Web Engineering for Wireless Networks

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ABSTRACT

Standing at the beginning of the twenty-first century, we are witnessing another revolutionary development in the area of communications – the integration of the Internet and wireless networks. This is paving the way for the *Mobile Internet*, which is wireless Internet access on devices such as PDAs, Mobile Phones etc. The ability to access Internet and network based services through these kinds of mobile devices may lead to anywhere-anytime computing. The fusion of the Internet, wireless networks, and mobile devices is a milestone in creating pervasive environments and offers exciting opportunities for all the stakeholders. However, this also leads to a variety of technical issues. This thesis focuses on two such important issues viz. delivering contents according to the users' preferences and the capabilities of access devices, and determining the location of user/device based on some feedback obtained from the underlying wireless network. The results may be used in provisioning of Location Aware Services and availability of the Mobile Internet on devices of varying capabilities. The work was carried out on an IEEE 802.11 WLAN configured in the infrastructure mode.

For inferring the location of a device connected to a wireless network, a number of techniques have been proposed in the past. These techniques are generally based on the premises that as radio-signals travel they deteriorate in strength due to path loss phenomenon. Thus, from a source emitting the radio signals, the Received Signal Strength (RSS) would vary with the distance or in other words if we record RSS some distance away from the source we can infer the distance based on the comparison of the RSS value with previous measurements. The location fingerprinting technique suggests recording of RSS values from multiple radio signal sources (Access Points) and correlating these values with the location at which the recordings were made. Such "RSS-Location" tuples may be stored in a database that may be searched later for a given value of RSS to infer location.

The location fingerprinting technique has been used with simple distance based measures and more sophisticated Artificial Intelligence techniques. As simple distance based techniques do not take into account the dynamically changing surroundings (movement of people, furniture etc.) and traffic conditions, the simple RSS comparisons do not lead to accurate results. Moreover, they are not intelligent enough to deal with untrained locations. In such dynamic environments, application of Artificial Intelligence (AI) Algorithms for signal classification seems quite

appropriate. AI based techniques, such as back-propagation, have been applied earlier to the problem of location determination.

We investigated applications of k-Nearest Neighbor (k-NN), Multi Layer Perceptron (MLP), Self Organizing Map (SOM), and Support Vector Machine (SVM) algorithms to the problem of signal classification and found that SOM and SVM perform at par as both the algorithms were able to determine the location correctly with an accuracy of 88%. Using MLP and k-NN we obtained an accuracy of up to 84%. The results have been summarised in Chapter 5 of the thesis Moreover, SOM is computationally simpler in comparison to MLP, SVM and k-NN. Further, it can be readily trained to accommodate new locations. During our study, we also developed a SOM based location fingerprinting software tool called *SOMLoc* using VisualBasic.Net platform.

Achieving device independence in a cost effective manner is a challenge in the field of Web Engineering. A number of techniques have been proposed for this purpose such as brute force, based on HTTP Headers, Composite Capability/Preference Profile (CC/PP), and contemporary approaches such as Cascading Style Sheets, Microsoft FrontPage plug-ins, Device Independent Authoring Language (DIAL). All these techniques have their limitations and have been discussed in detail in this thesis. The modern approaches, such as DIAL, advocate development of new formats and standards for content filtering and presentation. However, porting the existing content available on the Internet to new untested formats would require enormous efforts and resources. To cater to this requirement, we found the CC/PP model proposed by W3C to be the most suitable amongst all the approaches. However, the model itself is not complete and leaves too many issues unanswered.

In this thesis, we proposed a framework – *The User Agent Based Profile Transfer for Device Independence (UAProfiT)* for achieving Device Independence. This distributed model is based on CC/PP model and addresses all prominent excruciating issues of the CC/PP framework. The *UAProfiT* framework is extensible, flexible and reusable. Its functionality can be readily extended by developing appropriate 'Monitor-Editor-Generators' (MEG) plug-ins in Java. It provides flexibility in implementation. The framework can be put into operation in two different ways, by either using a CC/PP Web Server or a CC/PP Proxy Server. It also provides an opportunity to the local proxy administrators to tailor contents according to their organizational requirements without depending on any third party. As the framework has been developed on plug-and-play model it offers platform for achieving reusability. A comparison of the *UAProfiT* with other prevailing techniques is given in chapter 7.

We also demonstrated the end-to-end realization of the proposed framework by implementing the *UAProfIT* system using ASP, Java and an intermediary server. Thus, a prevailing gap for implementing CC/PP has been filled. We also proposed a model for integrating the *SOMLoc* and *UAProfiT* systems for implementing location aware services.