urban air quality that takes into account future considerations. We achieve this by utilizing context-aware computing technologies, which can also facilitate smart health efforts.

The framework utilizes contextual information to provide notifications regarding potential risks of air pollution and employs smart sensors as instruments for monitoring key indicators of air pollutants. Next, we provide the IO approach for Layer Optimization, which effectively streamlines the model's execution and eliminates superfluous overhead, all while maintaining system speed.

These results suggest that a framework incorporating optimization techniques can be used to provide effective air quality management in smart and sustainable cities while also meeting their objectives (Ilie et al., 2020).

E-HoA: A Distributed Layered Architecture for Context-aware Autonomous Vehicles

The objective of this research is to establish the necessity of implementing the Embedded Higher-order Agent (E-HoA) architecture to meet the demands of ambient systems such as automobiles and other advanced modes of transportation that rely on a higher-order agent system. The autonomous control system of this design will utilize the mentioned platform and convert beliefs into action by employing the Robot Operating System (ROS). It is highly suitable for controlling the cycle of an automobile.

In general, the architectural principles of E-HoA demonstrate that the system can enhance awareness of autonomous cars regarding the environment and the necessity to respond appropriately in situations that demand unplanned actions (Bahrami et al., 2019).

Development of a Context-Aware Assistive System for Manual Repair Processes - A Combination of Probabilistic and Deterministic Approaches

This paper discusses excellent strategies for organizing various activities. Activity recognition and labour activity summarizing are used. The existing processes model can fulfil work processes by merging HMMs and Petri nets. After activity recognition, this model lets the system suggest activities and motion types.

This section details the process model and how Petri nets and HMM are interwoven. They offer an action plan for implementing the paradigm. The approach can be applied to assembly and rework in a context-specific manner, but customisation across the scope requires more effort (Chaouche et al., 2020).

Dealing with Failures for Execution Consistency in Context-aware Systems

This study addresses BDI agent priority and multitasking management to boost decision power. We continually monitor the agent and ensure he/she completes vital tasks, even if they are challenging. Planning identifies key tasks alongside direct supervision.

To illustrate this approach, we examine an autonomous car navigation application. This example shows how our technique helps these vehicles make better real-time decisions to maximize efficiency and safety (Wang et al., 2019).

Evaluating Smart PSS Solutions with Context-Awareness in the Usage Phase

The significant progress in Internet of Things (IoT) technology is facilitating the digital transformation of traditional paradigms through the implementation of intelligent Product-Service Systems (PSS). These systems serve as enduring companions for users, providing support throughout the entire lifespan of a product, particularly during its usage. These intelligent PSS (Personalized Search Systems) must adapt similarly to our preferences. Sellers of these systems must be perceptive, adjusting their products to the latest advancements in consumer behaviour. The focus of our study is to analyze the effectiveness of these intelligent PSS during the consuming phase. Our objective is to ensure that these technologies consistently possess knowledge of the actual conditions that consumers are experiencing by implementing a context-aware methodology (Bertram et al., 2021).

Privacy-preserving cloud-connected IoT data using context-aware and end-to-end secure messages

Cloud platforms and IoT devices are transforming smart buildings, agriculture, and industry. Cloud systems analyze and store data, whereas IoT devices sense and respond. Many IoT applications, especially those using publish-subscribe protocols like MQTT, lack standardized message formats. Even with Transport Layer Security (TLS), end-to-end message security is difficult, especially for sensitive content.

This paper introduces a new technique that provides end-to-end security and standardizes publish-subscribe message topics and payloads with context-aware information at the device and cloud levels. Compared to earlier approaches, our results demonstrate a 40% topic size reduction and a 50% payload size reduction. This improves IoT communication security and efficiency, speeding device data processing (Ferraz Junior et al., 2021).

A Context-Aware Approach for Extracting Hard and Soft Skills

Due to the growth of Internet recruitment, candidate screening is more expensive, time-consuming, and laborious. Skill-based recruitment is growing to speed up hiring. Hard and soft skills must be automatically and reliably retrieved from job descriptions and resumes. A context-aware sequence and token classification model for skill extraction is provided in this paper. Machine learning classifiers and specialized word embeddings like BERT are used to validate the models on a public job description dataset. Our methodology works; the best models use BERT embeddings and extra language information (Wingsa et al., 2021).

Integrating contextual information into multi-class classification to improve the context-aware recommendation

Data mining, information retrieval, and e-commerce value contextual information. Context-aware recommender systems advise users using contextual data. These systems classify historical data to predict future events. By integrating contextual information into multi-class classification, this article enhances recommended findings. We found that this connectivity greatly improves personalized user recommendations (Ferraz Junior et al., 2021).

A Survey of Middlewares for Self-adaptation and context-aware in Cloud of Things Environment

The increased usage of smart gadgets, linked goods, cellphones, and sensors has led to Big Data. Cloud computing is effective for data analysis and storage due to these devices' limited resources. As the IoT integrates with cloud capabilities, the Cloud of Things (CoT) has arisen, creating several potentials. Due to the heterogeneity of devices, distribution, dynamic environment, and cloud services, middleware is needed. This project investigates CoT environment self-adaptation middleware. We review important characteristics before comparing current middleware. Dynamic and static adaptation middleware follows. Finally, we discuss current challenges in developing unique middleware that may instantaneously and dynamically adjust cloud services based on object context (Souki et al., 2022).

Context-aware Acoustic Signal Processing

Data processed in context is more intelligible, easier to grasp, and contains more information because of the surrounding context. Even in audio signal processing. This research introduces a Deep Learning-based ensemble neural network strategy for context integration in learning systems. Acoustic signal analysis is used to analyze machine sound data for pumps, slide rails, and valves in many use cases. Mel-spectrograms train convolutional neural networks for audio data analysis and image processing (Augusto, 2007).

A Survey on Context-aware Systems

Context-aware systems offer consumers and application developers exciting new opportunities by tuning system behaviour to contextual data. Used with mobile devices, these technologies boost usability, making them more valuable. The majority of context-aware systems use a layered conceptual design framework and common architecture concepts. We explore contemporary context-aware systems, focusing on middleware and frameworks that simplify context-aware application development. These systems demonstrate context-aware computing's key components and methods (Liu et al., 2018).

Context-aware Knowledge-based Systems: A Literature Review

As a subclass of intelligent systems, context-aware systems provide smart service customer-specific products and services. To improve smart services, contextual data must be organized and modified to produce information. This makes knowledge-based strategies essential for context-aware systems. Indeed, knowledge-based systems and context awareness have grown in relevance for decades. Few studies have studied how to combine the two areas to maximize their benefits. This work reviews the literature on modern contextaware system conceptualization, focusing on the knowledge-based approach, to stimulate further research. The study's implications and issues will be discussed (Meßmer et al., 2023).

Contexts and Context-awareness Revisited from an Intelligent Environments Perspective

The unconscious understanding of context helps humans tackle daily challenges. Many computer science subfields are now using this approach to construct useful systems. Giving the system context awareness may help it make smart real-world decisions. Many systems attempt context awareness, but there are few standard methods. Lack of consensus on sound principles or standards for the scientific community and developers interested in these systems is the key problem. Multiple thorough polls have been done (Baldauf et al., 2007).

Table 1: *Comparison Table*

Paper	*Paper Type*	*Technique Used*	*Summary of Results*	*Summary of Limitation*	*Reference*

Context-Aware Empowering Business with AI: Case of Chatbots in Business Intelligence Systems	Experiment	Path Planning, Pose Recognition	Plans paths to avoid collisions and attain goals, enabling human-robot collaboration efficiency and safety.	Requires validation in real-world manufacturing environments.	Azmi et al., 2023
Fuzzy-based Diagnostic Agent for Context-Aware Patient Monitoring	Experiment	Fuzzy Logic	Provides accurate medical data interpretation via Body Area Network for remote healthcare supervision.	The complexity of fuzzy logic reasoning may impact system scalability.	Magano et al., 2018
Context-aware Gossip in Ad hoc Vehicular Networks	Experiment	Simulation	Keeps dynamic vehicular networks intact while reducing redundant emergency alerts, promising faster and more productive research with large datasets.	Simulation results may not fully represent real-world scenarios.	Bennakhia et al., 2019
A meta-model for context-aware adaptive Business Process as a Service in a collaborative cloud environment	Survey	AI, BI Integration	Discusses how AI methods and implementations can improve business intelligence (BI) decision-making.	A theoretical overview may lack practical implementation details.	Hidria et al., 2019
A Survey of Middlewares for Self-adaptation and context-aware in Cloud of Things Environment	Survey	Middleware Comparison	Assesses Cloud of Things middleware for dynamic adaptability, identifying issues.	The survey-based approach may not cover all possible middleware solutions.	Souki et al., 2022
Integrating contextual information into multi-class classification to improve the context-aware recommendation	Experiment	Classification, Recommendation	Improves recommendation results by considering contextual information and classification.	Limited to correlation analysis, may not provide insights into other aspects of recommendation systems.	Stitini et al., 2021
A Context-Aware Approach for Extracting Hard and Soft Skills	Experiment	Automated Skill Extraction for Recruitment	Suggests methods for obtaining excellent performance by removing soft and hard skills from job descriptions and resumes.	Performance evaluation is limited to specific datasets, and may not generalize to all contexts.	Wingsa et al., 2021
Privacy-preserving cloud-connected IoT data using	Experiment	Context-aware IoT Message Standardization	Accomplishes byte efficiency in subject and payload by standardizing.	Evaluation based on specific metrics may not capture all aspects of IoT.	Ferraz Junior et al., 2021
context-aware and end-to-end secure messages	Experiment	Communications with context awareness for end-to-end security in IoT	Communications with context awareness for end-to-end security in the Internet of Things.	Evaluation based on specific metrics may not capture all aspects of IoT.	Ferraz Junior et al., 2021
Evaluating Smart PSS Solutions with Context-Awareness in the Usage Phase	Experiment	Smart Product-Service Systems Evaluation	Presents a context-aware method for assessing the performance of the smart PSS throughout the usage phase.	Limited to evaluation methodology, may not cover all aspects of smart PSS performance.	Wang et al., 2019

Dealing with Failures for Execution Consistency in Context-aware Systems	Experiment	Symbolic Guidance for BDI Agents	Focuses on autonomous vehicles and presents a method for directing BDI agent behaviours under concurrency and relevance requirements.	Limited to the theoretical proposal, lacks empirical validation.	Chaouche et al., 2020
Development of a Context-Aware Assistive System for Manual Repair Processes - A Combination of Probabilistic and Deterministic Approaches	Experiment	Petri Net, Hidden Markov Model (HMM)	Presents a context-sensitive support system for assembly and rework workers using HMM and Petri nets for intuitive process modelling to evaluate extensive vulnerabilities.	Validation of the proposed system implementation may be required in real-world scenarios.	Bertram et al., 2021
E-HoA: A Distributed Layered Architecture for Context-aware Autonomous Vehicles	Experiment	Belief-Desire-Intention (BDI), ROS	Outlines a framework for ambient systems that are aware of context, allowing autonomous cars to carry out plans depending on contextual cues.	Limited validation in real-world autonomous vehicle scenarios.	Ilie et al., 2020
A Mechanism for Air Health Monitoring in Smart City Using Context-Aware Computing	Experiment	Context-aware computing, Smart Sensors	Suggests a framework for context-aware computing and smart sensor monitoring of air quality in metropolitan areas, with emphasis on input layer optimization.	The effectiveness of input layer optimization may vary based on sensor accuracy and environmental conditions.	Ghose & Rehena, 2019
Designing a context-aware recommender system in the optimization of the relief and rescue	Experiment	Context-Aware Optimization Algorithm	Examines how to best distribute relief workers in earthquake emergencies while taking context into account.	Evaluation is limited to simulated earthquake crisis scenarios.	Bahrami et al., 2019
Detecting Bogus Information Attack in Vehicular Ad Hoc Network: A Context-Aware Approach	Experiment	Feature Extraction, Hierarchical Clustering	Explains a Bayesian-based hypothesis testing, feature extraction, and hierarchical clustering method for context-aware detection in VANETs.	The evaluation may lack real-world deployment, and sensitivity to network dynamics may impact detection accuracy.	Ghaleb et al., 2019
A Context-Aware Safety System for Human-Robot Collaboration	Experiment	Human-Robot, AI	Introduces a safety system for human-robot collaboration using artificial intelligence.	Privacy concerns.	Liu et al., 2018
A Survey on Context-aware Systems	Survey	Context-Aware Architecture Principles	Analyzes popular frameworks and architectural principles for context-aware systems, with a particular emphasis on middleware and development frameworks.	The survey-based approach may not cover all possible context-aware systems, limited to existing frameworks and architectures.	Baldauf et al., 2007

Contexts and Context-awareness Revisited from an Intelligent Environments Perspective	Survey	Conceptual Framework, Context Operations	Outlines important ideas and procedures for system developers in a theoretical corpus for context-aware systems.	The theoretical approach may lack empirical validation, and applicability in practical contexts may vary.	Augusto, 2007
Context-aware Acoustic Signal Processing	Experiment	Ensemble Neural Networks	Offers a deep learning strategy that uses ensemble neural networks to include context into auditory signal processing.	Limited discussion on real-world application and validation, and scalability to other contexts may need further investigation.	Meßmer et al., 2023
Context-aware Knowledge-based Systems: A Literature Review	Survey	Literature Review, Knowledge-based Approach	Examines the research on balancing knowledge-based systems for smart services with context awareness, highlighting challenges and implications.	The literature review-based approach may not cover all recent advancements, and discussion is limited to conceptual aspects of integration.	Vu et al., 2023

CONCLUSION

In conclusion, recent advancements in context-aware systems have ushered in a new era of intelligent and adaptive technology across a multitude of areas. These systems have demonstrated remarkable proficiency in interpreting contextual cues to maximize productivity while preserving security, thanks to the application of sophisticated algorithms like fuzzy logic and machine learning. Context-aware systems have proven their adaptability and effectiveness in a range of contexts, such as seamless human-robot collaboration in manufacturing environments, healthcare monitoring using sensor data processing, and dynamic emergency vehicular networks. By continuously adapting to changing surroundings, these systems offer scalable solutions that promise safer, more intelligent interactions across different domains. As technology continues to progress, there is great potential for developing context-aware systems.

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REFERENCES

Augusto, J. C. (2007). Contexts and context-awareness revisited from an intelligent environments perspective. *International Journal of Ad Hoc and Ubiquitous Computing*, 2(4), 263.

Azmi, M., Mansour, A., & Azmi, C. (2023, August 14-16). A context-aware empowering business with AI: Case of chatbots in business intelligence systems. *5th International Workshop of Innovation and Technologies (IWIT 2023)*, Halifax, Nova Scotia, Canada.

Bahrami, N., Argany, M., Samani, N. N., & Vafaeinejad, A. R. (2019). Designing a context-aware recommender system in the optimization of the relief and rescue. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences.*

Baldauf, M., Dustdar, S., & Rosenberg, F. (2007). A survey on context-aware systems. *International Journal of Ad Hoc and Ubiquitous Computing*, 2(4), 263.

Bennakhia, A., Ben Nakhia, A., & Marafia, A. (2019, November 4-7). Context-aware gossip in ad hoc vehicular networks. *10th International Conference on Emerging Ubiquitous Systems and Pervasive Networks (EUSPN 2019)*, Coimbra, Portugal.

Bertram, P., Kränzler, C., Rübel, P., & Ruskowski, M. (2021, June 15-18). Development of a context-aware assistive system for manual repair processes - A combination of probabilistic and deterministic approaches. *30th International Conference on Flexible Automation and Intelligent Manufacturing (FAIM2021)*, Athens, Greece.

Chaouche, A.-C., Ilie, J.-M., & Pecheux, F. (2020, November 2-5). Dealing with failures for execution consistency in context-aware systems. *11th International Conference on Emerging Ubiquitous Systems and Pervasive Networks (EUSPN 2020)*, Madeira, Portugal.

Ferraz Junior, N., et al. (2021). Privacy-preserving cloud-connected IoT data using context-aware and end-to-end secure messages. *18th International Conference on Mobile Systems and Pervasive Computing (MobiSPC)*, Leuven, Belgium, August 9-12.

Ghaleb, F. A., Zainal, A., Maroof, M. A., & Rassam, M. A. (2019). Detecting bogus information attack in vehicular ad hoc network: A context-aware approach. *16th International Learning & Technology Conference*.

Ghose, B., & Rehena, Z. (2019). A mechanism for air health monitoring in smart cities using context-aware computing. *Third International Conference on Computing and Network Communications (CoCoNet'19)*.

Hidria, W., M'tira, R. H., Saouda, N. B., & Guedira-Guegan, C. (2019). A meta-model for context-aware adaptive business process as a service in a collaborative cloud environment. *CENTERIS - International Conference on Enterprise Information Systems / ProjMAN - International Conference on Project MANagement / HCist - International Conference on Health and Social Care Information Systems and Technologies.*

Ilie, J.-M., Chaouche, A.-C., & Pecheux, F. (2020, April 6-9). E-HoA: A distributed layered architecture for context-aware autonomous vehicles. *11th International Conference on Ambient Systems, Networks and Technologies (ANT)*, Warsaw, Poland. Paris, France: LIP6, UMR 7606 Sorbonne Université; Constantine, Algeria: MISC Laboratory, University Abdelhamid Mehri - Constantine 2.

Liu, H., et al. (2018, June 11-14). A context-aware safety system for human-robot collaboration. *28th International Conference on Flexible Automation and Intelligent Manufacturing (FAIM2018)*, Columbus, OH, USA.

Magano, T., Djouani, K., Kurien, A., & Chibani, A. (2018). A fuzzy-based diagnostic agent for context-aware patient monitoring. *8th International Conference on Current and Future Trends of Information and Communication Technologies in Healthcare (ICTH 2018)*.

Meßmer, L.-M., et al. (2023). Context-aware acoustic signal processing. *27th International Conference on Knowledge-Based and Intelligent Information & Engineering Systems (KES 2023)*.

Perera, C. (2012, September). Capturing sensor data from mobile phones using global sensor network middleware. ResearchGate.

Souki, O., Djema, R. B., Amous, I., & Sedes, F. (2022). A survey of middlewares for self-adaptation and context-aware in a cloud of things environment. *26th International Conference on Knowledge-Based and Intelligent Information & Engineering Systems (KES 2022)*.

Stitini, O., Kaloun, S., & Bencharef, O. (2021, November 1-4). Integrating contextual information for improved context-aware recommendation. *8th International Symposium on Emerging Information, Communication and Networks (EICN 2021)*, Leuven, Belgium, pp. 1-5.

Vu, T.-M.-H., Dinh, T. L., Dam, N. A. K., & Pham-Nguyen, C. (2023). Context-aware knowledge-based systems: A

literature review. *56th Hawaii International Conference on System Sciences.*

Wang, Z., Li, X., Chen, C.-H., & Khoo, L.-P. (2019). Evaluating smart PSS solutions with context-awareness in the usage phase. *Third International Conference on Computing and Network Communications (CoCoNet'19)*.

Wingsa, I., Nanda, R., & Adebayo, K. J. (2021). A context-aware approach for extracting hard and soft skills. *10th International Young Scientists Conference on Computational Science*, Maastricht, The Netherlands.