THE DEVELOPMENT OF RTSD COORDINATES TRANSFORMATION SERVICE FOR MOBILE DEVICE

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Abstract: Web technologies are reaching more every day uses to an end-user due to the rapid development of smart phone devices. Especially in geo-spatial community, smart phones are being such integration device of technologies as GPS, RS, and GIS. From this reason, researches on those smart devices are currently more established than an ever. In this research, Royal Thai Survey Department (RTSD), the mapping agency, reports the development of RTSD coordinates transformation service support mobile devices. The service allows user to transform coordinates with local transformation parameters. Public users are able to access to our service by the web browser. Then the positions which are captured from GPS on a mobile device are displayed in various coordinate systems e.g. Geographic Coordinates System, UTM Indian1975, UTM WGS84, and MGRS (Military Grid Reference System). No client coordinates are send to the server (preserve a location privacy). Web technologies such as HTML5 (Geolocation), Proj4js, JQuery Mobile, and OpenLayers are selected and implemented. Finally, the discussion and issued from the research for the future work are described in the conclusion.

THE LOCAL DATUM

In geodesy, geodetic datum is comprised of an ellipsoid of revolution that defines the size and shape of the physical earth and the origin and orientation of the coordinate systems used to map the earth. Hundreds of different datums are established to frame position description (Ewing E. C. and Mitchell M. M., 1970).

Table 1: Local Datums.

Datum	Reference ellipsoid
Indian 1975	Everest 1830 a = 6377276.345 b = 6356075.413
WGS 84	WGS 84 a = 6378137.0 b = 6356752.3142

In Thailand, the two datums are used Indian1975 and WGS84 Datum (Table 1). Indian datum was first establishment in 1873 by King Rama V. The set coordinates were computed from the adjustment of the first order control network consists of 362 triangulation stations together with 200 first order traverse stations. The network includes 66 Laplace astronomic stations, 60 Doppler satellite stations and a large number of gravity stations. The geodetic coordinates are based on a 1975 adjustment (Mugnier J. C., C.P., C.M.S). In 1997, RTSD had recompiled national map from map series L7017 to L7018 and the datum was changed to WGS84.

Even though Thai national map has been changed responding to WGS84 reference frame. The Department of Lands still uses Indian1975 reference datum due to the coordinates of lands are in accordance with laws. Thus, the coordinates transformation is needed.

COORDINATES TRANSFORMATION

Due to global action in this day, the coordinates of the location need to be the same mathematical framework relation. It is difficult to compute directions and distances between points that referenced to different geodetic coordinates systems. There many techniques to transform the coordinates to the same system. But the single technique is required for the national procedure. RTSD proposes a transformation method using Abridged Molodensky transformation (EPSG, 2004). Three shift parameters are required as following equation:

$$f_{WGS84} = f_{Indian1975} + Df$$
$$l_{WGS84} = l_{Indian1975} + Dl$$
$$h_{WGS84} = h_{Indian1975} + Dh$$

Where Df, Dl, and Dh are Molodensky transformation formulas that contains the datum shift parameters which provided by RTSD.

COORDINATES TRANSFORMATION ON WEB TECHNOLOGY

SOA architecture (web service) usually implements by companies for developing system cause that contains scalable, evolvable and manageable capabilities. OASIS (2006) said that "The main drivers for SOA-based architectures are to facilitate the manageable growth of large scale enterprise systems, to facilitate Internet-scale provisioning and use of services and to reduce costs in organization to organization cooperation". From this reason, RTSD chooses the web service architecture for promoting the coordinates transformation service due to the web service easy to distribute. Additionally, Web service allows RTSD to change some transformation content without affect to related systems because of its implementation hidden from service consumers.

Web service whose provides spatial information is called Geo-spatial Web Service. Geo-spatial web service is standardized by two organizations OGC and ISO TC211. OGC focuses on the development of implementation standard while ISO TC211 is concentrating on developing theoretical/abstract standards (Zhao, P., Yu, G. and Di, L., 2007). OGC released a number of specifications for geo-spatial web community. The Coordinates Transformation Service is one of those specifications which provides user an ability for transforming feature coordinates reference system to others. Different provider may publish their features in a different coordinates system. To operate solution from different providers that have a different coordinates system requires a features transformation. For example, Department of Lands publishes a features service in UTM Indian1975 datum even through the Department of Forestry publishes their features service in UTM WGS84 datum. The middle user/client must transforms features to the same coordinates system before performing spatial operations. The constraint usually happen with system that uses both of those services feature.

Recently, RTSD developed such system that supports SOA-based applications (Chunithipisan S., Supavetch S., and Phromthong C., 2011). The service available online for whose requires automatic transformation in OGC Web Service interface. The services integration in web-based GIS systems can be realized by this kind of service. Because of the standard web service is self-contained, self-describing, modular applications that clients can publish, locate, and dynamically invoke across the Web (Alameh, N., 2003).

MOBILE-BASED TRANSFORMATION APPLICATION

Not only mobile-based applications have some limitations such as hardware performance or a screen display but also provides some benefit which is a portable ability (users often take it in every day life). In addition, smart phone device which contains GPS receiver can be used as a positioning device. Accuracy of that positioning is sufficient for navigation purpose.

Because of navigation utility has rich positioning events than a transformation function is frequently executed. A transformation process should be executed in client device (mobile device) than send its to server for processing. Additionally, client processing also preserves an ability such as location privacy for user.

THE OPEN STANDARDS AND OPEN SOURCE SOLUTIONS FOR THE DEVELOMENT

RTSD selected a web-based architecture to develop an application because a web-based application can be executed in various devices such as Personal Computer and Mobile Device (i.e., smart phones, iPad, or Galaxy Tab). The javascript libraries (open source) which relevant to the development of an application can be described as follows:

Coordinates Reference Systems

In web mapping community, coordinates reference systems are based on EPSG standard. EPSG (European Petroleum Survey Group) is a scientific organization with ties to the European petroleum industry consisting of specialists working in applied geodesy, surveying, and cartography related to oil exploration. EPSG compiled and disseminates the EPSG Geodetic Parameter Set, a reference data for coordinates reference system and coordinates transformation description. EPSG data set is distributed through a web-based delivery platform. Thus, most web-based programming libraries implement EPSG standards for their development.

Coordinates Transformation

Proj4js is a javascript library that used to transform coordinates between two different systems including datum transformation. Proj4js enables transformation in the browser that allows geographic data stored in different projections to be combined in browser-based GIS application. Proj4js supports user to define transformation parameters based on EPSG recommendation structure. The local parameters (datum shifts) that derived from RTSD can be defined as follows:

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Proj4js.defs["EPSG:32647"] = "+proj=utm +zone=47 +ellps=WGS84 +datum=WGS84 +units=m +no_defs";
Proj4js.defs["EPSG:32648"] = "+proj=utm +zone=48 +ellps=WGS84 +datum=WGS84 +units=m +no_defs";
Proj4js.defs["EPSG:24047"] = "+proj=utm +zone=47 +a=6377276.345 +b=6356075.41314024 +towgs84=204.5,837.9,294.8,0,0,0,0 +units=m +no_defs";
Proj4js.defs["EPSG:24048"] = "+proj=utm +zone=48 +a=6377276.345 +b=6356075.41314024 +towgs84=204.5,837.9,294.8,0,0,0,0 +units=m +no_defs";
```

Figure 1: Defining the transformation parameters

Displaying an Interactive Map

OpenLayers: is a javascript library that used to display map data in web browsers. A number of web mapping applications use OpenLayers for displaying their map and features. In OpenLayers, Proj4js is used to manage coordinates systems and transform coordinates system (including datum) of points between the different map layers. Additionally, OpenLayers supports Google Maps displaying as a background as demonstrated in Figure 2.

Figure 2: Displaying map by OpenLayers

JQuery: is a javascript library that used to design an application layout and control an interaction between application and user (Figure 3). For examples, user adds a target by typing a coordinates or get the current position from Geolocation (HTML5) by clicking a button.

Figure 3: Application layout by JQuery Mobile.

TESTING

The application was tested on mobile devices such as iPhone, HTC One V, Sumsung Galaxy Tab 7.0, and iPad. All mobile browsers are working fine but the best is an iPad. The coordinates in which captured by GPS device; Geographic Coordinates (WGS84), UTM Indian1975, UTM WGS84, and MGRS (Military Grid Reference System) are displayed in the same pop-up window (Figure 4). Then, user is be able to compare with the different paper maps (UTM Indian1975 and UTM WGS84) in a field procedure.

The coordinates between UTM Indian1975 and UTM WGS84 that calculated by an application are also compared with the coordinates transformed by Geodetic software (TGO: Trimble Geomatics Office). The differences between the coordinates set are approximately 1 cm (an accuracy of the transformation).

Figure 4: Coordinates which are transformed by application is shown in the pop-up block.

CONCLUSION

In our application, web-based application, users are able to transform the coordinates system without downloading and installing a sophisticated geodetic software. If a mobile device contains GPS receiver, the accuracy of positioning are better than using A-GPS (Assisted GPS). Surveyors can bring their own smart phone and using RTSD's application everywhere.

Finally, in a future work, the location-based informations such as the location of horizontal control stations, vertical control stations, magnetic stations, and gravity stations (the national geodetic control points) will be included. The

differential GPS that distributes a GPS Correction (GPS-C) via NTRIP (Network Transport of RTCM via Internet Protocol) protocol must be included for improving Location Base Service (LBS) on the others accurate scale. For example, the location-based informations which are close to each others then 1-5 meters such as trees information in a national park or animals information in a zoo.

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