Research and Implementation of Mobile APP for Interactive Weather Service based on SOA Framework

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Abstract: Depending on the development of Internet of Things (IOT) and smart phone technology, mobile APPs are becoming increasingly prevailing in the general public, thus, weather service APPs have become one kind of most popular APPs among varied types of mobile APPs. Therefore, an attempt of implementation of new conceptual weather service mobile APP based on SOA framework with fine-gridding data through intellectual and interactive approach has been discussed in this study.

Keywords: SOA, Mobile APP, Human-Computer Interaction, Gridding meteorological data

0 Introductions
Depending on the improvement of the living level, focuses on the influence of the weather is becoming increasingly important when the public planning and conducting their social activities. Thus, numbers of weather APPs have become more popular recently than ever before. The frequency of use of the weather APPs, including the Moji Weather, Sina Weather, China Weather and Yahoo Weather, are ranked eighth among all kinds of APP based on the investigation of the China Internet Consuming Research Center. The attracting design of UI and 7-day weather forecast and sorts of life indices provided by the China Meteorological Administration are the common characteristics of all the weather APPs mentioned above. However, different APP also have its own features, for instance, based on the LBS and radar reflectivity, the Caiyun Weather could give personalized precipitation forecast corresponding to the location of the user. Although, variance weather APPs could provide distinctive functions to different users, the traditional 7-day weather forecast could not satisfy the increasingly demand for the accuracy and personalization of public users from finer subdivisions corresponding to variant career. Furthermore, the user of the social communication APP WeChat within China has exceeded 400 millions, thus, the approaches of dissemination of the personalized weather information through WeChat are becoming a hot topics when developing APPs.

The attempt of dissemination of customized and personalized weather forecast information, using Human-Computer Interaction technique depending on the fine-gridding meteorological data and Service-Oriented Architecture (SOA) framework, through users’ social network would be discussed in this study.

1 Interactive Mobile Meteorological Service
So far, unilateral weather service is still the dominant technique within the smart phone weather APP field, e.g. community-style weather service, which provide user the function of...
photographing and uploading of real time weather pictures, such as Sina Weather and Moji Weather; passive-mode weather service, which could only receive the warning information from meteorological administration passively, such as China Weather; active-mode weather service, which could implement the function of inquiry of weather information actively through pre-designed menu, thus, unilateral service technique, which could provide customized and personalized weather forecast information corresponding to distinctive users, is still rare in the weather APP domain, a primary challenge of implementation of the unilateral Human-Computer Interactive weather service is the complex demand of system design. Nevertheless, an attempt of implementation of unilateral Human-Computer Interactive weather service technique has been developed within the new weather APP named Intellectual Meteorology which is designed by the Zhejiang Meteorological Administration. “I-Forecast”, a function of active generation of personalized weather forecast service is the primary innovative function of this APP.

2 “I-Forecast” function-Generation of personalized weather forecast service
Professional knowledge and specific experience is the basis to make accurate weather forecast, therefore, the lack of these knowledge and experience makes the most of the general public unable of making personalized weather forecast depending on their own demand. The aim of the “I-Forecast” function is to simplify the process of making weather forecast for the general public and to show the results appropriately on the smart phone. This function could be implemented based on the preparation of the data and environment discussed in the following content.

2.1 The preparation of basic gridding data.
Station weather data need to be transformed into gridding format in order to produce weather forecast at arbitrary location. Two types of station data are used in Intellectual Meteorology and, specifically, the “I-Forecast” module (Table 2.1). The real time station observation is stored in database and the weather forecast information derived from numeric models is stored in a specified gridding format files, named MICAPS 4 format file (Meteorological Information Comprehensive Analysis and Processing System, MICAPS).

<table>
<thead>
<tr>
<th>Category</th>
<th>Index</th>
<th>Format</th>
<th>Refreshing frequency</th>
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<tbody>
<tr>
<td>Observation</td>
<td>Weather Phenomenon(WP)</td>
<td>MICAPS4</td>
<td>5 min</td>
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<td></td>
<td>Radar Reflectivity</td>
<td>Binary</td>
<td>10 min</td>
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<td>Wind</td>
<td>Discrete station</td>
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<td>Visibility</td>
<td>Discrete station</td>
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<td>Forecast</td>
<td>3-hour Precipitation Forecast</td>
<td>MICAPS4</td>
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<td></td>
<td>3-hour Temperature Forecast</td>
<td>MICAPS4</td>
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<td></td>
<td>3-hour WP Forecast</td>
<td>MICAPS4</td>
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The first step of the preparation of gridding data is the transformation of station observation data to gridding format through appropriate interpolation algorithm. Interpolation is one of the most popular analysis methods used in meteorology field, and lots of weather service systems conduct the transformation of discrete data to continuous field data then produce contour or stain chart.
Inverse distance weighted method, Cressman objective analysis method, Spline method and Kriging method are some prevailing interpolation methods. In Intellectual Meteorology APP, the Kriging interpolation is used.

\[ Z = \sum_{i=1}^{n} \lambda_i Z_i \]

Formula 1

The essence of this method is the best unbiased linear estimation of interpolated point using existing regionalized raw data and Variogram (Formula 1). The capital Z on the left of the equation represents pending valuation, \( \lambda_i \) represents weight corresponding to different station value, \( n \) represents the station numbers used in the interpolation, \( Z(x_i) \) represents real time observation value.

As the advantage in display and storage efficiency of binary forma, the second step of the data preparation is to process the gridding observation and forecast data into binary format.

2.2 GIS technique application

User of “I-Forecast” module could directly access to the accurate weather information around the position where the user located through the contour chart of weather information overlying on the base map layer. Google maps, Baidu Maps and Amap are three primary third party map service suppliers in China.

“I-Forecast” module is based on the Amap map service which LBS service in the SDK. Depending on the Hybrid positioning mode and advantage on response speed and power management on mobile platform, Amap SDK has becoming one the best positioning SDKs around the world. The process of positioning using Amap service includes: 1. Sending request of positioning and deciding positioning method including GPS, Network and Hybrid; 2. Callback positioning information; 3. Display of positioning information including coordinates, accuracy etc.; 4. Cease positioning and destroy related private information.

Positioning information returned by the Amap service was used to extract corresponding weather information from the gridding data, thus, implement the main function of “I-Forecast” module.

2.3 Expanding influence depending on the social networks APP

The conclusion of the investigation of China Internet Consuming Research Center demonstrates that the usage of social networks APP is on the top of the list with the percentage of 68.4% and weather service APP is at the eighth position with the percentage of 19%. Therefore, it could be concluded that weather service APPs have relatively high penetration rate in the general public’s daily life. However, the penetration rate of Intellectual Weather could be improved by the linkage of social networks APP and the Intellectual Weather APP.

The dissemination approach through prevailing social networks, including WeChat, QQ, Weibo and E-mail, has been embedded in the “I-Forecast” module (figure 2.3.1). The WeChat interface as example, the linkage process constitutes: 1. Creating APP; 2. Sending approval request; 3. Request approved and achieve AppID.
3. Design of the “I-Forecast” module

The whole module was constituted with the following parts: 1. Data processing sector which is in charge of transformation of station data to gridding data and then to the binary format; 2. Data transmission sector which was responsible for the upload of gridding data from rear end server to the front end server; 3. Development of client APP which was based on the IOS and Android platform. The process of design of the client APP and the UI will be introduced in the following sections.

3.1 Design of UI

The primary purpose of the “I-Forecast” module is to simplify the manufacture process of weather forecast, which was always seemed to be a complex procedure for the general public, for individuals with varied requirements. Figure 3.1.1 to 3.1.5 demonstrate the making process of personalized weather forecast, the buttons on the top of the UI display the steps of making weather forecast and the cartoon at the right bottom corner would provide Appropriate introduction and remind during the whole process of making weather forecast for users.
### 3.2 Design of framework

The framework of this module was based on SOA, which could implement efficient deployment and combination of loosely coupled, coarse-grained application components through networks depending on different requirements. The service layer, which could be called directly, is the cornerstone of SOA. The data layer, processing layer and partial application layer comprised the whole service layer that will be detailed in the following:

The architecture was divided into four layers: the underlying layer is data layer which could achieve sorts of observation and forecast data; the upper layer is processing layer which responsible for the data transformation from raw format to binary gridding format and data mining and analysis; the application layer, running above the processing layer, extracts and display observation and forecast data depending on distinctive requirements and habits from different users; the top most layer is user layer, which provide interface to third party APPs, make it possible for user to share and disseminate personalized weather information through third party APPs. The framework is shown in figure 3.2.1

<table>
<thead>
<tr>
<th>User Layer</th>
<th>WeChat</th>
<th>QQ</th>
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<th>SMS</th>
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<tr>
<td>Application Layer</td>
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<td>Extract Forecast Data</td>
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<td>Extract Observation Data</td>
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<td>WebService Interface</td>
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<td>Processing Layer</td>
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<td>Data Mining</td>
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<td>GIS Analysis</td>
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<td>Binary Processing</td>
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The manufacture procedure of weather forecast for different users could be depicted as follows: First, the position should be decide in order to make the APP extracting appropriate weather information depending on the predefined position, the position could be achieved by automatic positioning function or by user selection; Next, temperature, precipitation, pressure, wind etc. could be extracted from the background gridding data corresponding to the predefined position acquired in the first step and displayed with contour chart overlying on the base map; Then, reflectivity data covering the whole province area could be displayed and the real time information according to precipitation and snowfall could be realized by users with partial meteorological profession based on the reflectivity; Furthermore, as most user of the APP have no meteorological education background, next 24-hour precipitation forecast products, which could help the general public to aware whether there is rainfall in the future, will be provided; At last, the final products with accuracy forecast of a variety of weather information will be displayed on the screen. Each product from one of the above intermediate steps could be extract separately as well as integrated as a whole to share or disseminate through third party social networks APP. Detailed flow chart of personalized manufacture process of weather forecast was given in figure 3.2.2.

4 Status quo of the application
The new version mobile APP Intellectual Weather embedded with forecast information from Zhejiang Meteorological Observatory, which was developed based on the old version Intellectual Weather that was cooperatively developed by Zhejiang Meteorological Administration and Zhejiang Telecom, has been released through Apple APP Store and some major Android APP Markets in Nov. 2014. Accurate real time and 24-hour forecast of weather information corresponding to any position within Zhejiang Province could be provided to user through simple UI and interaction, meanwhile, varied approaches of dissemination of weather information through third party social network APP make it convenience for users to share personalized
weather information to friends. As the increasing download after releasing, Intellectual Weather has been listed in the high quality APP category by lots of public APP markets.

5 Conclusions
“i-Forecast” is an attempt of Human-Computer Interactive weather information service. Providing of real time observation and forecast information of weather and environment at where the user is located based on the Amap positioning service makes “i-Forecast” the first APP that implemented the new weather service concept. The statistics of the feedback manifest that the simple and practical function are the primary advantages for users to consider in selecting weather service APP.

Although “i-Forecast” has achieved great success in weather service APP category, enormous improvements are under conducting in order to level up the users’ experience of the APP: 1. Expending the data coverage extent from Zhejiang province to the whole country scale; 2. Prolong the forecast time range from 24-hour to 7-day; 3. Upgrading the manufacture process of personalized weather forecast and providing “one-button” release function; 4. Accessing to the severe weather forecast data and providing severe weather warning service.

References
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