

OdditDB: Auditable and Adaptable Database System for Enhancing Robotics Data Integrity

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Abstract—This paper introduces an innovative database system designed to track scientific data changes, offering flexibility and rapid customization for the next generation of robotics. As robotics evolve, the demand for reliable, auditable, and customizable databases grows, as does the need to ensure the trustworthiness of robotic actions and responses. Our database system provides an auditable trail of data changes, enabling the tracing of inconsistencies or errors in robotic actions back to their origins. This transparency builds confidence in the capabilities of machines. As we look ahead to the future of robotics, particularly in the context of 2030, robust backend systems are essential to support advanced functionalities. Our database system is poised to serve as a foundational element, fostering collaborations, forming new partnerships, and playing a pivotal role in defining the trajectory of robotics in the years to come.

I. INTRODUCTION

In an era where robotics and technology are rapidly advancing towards unprecedented heights, the need for robust, auditable, and adaptable database systems has never been more critical [5]. This paper introduces a groundbreaking tool, OdditDB, designed to empower researchers with a seamless and auditable database deployment mechanism. Auditability in this database refers to the systematic tracking of all data interactions, capturing the specific operations performed on the data, the individuals responsible for those actions, and the precise timestamps of each event. This audit trail ensures transparency, accountability, and verifiability of all changes made within the system.

OdditDB offers researchers a powerful platform to manage, manipulate, and secure their data in a structured and traceable manner. Through a standardized JSON Schema format, this tool streamlines data operations while ensuring the integrity and authenticity of each action taken.

In the following sections, we present the essential features, concepts, and benefits of OdditDB, shedding light on its potential to revolutionize the way researchers interact with data. By exploring the synergy between auditable databases and the ever-advancing realm of robotics, we embark on a journey to define the future of data management and its profound impact on the realm of robotics innovation.

II. MOTIVATION

OdditDB seeks to address the following challenges faced by the field of robotics:

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- Modern robotics often involves complex data, decisions, and actions, and the absence of proper audit data trails in traditional databases like MySQL can lead to difficulties in tracing errors.
- Many existing database solutions, such as SQL Server, carry significant costs.
- Ensuring the security and integrity of data is paramount, and traditional systems may be deficient in stringent security measures [3].
- Robotics applications frequently need dynamic scaling, a capability not always economically feasible in tools like MySQL [4].
- Traditional databases may hinder collaboration and interdisciplinary research, failing to embrace open-source methods.

In contrast to previous work, including a robotics database presented by Niemueller [4], OdditDB emerges as a tailored response to these unique challenges. Unlike the MongoDB-based system that emphasizes real-time data handling, powerful querying, adaptability to evolving data structures, and applications such as fault analysis and performance evaluation, OdditDB sets its focus on auditability, cost-effectiveness, stringent security measures, dynamic scalability, and collaboration. This approach positions OdditDB as a tool specifically designed to meet the demands of the robotics industry, paving the way for more efficient, secure, and innovative research and development.

III. ODDITDB DESIGN

OdditDB is meant to be a lightweight web-application built for long-term research purposes [2]. The design is underpinned following these principles:

- **Cost-Effectiveness [1]:** OdditDB minimizes costs with affordable off-the-shelf components, avoiding expensive proprietary solutions.
- **User-Friendly [2]:** The application ensures ease of use, with a user-friendly web-application located in a single domain.
- **Secure Encryption [3]:** Data security is paramount in OdditDB, with encryption during storage and transmission to thwart unauthorized access.
- **Open Source [1, 2]:** Embracing an open-source approach, OdditDB welcomes collaboration, innovation, and continuous improvement.
- **Flexibility [4]:** OdditDB's flexibility allows for any database design, with user-input templates promoting customization for each user's needs.

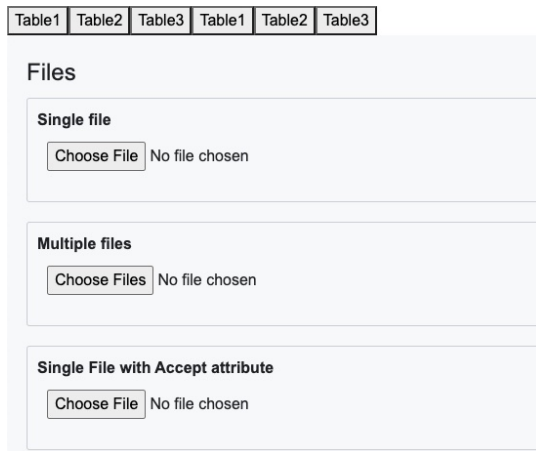


Fig. 1. Example of OdditDB User Interface

- **Research Empowerment [2]:** Beyond functionality, OdditDB empowers researchers with tools for efficient, secure, and collaborative data management.

To realize these principles, OdditDB’s architecture incorporates key components [2]:

- 1) Main application server leveraging AWS Lambda and API Gateway.
- 2) DynamoDB for unstructured data storage, ensuring efficient and scalable database management.
- 3) S3 for secure and reliable file storage.
- 4) CloudFront for content delivery, enhancing user experience.
- 5) Utilization of Serverless framework for seamless deployment and management.
- 6) Continuous Integration/Continuous Deployment (CI/CD) principles using GitHub Actions for automated workflows.

IV. SETUP AND USE

The system’s setup can be easily accomplished by following our detailed documentation. Although the initial process may take 1-2 hours, subsequent use of the tool, such as uploading data, is much quicker and more straightforward. Users are guided to create a customized database template to accommodate their specific data needs.

Once set up, users simply upload data in the format defined by their custom database template. They can then access this uploaded data and generate audit trails as needed. These audit trails then allow users to analyze the data to scan for issues or improvements.

V. USE CASES

The open-source and customizable nature of OdditDB supports various applications in academia and research, including:

- **Auditing of Robot Actions [5]:** OdditDB ensures data integrity by recording changes in robot actions, enhancing transparency, and enabling researchers to track and verify robotic manipulations.

- **Machine Learning Data Trails and Reproducibility [5]:** OdditDB documents each step of machine learning experiments, promoting reproducibility and result validation.
- **Collaborative Research and Data Collaboration [2]:** OdditDB fosters interdisciplinary collaboration by providing a transparent platform for data sharing, maintaining an audit trail of changes and promoting holistic research outcomes.

The data, with these specific use cases, can be uploaded to the database, providing a secure storage method. This stored information then forms an audit trail, allowing for comprehensive tracking of data modifications. Audits can capture when, how, and by whom the data was altered, thereby enhancing transparency in the data utilized for robotic systems and research.

VI. VISIONS

OdditDB, the cost-effective and open-source auditable database solution, envisions a future where robotics innovation is underpinned by data integrity and collaboration. Aligned with the symposium theme, “Defining the Future of Robotics – Towards 2030 and Beyond,” OdditDB is set to shape the next decade of robotics advancement. In this future, OdditDB empowers researchers, students, and industry professionals to verify and trace robotic actions and responses with confidence. Auditable data management becomes the cornerstone of trustworthy and reliable robotics interactions, driving adoption in healthcare, manufacturing, exploration, and beyond.

OdditDB also envisions a collaborative landscape where interdisciplinary teams seamlessly share data, fostering breakthroughs that push robotics boundaries. Human-robot interaction becomes more empathic and intuitive, culminating in a harmonious coexistence that drives progress and transforms industries. As we journey towards 2030, OdditDB’s auditable data paves the way for defining the future of robotics. This vision aligns seamlessly with the symposium’s theme, embracing accountability, transparency, and collaboration as we shape a world where auditable interactions inspire innovation and redefine the possibilities of robotics.

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