A Mobile API Solution for Localised Weather Forecast Representation

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Abstract— **In Cameroon, especially in some rural areas, weather forecasting is essential for the everyday activities of the population. Since mobile phones are being extensively used in those areas, the population should be able to acquire the appropriate weather information through such devices. However, most rural populations, such as the Tupuri (Tpuri), use native terms to refer to the weather conditions, mainly based on calendar references. Our paper aims to combine international weather forecast with the local weather description of rural populations in Cameroon, enabling the locals to have fast access such information evolving their everyday activities. We propose an API framework, for mobile development, to extract and present combined and localised weather forecast, showcasing the Tpuri population of Cameroon.**

Keywords-Mobile API; hybrid application development; weather forecast; weather localisation; Cameroon; Tupuri; Tpuri

I. Introduction

In our era, climate conditions are changing, making the weather forecast an increasingly challenging process. Disasters can be prevented, livestock productivity can be increased, and populations can be prepared for adverse weather conditions, when a forecast is available. Nowadays, especially with the evolution of the Internet, local weather forecasts are widely available through websites that either present related information, or provide with widgets and APIs to retrieve the forecasts from other sources. At the same time, with the development of mobile communications, the users can receive, at any time and anywhere, weather forecasts on their devices.

Considering the popularity the Internet and the mobile communications have gained the last years, we can assume that most of the population worldwide have access to weather forecasts. However, there are populations, especially in rural areas, that have limited access to such information, fact that limits their ability to adjust their activities and protect their lives. One such rural population is the Tupuri (Tpuri), which lives in some areas of Cameroon and Chad. The Tpuri have their own local languages and use their own symbols and rules, to communicate and perform their everyday activities. They also use this language for weather prediction. Although being mostly a rural population, the Cameroonian Tpuri have developed the communication through mobile phones and their mobile network consists a medium that may support the improvement of their everyday activities.

In this paper, we focus on combining the international weather forecasts with the local weather description of the Tpuri population in Cameroon. In order to do so, we suggest an API, for mobile development, which receives local weather forecasts from international resources and presents the information adjusted to the Tpuri native weather reference.

The sections of this paper are divided as follows. In Section 2, we describe the current situation of weather prediction and mobile communications in Cameroon. In Section 3, we give details on the method that the Tpuri people use for weather references. Section 4 includes a description of the selected weather forecast API that we use for our approach. In Section, 5 we present our API solution, giving details on the system architecture and the technology. Finally, in Section 6, we discuss our approach and conclude with our intended future work on the topic.

II. Weather Prediction and mobile Communication in Cameroon

Weather forecasts are of a great importance especially for rural populations. However, having access to accurate weather forecasts is not easy for the populations in Cameroon. The *Cercle de Concertation de la Société civile Partenaire du MINFOF/MINEP* (Dialog Group of the Civil Society Partner of Ministry of Forestry and Wildlife, and Ministry of Environment and Protection of Nature) diagnosed the case of meteorological data in Cameroon. The report published in February 2012 [16] stipulates that out of the 58 existing weather stations in Cameroon, only 3 operate. The deteriorated infrastructure is not the only challenge. The lack of technical personnel makes the situation worse. The same report declared that out of the 59 meteorologists in Cameroon (in 2010), 9 went to retirement during 2011 and 15 others will retire between 2012 and 2015.

In Cameroon, the meteorological services are managed by the National Meteorological Service (NMS) of Cameroon, which is under the supervision of the Ministry of Transport. The tasks assigned to this service are, among others, the gathering of climate information, the composition of weather forecasts, the dissemination of meteorological information etc. Except for the air transport, for which the weather data are essential, no more data are available, for

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example, for planning the agricultural activities. Indeed, many Cameroonian (e.g. farmers) face the challenge of accessing understandable weather data, because they rely on traditional weather knowledge and, if any, on some forecasts from worldwide weather systems. Providing, as possible, a more accurate weather forecast, requires the collection and analysis of a large amount of data. Hence, the data should be collected over the years in order to generate accurate weather forecasts.

In Cameroon, as in many Sub-Saharan countries, extreme weather and climate events have often various consequences [12], which include loss of lives and livelihoods, damage to infrastructure, increased risk of disease outbreaks, lack of food/water/pasture, mass migration, degradation of the environment, retardation of socio-economic growth, etc.

For example, in August 2012 [9], in the far north region of Cameroon, a sudden flood caused various disasters and victims. Crops were destroyed, cattle disappeared, citizens were forced to leave the flooding areas and people perished under the massive inundations. This disaster might have been prevented, or hindered, if a weather forecaster was available to dispatch information and warn the population in the affected areas. Furthermore, if traditional weather knowledge was used systematically, the population might have been helped to predict and prevent, or at least limit risk related to extreme weather conditions.

If we consider the impact of the livestock sector in Cameroon, the gross domestic product (GDP) in this sector, in 2005, was estimated at 132.8 billion FCFA francs per year (10.36% of GDP) in the primary sector, which corresponds to 2.1% of the national GDP. This sector provides income for about 30% of the rural population (80% of the Cameroonian population lives in rural areas). In 2009, the agricultural sector was estimated for approximately 75.6% of the primary sector with 68.8% for subsistence farming and 6.8% for export crops [17]. As temperature and precipitation are important to agriculture, unexpected weather and climate changes have direct impacts on the livestock productivity.

However, the NMS of Cameroon is poor. It does not provide dynamic data accessible to the users via the Internet, or other medium, like radio or TV, but instead, only static and out of date information on its website. This lack is also followed by the lack of related APIs for data exchange, which could at least enable the acquisition of weather forecast information from other resources.

On the other hand, in Cameroon, the mobile phone market has potential for the development of diversified areas. In fact, a lot of effort has been done to improve the mobile network, making it the most reliable communication network in Cameroon. The situation is the same for many Sub-Saharan countries as well [4]. Mobile operators, which are CAMTEL, MTN and ORANGE, have invested in infrastructural mobile facilities throughout the territory. The mobile network covers over the 80% of the land area. According to the Telecommunications Regulatory Board (TRB) [6], the structure for regulating telecommunications in Cameroon, mobile phone subscribers increased from 0.66% (103279 subscribers) to 44.07% (9,6 million subscribers whereas 6,27% CAMTEL, 50,72% MTN and 43,01% ORANGE) from 2000 to 2010. In July 2012, the first Mobile Virtual Network Operator (MVNO) in Cameroon and also in Sub-Saharan countries, called Set'mobile, has started its activities with an offer for 50,000 subscribers. Thus, we identify a great potential for development in the field. Especially important is the development of tailored applications that aim to support the particular activities of the Cameroonian population and those of other Sub-Saharan countries.

Having considered the current situation of mobile infrastructure and the need for weather prediction in the rural regions of Cameroon, we were further motivated to suggest a model that combines both fields, and gives an important tool for the indigenous populations.

III. Native Weather Forecast Techniques

Tpuri is one of the, around, 250 tribes existing in Cameroon. They live in the northern part of Cameroon and southern part of Chad, and extend on both sides of the borders between the two countries. The latitude and longitude of the area where the Tpuri live (Tpuriland), in Cameroon, is 10° north and 15° east. The majority of the population lives in rural areas, therefore have agriculture as their main activity to make their living. In this region, the agricultural activity encompasses crops such as millet / sorghum, peanuts, onions, beans and rice. The farming of such crops is highly sensitive to climate changes (drought, flood, etc.). Therefore, weather prediction is of high importance for those populations.

In order to predict the climate changes and give details on the weather conditions, the Tpuri folk rely on indigenous weather knowledge, which is oral and descriptive. In general, the terminology for weather and climate uses words such as dry, wind, rain, humidity, tornadoes etc. Also, the Tpuri rely on such words to describe the weather and climate changes. In order to understand the way this folk describes the weather, we shall consider their calendar description. The Tpuri's calendar is seasonal, therefore, it is based on the local sequence of natural and agricultural events. Referring to the Gregorian calendar, for the Tpuri folk, the new year starts in October. Table I, below, indicates the months in English, as those referred to the Tpuri language [14]. In this table, *few* means "month" or "moon". For example, *few burgi* means "month of dust".

TABLE I. Month Correspondence of Tpuri and English

few kage	few duugi	few baare	few daa	few darge	few ka'arang
Oct.	Nov.	Dec.	Jan.	Feb.	March

few mene	few burgi	few baa	few yaale	few jon fen sõore wa	few waŋ
April	May	June	July	August	Sept.

Table II provides the meaning of each month, and some related seasonal activities. Furthermore, classified as an event calendar, the table shows the association of natural phenomena, including meteorological events to each month, and the temperatures, which are described orally according to each *few*. The Tpuri only describe the way they feel the weather, i.e. the sensation of the temperature, but not the degrees. They do not use a unit to measure the temperature.

TABLE II. CALENDER OF ACTIVITIES ADAPTED FROM [14]

few	*explanation*	*meteorological events*	*reference*
ancoo	months of cold season, harvest season: peanuts, peas potatoes	cold	October to November
ceere	moon of cool	cold, very cold	December to January
hissi	period of high heat	dry, hot, sun	February to March
burgi	moon of dust	light to heavy wind, dust	April
jo'ge, kabge, mulum	months of sowing, begin for rainy season	light rain	May
baa, yaale	moon of rain / rainy season	rain, humidity	June to July
gumugi, musgware	people are weak and easily catch diseases / outbreak of diseases due to heavy rain	heavy rain, humidity	July to August
hoole gara	red millet harvested at the end of rainy season	rain, humidity	August to September
twale	months when the sun burns	light rain, sun, very hot and humid	September to October

In this table, *ceere*, which means “cold”, is the period in which temperatures range between 15° and 20° C, and *hissi*, which means “hot”, is the period when temperatures start from 40° C. Consequently, the table builds data records that use, for example, month or temperature, as reference, to match the traditional weather description with those from the existing weather systems. In our API suggested solution, we will use these records, in a database, to describe the weather and climate as the indigenous populations in Cameroon do. But, let us first see what the existing weather APIs provide.

IV. WEATHER FORECAST APIS

Various weather APIs are available online. Mostly, they use the Representational State Transfer (REST), which leverage the HTTP protocol to provide weather data, in JSON or XML format, to other related systems.

In this paper, we use the API provided by World Weather Online [8] (WWO) to showcase our approach. We chose this API only as an example, due to the features it provides, and the detailed weather information for the area of our study, namely the Tpuriland. The provided features are free of charge (for personal and commercial use), therefore suitable for prototyping.

The WWO API provides, for a chosen area, current weather information, as well as for the next 10 days, and the past, up to the 1st July 2008. Some of the information available through this API, is the date/time of the observed weather conditions, the temperature, element description (such as precipitation, humidity, wind speed/direction and atmospheric pressure) and weather description with text and images.

To retrieve information using WWO API, developers shall build simple HTTP requests, including specific keyword variables that refer to specific requested weather, location or data/time attributes. Such attributes are city (filtered by country), town name (filtered by country), latitude and longitude, or IP address. Furthermore, they shall specify the API key (which specifies the licence for its use), the format (XML, JSON or CSV) for the results, and the number of the days for the forecast. The country is an optional value.

An example of an HTTP request, for the region of Kolara in Cameroon, where the Tpuri population lives, looks as follows:

```
http://free.worldweatheronline.com/feed/weather.ashx
?key=xxxxxxxxxxxxxxxxx
&q= 10.272019,14.650269
&date=2013-02-14&format=json
```

For the aforementioned query, a portion of the result in JSON format for the 14th February 2013, would look like this:


```
{
  "data": {
    "current_condition": [
      {
        "cloudcover": "0",
        "humidity": "6",
        "observation_time": "12:19 PM",
        "precipMM": "0.0",
        "pressure": "1006",
        "temp_C": "38",
        "temp_F": "100",
        "visibility": "10",
        "weatherCode": "113",
        "weatherDesc": [
          {
            "value": "Sunny"
          }
        ],
        ....
      }
    ],
    "request": [
      {
        "query": "Kolara, Cameroon",
        "type": "City"
      }
    ],
    "weather": [
      {
        "date": "2013-02-14",
        "precipMM": "0.0",
        "tempMaxC": "39",
        "tempMaxF": "102",
        "tempMinC": "24",
        "tempMinF": "74",
        "weatherCode": "113",
                    ....
        ]
    }
}
```

The following figure depicts a screenshot of a weather forecast, requested with the aforementioned query, for the Kolara region, as represented in the website of the API.

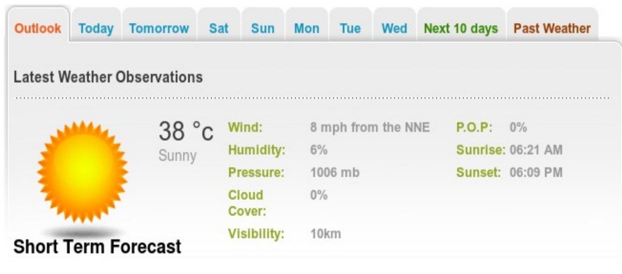

Figure 1. Weather Forecast for Kolara in Tpuriland (14th February 2013)

V. API Solution for combined Weather Forecast

Based on the weather forecast that the World Weather Online API provides, we suggest an API model that combines those data with the traditional and indigenous climate knowledge that the Tpuri use, for local weather reference. In our solution, we receive the weather forecast from the selected API, we match the information with the information the Tpuri use to describe the weather conditions, based on the aforementioned calendar, and we then extract combined data.

In the next section, we explain the system architecture for the model. We also give details for the technology to implement the model, as well as the way this can be used later as a mobile application.

A. System Architecture

As already mentioned in Section 3, the selected API offers the forecast data in three formats, namely XML, JSON and CSV. Our model, we choose to explain the approach using the provided JSON format, due to the tools we suggest for the implementation.

The following figure gives an overview of the system architecture.

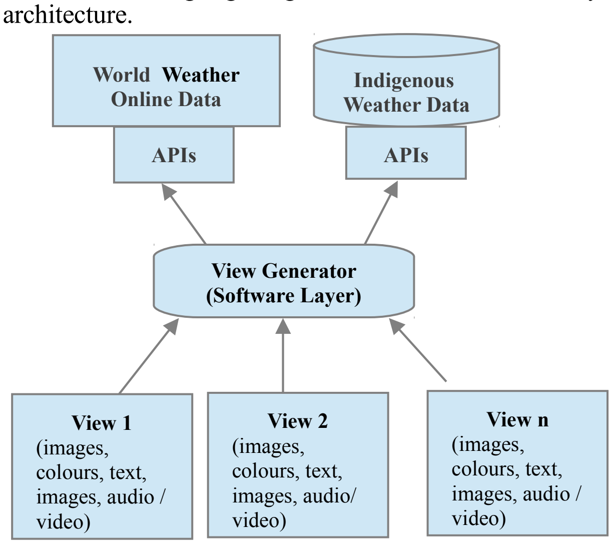

Figure 2. API System Architecture

As the figure shows, the model consists of the following parts:

World Weather Online Data

This part consists of data derived from the World Weather Online API. The data are being retrieved upon demand, for specific date, in JSON format, when Internet connection is available.

Indigenous Weather Data (IWD)

Those data are stored in a database. They reflect, in our case, to the descriptive terms that the Tpuri use for weather reference. Those data are being extracted in JSON format through a related API. The extraction does not require Internet connection.

View Generator

This part is an API that matches the weather forecast data with the Tpuri descriptive data. The view generator receives the JSON input from the aforementioned APIs, and produces a combined JSON file. The weather forecast data include date details that are being matched with the month reference details in the descriptive data. The data process is being performed offline.

Views

The views are representations of the result that the view generator produces. The view generator extracts a JSON file with the combined weather forecast. This file can be then used by a mobile application to print the results in several formats, namely the views.

Since the proposed model uses an Internet connection and a web-based API, it is suitable for a hybrid mobile application. Concerning the bandwidth in the area where the Tpuri live, the download speed goes up to around 0.36 Mbps, and it is sufficient for downloading the appropriate weather information. Once the hybrid app has been installed on the user's mobile device, the typical weather synchronisation process would look like this:

1. The user goes online, when Internet connection is available.
2. Data in JSON format are downloaded from the WWO via the respective API.
3. Indigenous data, in JSON format, are extracted from the IWD via the API.
4. Data from WWO and IWD are combined in JSON output.
5. The JSON format is used from the hybrid app to present the weather forecast in several views with different images, symbols, text, etc..

B. Technology

Here we suggest an implementation approach, describing which technologies may be used to implement an app that makes use of our API framework.

While native apps are implemented in a high programming language (Java or Objective-C etc.), hybrid apps are basically Web applications specifically optimised for use on mobile devices. Hybrid apps provide a good compromise between native and Web apps to build platform-independent apps. They are Web apps packed as native apps, creating , therefore, a combination of the important features of the native approach and those of the Web.

To implement an app with the aforementioned conceptual approach, we rely on hybrid mobile development using HTML5 and technologies that pertain to it.

Related to the HTML5 technologies, some software developers of the World Wide Web insist that these technologies are revolutionising the Web and its use [1][2]. In fact, HTML5 offers new possibilities to develop Web apps that, although running offline, can process persistent data locally, using Web SQL Database and data in JSON format, through the JQuery library. In order to implement the to implement the conceptual approach, the tool PhoneGap is suitable. PhoneGap [18] is an open source tool that provides a simple and lightweight way for packing Web apps, to operate as native apps, for diverse mobile platforms. It implements a full access to device APIs, such as accelerometer, camera, geolocation, network, alert etc.

This entire approach uses flexible and easy-to-use, web and mobile based technologies, which, by providing weather forecasts, improve the efficient use of Internet through mobile devices, in Sub-Saharan countries like Cameroon, where the Internet connection is still slow and unreliable.

VI. CONCLUSION

In this paper, we provided a model for combining international weather forecast with traditional weather reference information. We consider this model as a threefold. One of the main benefits of this model is that it supports the preservation of the traditional knowledge of Tpuri, which passes orally from one generation to the next, and it is threatened with extinction. The model also allows the integration of both indigenous knowledge and knowledge from well established systems, introducing mobile technologies and supporting the development in this field. Moreover, it provides useful and region-adjusted weather forecast information, assisting the local populations in their everyday activities. The model considers the instability of Internet connection, in most areas in countries like Cameroon (by performing offline, with stored data, when necessary), and exploits the benefits of mobile communications for supporting the locals.

Since most of the Sub-Saharan countries, such as Cameroon, bear similar cultural characteristics, we believe that this solution could be adjusted to other populations, and help to the further development of mobile communications further, for improving the quality of life. Therefore, we intend to continue the research on this field in order to implement, test and adjust our solution to the needs of those populations.

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