Mediator system for robotic applications

Rubanraj Ravichandran

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Department of Computer Science
University of Applied Sciences Bonn-Rhein-Sieg

Supervisors:
Prof. Dr. Erwin Prassler
Advisors:
Nico Huebel Sebastian Blumenthal

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1 Introduction

Robots generate large amount of data from different types of sensors attached to it and also from its hardware components. In our previous research work [3], we have conducted an extensive qualitative and quantitative analysis to find better databases and architectures that effectively store these data and consume it for further operations. Results from our previous work shows that, a single database is not suitable for every robotic scenarios. For example, in terms handling large BLOB data, mongoDB stored them faster but reading the data was slower compared to couchdb [3]. Also, to complete a given task robots depends on multiple source of information from internal sensors, as well as external sources for example world model, kinematic model, etc..

Adoption of multiple databases for robotic applications requires unique way of mediation to view multiple databases as a single federated database. Mediator approach helps to integrate data from different sources and produce a single result back to robots. Mediator abstracts the information of how data is being stored in different data sources from robot, and allows robotic applications stream data to mediator independent of databases used in the back-end.

To Map the data generated by robots with multiple databases, mediator system requires a proper data model predefined in the context of robotic applications. Modeling robot generated data helps to generalize the structure of data and defining relations between different objects in the robot systems. If we have a well defined robotic data models, then mediator will get the ability to mutate or query data from different data sources. Also it is important that, these data models should be extended to any robotic use-cases.

As mentioned in these papers [2],[2],[3], mediators are being used to integrate data from different data sources and few architectures supports single data model (e.g SQL), and others supports for different data models (e.g SQL,NoSQL, document store, etc..). Also, they are differ from query languages, ease of implementation, components used in their architecture. This project focuses on defining suitable data models for robotic applications and implementing a mediator system which act as a middle-ware between robots and databases.

2 State of the art analysis

Fahl et al. [2] proposed an active mediator architecture to gather information from different knowledge base and combine them to a single response. AMOS[1] architecture uses Object-Oriented approach to define declarative queries. This distributed architecture involves multiple mediator modules to work collaboratively to collect the required piece of information and produce final result. Primary components of AMOS architecture are,

- Integrator - Gather data from multiple data sources that have different data representations.
- Monitor - Monitor service always watch for any data changes and notifies the mediators. This is helpful in the case where system needs an active updates to change its current task.
- Domain models represents the models related to application which helps to access data easier from any database through a query language.
- Locators helps to locate mediators in the network.

Integrator module is built with two internal components called IAMOS[2] and TAMOS[3]. First Integration AMOS parse the query and send individual requests to Translational AMOS modules which are responsible for heterogeneous data source. Then,all TAMOS modules return the individual results to IAMOS for integrating all the results. To query multi databases from IAMOS, IAMOS servers are mapped with TAMOS servers with the help of Object-Oriented query language.

[1]Active Mediators Object System

[2]Integration Active Mediators Object System

[3]Translation Active Mediators Object System

Ahmed et al. [1] developed a heterogeneous multi-database system called Pegasus that supports multiple heterogeneous database systems with various data bases models, query languages and services. Pegasus predefines its domain data models based on object oriented approach and also supports programming capabilities. These objects are created and mapped with the types and functions with the help of HOSQL[4] statements. HOSQL is a declarative object oriented query language which is used by Pegasus to manipulate data from multiple data sources.

Pegasus system supports two types of data sources, local and native data sources. Whenever a new data source joins Pegasus system, schema integrator module imports schema from data source and update its root schema with the new schema types. The final integrated schema shows the complete blueprint of the different data sources participates in the data integration. Pegasus system work-flow is comparatively similar to AMOS architecture, but they use different different query language and data modeling strategies.

3 Problem Formulation

Our previous work results reveals not all databases reacts in a similar fashion for different heterogeneous data from robotic applications. Also, there are no data models has been defined in the context of robotic application sensor data. For example, black box designed for ROPOD project simulation uses mongoDB to store raw sensor data with out any data model.

(contact alex or santhosh to see the current implementation and complete the problem here)

In terms of supporting multiple databases setup for robots, we need a systematic approach to store and retrieve data from external sources and, a well defined data model that can map components and sensors to a robot and also with the world model.

These are the major problems will be discussed and addressed in this

[4] Heterogeneous Object Structured Query Language

work,

- Data model for robotic applications
- Implementation of single mediation layer to connect between robots and databases (different data model)
- Unique query language that can be used by robots to talk with different databases via mediator.

3.1 Use cases

Need to be defined

4 Workplan

This workplan shows the major decomposition of the workpackages, start time and end time. This project starts on August 15^{th}, 2018 for 6 months duration and ends on February 15^{th},2018.

4.1 Work packages

5 Deliverables

5.1 Minimum

- Report on state of the art analysis.
- Collection of existing IoT device management tools which are capable to do OTA updates.
- Qualitative comparison of these tools based on the work flow, advantages and disadvantages.

5.2 Expected

- Designing and implementing test bed for peer-peer and multicast protocol.
- Running experiments and collection of results.
- Analysis of results.

5.3 Maximum

- Incorporate best performed decentralized file sharing protocol with CP-Swarm platform to handle OTA update.

References

[1] Ahmed, R., DeSmedt, P., Du, W., Kent, W., Ketabchi, M. A., Litwin, W. A., Rafii, A. and Shan, M.-C. [1991], 'The pegasus heterogeneous multidatabase system', *Computer* **24**(12), 19–27.

[2] Fahl, G., Risch, T. and Sköld, M. [1993], 'Amos-an architecture for active mediators'.

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