Utilization of NoSQL database for disaster preparedness

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Abstract

Nowadays, in the age of big data, geodatabases become more critical with respect to geospatial data volume, variety and capacity. It is required that geodatabases must be capable enough to cope with high stakes of geospatial data service during production, manipulation and publication stages.

The concept of NoSQL database has been introduced as a potential alternative solution to existing SQL databases which is supposed to grow more rapidly in the near future. It has the prospective to combine the powerful capability of GIS data processing with an approach of non-relational Data Base Management System (DBMS). This type of data warehouse can potentially accommodate variety of information over the World Wide Web (www) space with different structures into one single geodatabase. MongoDB as one instance of NoSQL database introduces an open source document storage empowered by a replication using data partitioning approach across multiple machines.

For the work described in this paper it has been used for the integration of open access geo-information by extracting geospatial information from a near real time earthquake service i.e. Geofon. Geospatial information is extracted from the Geofon uniform resource locator (url) then transferred into documents in MongoDB. This demonstrates the geospatial data integration in order to improve earthquake information contents as well as to enable GIS analysis approach using Python scripting environment in ArcGIS 10 platform. It shows a reliable performance even for handling a relatively big geographical names data from GEOnet Names Service (GNS).

Keywords: Earthquake, NoSQL, non-relational, rapid mapping, geographical names

1 Introduction

The occurrences of disasters all over the world trigger the awareness of many responsible institutions around the globe to deliver useful services in order to perform disaster preparedness.

Using a Desktop GIS as a basic processing platform, this practical work has combined two point features from different sources into one single geodatabase in MongoDB.

The motivation of this paper is to integrate near real time information from web service in a GIS Desktop using NoSQL database (MongoDB) as the data warehouse by enabling geospatial functionality.

2 NoSQL Database

NoSQL databases introduce a new approach to overcome the problem of data structure inconsistency as a challenge to the conventional Relational Data Base Management System (RDBMS) [2]. The most important factors that trigger NoSQL technologies were the uprising of crowdsourcing and technology driven demand [1].

MongodDB as an instance of NoSQL database implements schema flexibility by using Java Script Object Notion (JSON) format and document based approach [3]. Actually those two approaches will combine the advantages of flexible data structure and data transfer capabilities.

3 Earthquake webservice

Geofon is one instance of the earthquake information service operated by German Geo-research Centre (GFZ) which is basically in near real time manner. Although the sensor platform is always switched on to monitor seismic activities but usually it also analyses recorded data before any further public distribution (Figure 1).

Figure 1: Geofon web service

4   Integration concept

Data integration has been performed by the following technical implementation steps:

1.   Geospatial data creation

It combines capability to read, filter and transfer geospatial content from Geofon and GNS into MongoDB, in the context of disaster preparedness. Those two features have been stored in one single data MongoDB collection on a document basis (Figure 2).

Figure 2: Document based storage
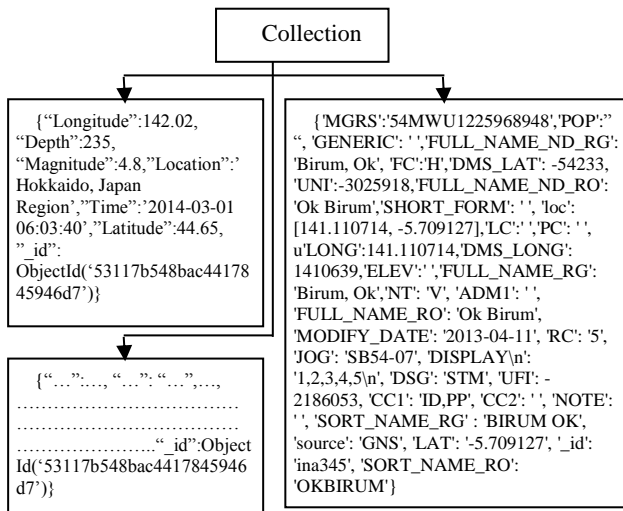
2.   Real time integration

By simply implementing scheduled task, a python script will be executed on each frequent time i.e. every 5 minutes in order to get real access to seismological monitoring network around the globe maintained by Geofon service.

3.   Geospatial Index and Query

By using subsequent updating for the whole document, it creates one additional field i.e. 'loc' that contains Longitude and Latitude data in a float values for geospatial index purposes.

As an instance to improve the "location" field in Geofon earthquake service, the "near" function in MongoDB has been implemented to get the nearest feature from latest earthquake occurrence. It improves the location field from "Bali Sea" to more accurate result of "Sekunci" (name of the island) automatically (Figure 3).

In addition using "within" radius functionality, field information from different features can be joined as a complementary intersection in geo-processing. This capability has been tested to join field within a certain radius which yield ArcGIS layer with additional field from earthquake event e.g. Magnitude, Depth and Time.

Figure 3: Geospatial functionalities
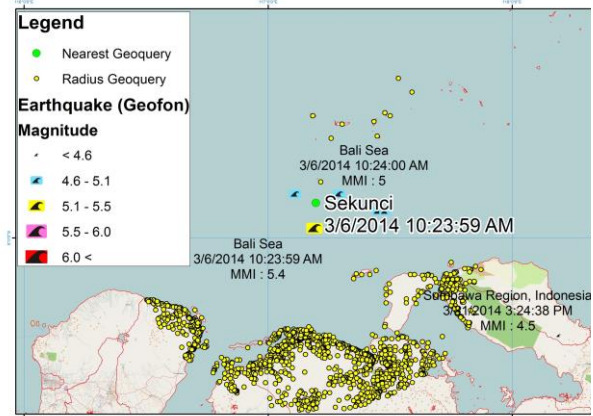
5   Conclusions

Geospatial information can be very useful if it is integrated with other information system. This practical work has integrated real time earthquake data from Geofon with GNS. As the final result, it brings real time information improved by static geospatial data source from GNS.

The NoSQL database plays some important roles in the integration system both as geospatial data storage and geospatial data processor. Geo-processing performance in MongoDB has been tested with reliable geo-querying function such as 'near' and 'within' in ArcGIS 10.

Real time integration is mainly supported by scripting capability in simple non-SQL query which enables geospatial analysis from different features and structures using NoSQL database approach.

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