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Research Article

Monitoring Web Resources & Improve QoS of Mobile Host using Fuzzy Logic

Kishor S. Wagh[Á*] and Ravindra C. Thool[B̂]

[Á]Department of Computer Engineering, Pune University, Marathwada Mitra Mandal's Institute of Technology, Pune, India
[B̂]Department of Information Technology, SRTMU Nanded, SGGS College of Engineering and Technology, Nanded, India

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Abstract

Web service provisioning is art of deploying web services on mobile devices; it is very new research topic to host web services on smart mobile phones. Now a day's use of mobile phones for other than its basic functionality is used. Today mobile computing has become ubiquitous mobile computing exits everywhere, every time, every place and in every device. This is possible due to advances in mobile device capability, advances in data transfer speed, improved wireless network infrastructure and current new advanced web technologies. Web services can be universally deployed and invoked using specified protocols. Implementing web service on Smartphones is a tedious process because of several resource restrictions and unreliable wireless network. This paper presents the resource monitors of Smartphones using fuzzy concept to improve the web service accessibility of mobile host. Mobile Smartphone has physically as well as configuration constrains with different operating systems like Android, iOS, blackberry, Symbian, and many others. Resource constraints of Smartphones are limited memory, low processing power, intermitted wireless connection and limited battery. This factor needs to be considered while implementing web services for mobile host. This paper presents fuzzy rule base monitoring of various resources of mobile host and used to improve quality of web service provisioning.

Keywords: *Smartphones, Mobile web services, Business logic, android, RESTful, fuzzy logic.*

1. Introduction

Web service provisioning is the process of assigning veracious service tasks of business processes. IT organizations can have multiple provisioning systems that exchange information about the multiple user records. In addition, there can be applications that interact with multiple provisioning systems. Web services technologies have advanced the infrastructure of internet-based applications by providing facilities like integration and interoperability of services provided by different organizations. So, instead of focusing on development of standalone applications, today, we build large-scale software applications by composing loosely coupled services.

Mobile devices have become highly popular in recent years. In the mobile web services domain, the resource constrained mobile devices are used as both web service clients and providers, still preserving the basic web services architecture in the wireless environments. While mobile web service clients are common these days, and many software tools already exist in the market, easing their development and adoption. Today there are many standard frameworks and approaches exists to host web services on mobile devices, I-jetty is the most popular framework used now a day. i-jetty is a port of the popular Jetty open-source web container for the Android mobile platform by which anyone can easily deploy web service on android mobile. Evolution of mobile web services influence internet era on lots of real time applications and everyday advancement in web service model and mobile devices captured not only regular users but also average users. A mobile device in the role of a service provider enables, amongst others, entirely new scenarios and end-user services and advancement in mobile devices reduces the physical restrictions like memory, CPU speed and all other physical parameters. The research by providing web services from smart phones is still sparse because of physical restrictions that mobile devices have. In spite of these physical restrictions how one can make web service perform better and provide quality of service.

The use of fuzzy inference systems enables the evaluation of the measured physical parameter values which helps deciding whether the requested service should be provided or not. Experimental results show significant improvements in the web service performance in both worst case and best case scenario and providing energy consumption.

This paper extends the previous work on the Hybrid framework using fuzzy logic that allows providing web services from android mobile device under real life settings and using current available technology. Rest of paper organized as follows: section II provides related work, next section describes the key challenges occur when web services provided by mobile device. Section III describes the details of mobile web service provisioning.

*Corresponding author: **Kishor S. Wagh**

Section IV describes the proposed fuzzy based hybrid framework and finally, last section concludes the paper and highlights our future research direction.

2. Related Work

Mobile web service offers thousands of services ranging from entertainment to required information for example news, weather forecast, maps and also transaction services like reservation, money transfer and mobile devices can host plenty of applications and web URLs. Mobile devices have some physical restrictions like low processing power, limited memory and short battery life so as a result of this there is handful of mobile web servers, so a serious perceptional effort is required for users in mobility to configure the most appropriate way to provide service using limited resources. The main focus in network computing is services and service cost. In order to build successful services and to meet all service objectives while at the same time is a tedious process. Deploying a web service on the full-fledged traditional server is very easy and performance of the deployed web service is very good because of availability of required resources and no physical restrictions like small CPU size. While deploying web service on mobile devices is a tedious process and performance of deployed web service is directly proportional to the physical resources available on a mobile device.

Now a day, service providers make intelligent utility allocation in a distributed on-demand virtual resources. There is some fuzzy resource allocation approach in which a Fuzzy Logic Controller is used to dynamically adjust the number of resources involved in serving requests. While implementing Fuzzy Logic on system, Fuzzy controller should be capable of capturing the complexity of utility systems such as uncertainty and dynamic nature. It should perform extremely well in such environment where numbers of service requests are unpredictable, which results into the abrupt peak load.

Fuzzy Logic is used in different environments to satisfy various criteria's for example service selection or to minimize resource consumption. Service selection fuzzy service proposes a user-preference-based selection engine to compose services, which allows users to define non-quantifiable factors and policies to represent their preferences. Then, the engine automatically composes web services into a package following these policies by use fuzzy logic. The engine ensures the whole package has the most satisfaction. QoS-aware service selection is also done using fuzzy logic; it includes user preferences and quality of service characteristics in the selection process of web services. The goal of this approach is to prove the feasibility of fuzzy selection and ranking approach, both from the point of view of the integration with current standards that govern the domain of web services and the performance of the implementation of fuzzy selection and ranking in service registries.

In resource consumption there are different types of parameters like memory consumption, CPU consumption and battery consumption. While implementing Fuzzy Logic for minimizing resource consumption, we need to consider parameters that increase resource consumption, for example processing and communication will drain the battery rapidly hence both should be kept at a minimum. Providing resource intensive Web services from mobile host needs to be done in a Fuzzy controlled manner to allow continuous service provisioning.

3. Mobile Web Service Provisioning

Web Service provisioning is the ability of mobile devices of hosting and offering different types web services so that users from different types of background can access it like a normal web server. This is possible due to advancements in mobile devices and wireless communication ability. Mobile devices containing advanced features like 3G or 4G support and fast processing speed can be easily used as a standalone web server by deploying web service on it. Web service provisioning is the art of deploying web service on mobile devices. Due to web services it has changed the role of mobile devices that is from a web service consumer to web service provider.

Mobile devices such as Smartphones and tablets have not only become part of us at homes and offices, but are also shaping how enterprise businesses and transactions are being carried out. As per the IDC release the latest round of tablet, Smartphone and PC forecasts are shown in figure 1. These forecasts also underscore how the majority of enterprises need to better plan how to get the most out of mobility investments given the constraints of their IT infrastructures.

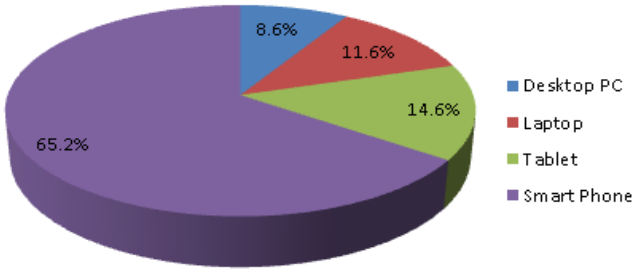

Fig.1 Source: DC Market share of computing device of end of 2013

Mobile Hosts enable federal integration of client specific services to the enterprise, by the maintaining web service designing protocols, also maintaining resources in resource constrained mobile devices. While developing web services for resource constrained mobile device encounter several technical challenges, like the quality of service (QoS). The role of mobile devices as a Web service consumer is elemental. So moving from web service clients to providers is feasible only if the web service is built with standard web service building architecture with acceptable performance and with no impact on the regular use of mobile devices.

We describe the state-of-the-art of mobile Web services provisioning, address its applicability and reliability, point out the research efforts, and explore the challenges and open research problems in the mobile Web services provisioning paradigm. Mobile web service provisioning can be classified based on architecture as

SOA (Service Oriented Architecture or SOAP based Mobile web service provisioning and ROA (Resource Oriented Architecture) or RESTful based Mobile web service provisioning.

The general concept of mobile web service provisioning introduced by (S. McFaddin, *et al*, 2003) and has implemented prototype for hosting web service on mobile host. Lightweight SOAP server architecture for mobile device was proposed by (S. Srirama, *et al*, 2006). The proposed server architecture is useful to provide the access to web services via HTTP. The above discussed approaches focus on hosting simple web service application hosting on mobile devices. Some researchers (L. Pham, *et al*, 2005) (G. Gehlen, *et al*, 2005) and (F. Aijaz, *et al*, 2008) has explored the usability of mobile web services in peer to peer environment. Mobile web service partitioning framework was proposed by (M. Hassan, *et al*, 2009). Author investigated application partitioning algorithms for web service partitioning so that part of a web service can be executed on remote computing node to reduce the burden on mobile host.

As per our previous preliminary comparative study (Wagh Kishor, et al, 2012) and Android Mobile Host performance evaluation of SOAP and REST (Kishor S Wagh, et al, 2013), it showed that REST is a more suitable architecture for provisioning web services on mobile smart phones. The RESTful approach enhances the performance of mobile Web services also described by many researchers. Smartphone prices are reduced and easily available the internet connection in very cheap rate, usability of Smartphone increased. While considering todays scenario of Smartphones is becoming more and more-smart in terms of processing power or more capable processor, memory addressing capability and advancement in mobile wireless technologies and web technologies. Due to this, mobile computing is becoming more and more popular for pervasive computing. Deploying web services on smart phone it is today need, because anyone can access mobile hosted web services any time anywhere and managing mobile hosted web services is also very easy.

3. Fuzzy Based Hybrid Framework

With the rapid progress in web services infrastructure and use in various industries, deploying one on the best suited mobile device is a repressive task, because there are some attributes which needs to be considered when it comes to deploying web service on mobile devices, attributes like limited memory or slow processing power, unlike traditional server configuration. So while it comes to web service performance on mobile devices, it kind of underrated for obvious reasons. Web service performance on a mobile device can be improved on some extend by controlling mobile device resources in real time environment which also results in resource consumption, as such it is natural to expect some automation of the process. A promising automatic resource restrictions method for improving service performance and resource consumption is to evaluate the suitability of the service with respect to aforementioned attributes, in particular, attributes whose values change over time like network speed which is a dynamic attribute and constantly fluctuate which is why difficult to measure.

Representational State Transfer (REST) architectures producing extended mobile Web service frameworks. This phase is achieved by the implementation of a prototype that allows performance evaluation of both extended frameworks. The evaluation of the load and performance of the distributed services is taking place using resource intensive applications. The results presented show that basing distributed mobile hosted services on REST is more suitable than using SOAP as underlying Web service infrastructure. The second phase relies on the outperforming REST-based framework to examine four distinct strategies for mobile Web service distribution mechanisms. In the last phase, evaluation results of the second phase are interpreted as Fuzzy Logic rules. These rule sets are used to trigger and control offloading schemes. Fuzzy control approach proposes a situation-aware framework for providing services with respect to calculating resources in a proactive manner. Current situation of available resources of mobile device is calculated and provided to the fuzzy class which then loads the FCL file. FCL file contains some contextual rule and conditions which are handled by defining legitimate linguistic variables through the Fuzzy Control Language (FCL).

The goal of proposed architecture is to create an efficient and reliable Android mobile host as a web service provider that includes web services deployed on the mobile host and clients access the content. The main aim is to create Light weight framework for Android host that takes care of resource limitations and battery life.

3.1 Fuzzy Performance Evaluation:

Performance evaluation was performed on Samsung Galaxy S Duos (GT-S7562) having following configuration.

Speed: 1 GHz
Card slot microSD, up to 32 GB
Internal 4 GB (1.8 GB user available), 768 MB RAM
GPRS Yes
EDGE Yes
Speed HSDPA, 7.2 Mbps; HSUPA, 5.76 Mbps
WLAN Wi-Fi 802.11 b/g/n, Wi-Fi hotspot
Li-Ion 1500 mAh battery
Stand-by Up to 445 h (2G) / Up to 330 h (3G)
Talk time Up to 13 h (2G) / Up to 7 h 25 min (3G)

For performing controlled web service architecture, we preferred jfuzzylite rather that jfuzzylogic because of some advandvantages that jfuzzylite has. Comparatively Size of jfuzzylite is very small than jfuzzylogic. Size of jfuzzylite is approximately 300KB which makes it ideal for the Android platform and size of jfuzzylogic is 2.94MB.

jfuzzylite is a cross-platform, free and open-source fuzzy logic control library programmed entirely in Java. Its goal is to allow to easily create fuzzy logic controllers in a few steps utilizing object-oriented programming

without requiring any third-party libraries. jfuzzylite is the equivalent of the fuzzylite library for Java and Android platforms introduced (E. H. Mamdani, et al, 1975)

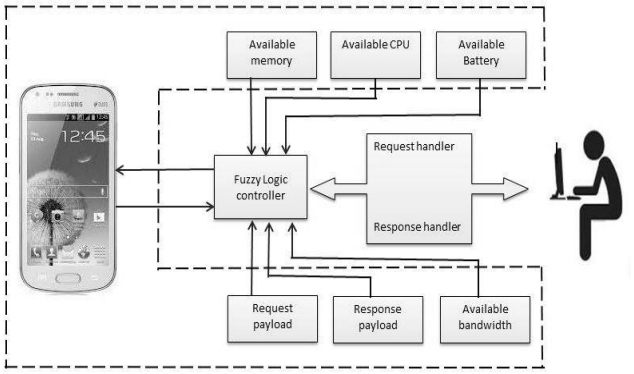

Fig.2 Fuzzy Control on the resources of android device

Fuzzy logic has several features that make it suitable for developing controlled web service architecture on mobile device. One of the most significant features is the flexible decision making from the data parameters. Fuzzy logic control provides a powerful alternative to traditional control algorithms that avoids consumption of large amount of resources like CPU and memory.

Design of a fuzzy logic controller

The design of an FLC consists of modeling the system inputs and outputs as linguistic variables, and creating the necessary inference rules that will control the system.

Linguistic Variables

A linguistic variable is a set of terms expressed in natural language that can represent the possible values that a system variable can take.[21] For example, variable Available_MEM is a linguistic variable whose values are in rage (0.000.. 786429.000) and are overlapped by range defined as small (0.000, 50000.000, 70000.000, 200000.000), passable (100000.000, 250000.000, 349524.000, 524286.000), large (500000.000, 900000.000, 1699048.000, 786429.000).

Fuzzification

Fuzzification is the process of making a crisp quantity fuzzy. This is done by simply recognizing that many of the quantities that is being considered to be crisp and deterministic are actually not deterministic at all, there is a certain amount of uncertainty, so the fuzzy control evaluate rules on the basis of input variables and gives strength to the rules. Here Rule1 and Rule2 have strength of 0.855 Rule3 have strength of 0.540 Rule6 and Rule7 have strength of 0.370.

Input Linguistic Variables and Fuzzification

```
FUNCTION_BLOCK Service Control

VAR_INPUT
Available_MEM: REAL;
Available_BAT: REAL;
Available_CPU: REAL;
Request_PAY: REAL;
Response_PAY: REAL;
Available_NWSPEED: REAL;
END_VAR

VAR_OUTPUT
RESPONSE: REAL;
END_VAR

FUZZIFY Available_MEM
RANGE := (0.000 .. 786429.000);
TERM small := Trapezoid (0.000, 50000.000, 70000.000,
200000.000);
TERM passable := Trapezoid (100000.000, 250000.000,
349524.000, 524286.000);
TERM large := Trapezoid (500000.000, 900000.000, 1699048.000,
786429.000);
END_FUZZIFY

FUZZIFY Available_BAT
RANGE := (0.000 .. 12.000);
TERM poor := Trapezoid (0.000, 1.000, 2.000, 3.000);
TERM moderate := Trapezoid (3.000, 4.000, 5.000, 8.000);
TERM excellent := Trapezoid (6.000, 9.000, 10.000, 12.000);
END_FUZZIFY

FUZZIFY Available_CPU
RANGE := (0.000 .. 1000.000);
TERM low := Trapezoid (0.000, 33.000, 55.000, 66.000);
TERM generic := Trapezoid (65.000, 120.000, 200.000, 400.000);
TERM high := Trapezoid (300.000, 400.000, 500.000, 1000.000);
END_FUZZIFY

FUZZIFY Request_PAY
RANGE := (0.000 .. 2048.000);
TERM short := Trapezoid (16.000, 64.000, 150.000, 256.000);
TERM long := Trapezoid (128.000, 950.000, 1024.000, 2048.000);
END_FUZZIFY

FUZZIFY Response_PAY
RANGE := (0.000 .. 2048.000);
TERM short := Trapezoid (16.000, 64.000, 150.000, 256.000);
TERM long := Trapezoid (128.000, 950.000, 1024.000, 2048.000);
END_FUZZIFY

FUZZIFY Available_NWSPEED
RANGE := (0.000 .. 100.000);
TERM weak := Trapezoid (0.000, 10.000, 15.000, 20.000);
TERM average := Trapezoid (15.000, 30.000, 40.000, 60.000);
TERM strong := Trapezoid (30.000, 40.000, 80.000, 100.000);
END_FUZZIFY
```

Defuzzyfication

Is a process that converts fuzzy terms to conventional expressions quantified by real-valued functions. Process of producing a quantifiable result (crisp) in fuzzy logic. Here output parameter terms are web service response and SMS response. On the basis of input parameters rules evaluate the process of defuzzyfication of output parameters.

Defuzzification of the output parameter

```
DEFUZZIFY RESPONSE
RANGE := (0.000 .. 20.000);
TERM ResponseOFF := Trapezoid (0.000, 5.000, 7.000, 8.000);
TERM ResponseON := Trapezoid (7.000, 15.000, 18.000, 20.000);
```

```
TERM SMSResponseOFF := Trapezoid (0.000, 1.000, 2.000, 3.000);
TERM SMSResponseON := Trapezoid (1.000, 4.000, 5.000, 20.000);

Defuzzification  definition
METHOD : COGS;
ACCU : MAX;
DEFAULT := nan;
END_DEFUZZIFY

RULEBLOCK
AND : MIN;
OR : MAX;
ACT : MIN;
```

Rules

The rules are nothing but the conditional statements that control the system. Rules are used by fuzzy inference which does the process of formulating the mapping from a given input to an output using fuzzy logic. The mapping then provides a basis from which decisions can be made, or patterns discerned. The process of fuzzy inference involves all of the pieces that are described in Membership Functions, Logical Operations, and If-Then rules.

Definition of the linguistic rules

RULE 1 : if Available_CPU is generic or Available_BAT is excellent then RESPONSE is ResponseON
RULE 2 : if Available_CPU is generic or Available_BAT is moderate then RESPONSE is SMSResponseON
RULE 3 : if Available_CPU is low or Available_BAT is poor then RESPONSE is SMSResponseOFF
RULE 4 : if Available_MEM is small and Available_BAT is poor and Available_CPU is low then RESPONSE is ResponseOFF
RULE 5 : if Available_NWSPEED is weak and Available_CPU is high and Available_BAT is poor then RESPONSE is ResponseOFF
RULE 6 : if Request_PAY is long or Response_PAY is long and Available_NWSPEED is weak and Available_BAT is poor then RESPONSE is ResponseOFF
RULE 7 : if Request_PAY is long or Response_PAY is long and Available_CPU is low then RESPONSE is ResponseOFF
RULE 8 : if Available_MEM is passable and Available_CPU is generic and Available_BAT is moderate then RESPONSE is ResponseON
END_RULEBLOCK

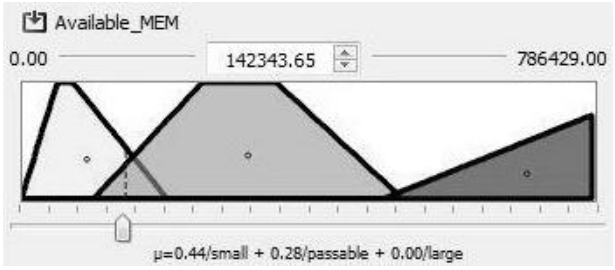

Fig.3 Variable set for available memory

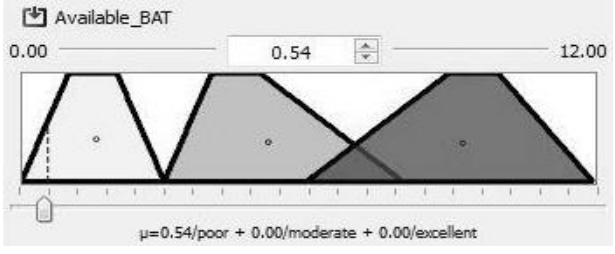

Fig.4 Variable set for available battery life memory

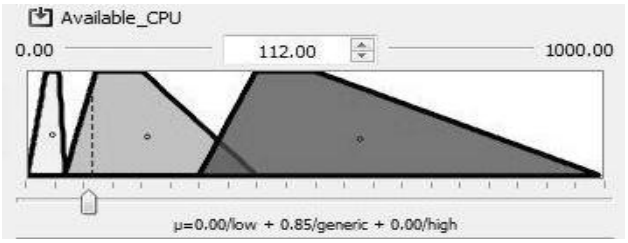

Fig.5 Variable set for processing power

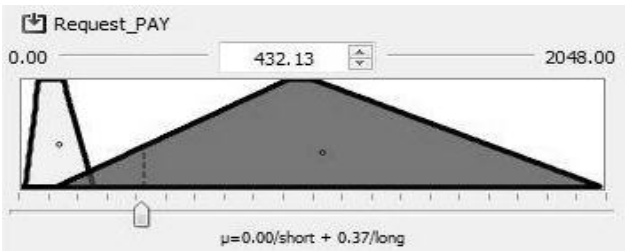

Fig.6 Variable set for request payload

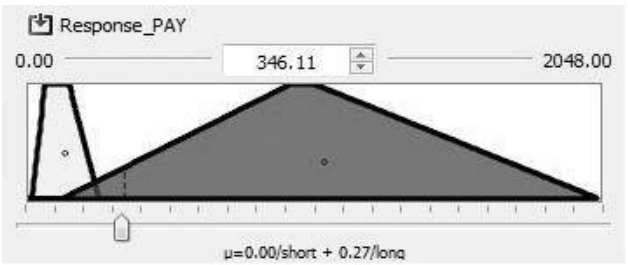

Fig.7 Variable set for response payload

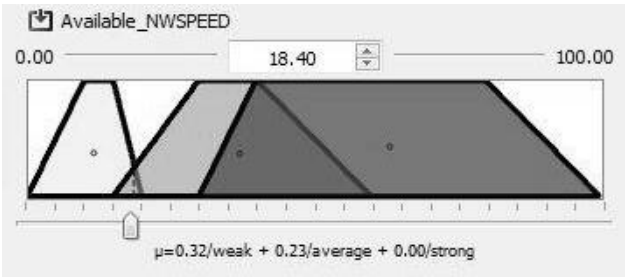

Fig.8 Variable set for available network speed

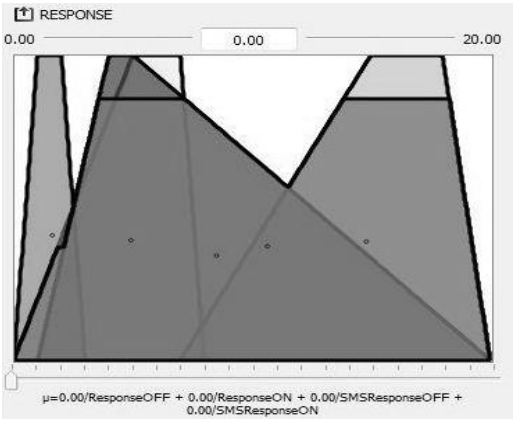

Fig.9 Variable set for Defuzzified result for web service response and SMS response

Conclusions

Today's modern powerful Android mobile devices can be used as web service provider and fuzzy concept improves its. The Mobile Host was developed on a smart Android phone. The Android Mobile Host processes service request and send the response to client. The client can access the Mobile Host services via HTTP protocol. In this scenario Mobile Hosts that can themselves offer services in a true mobile client-server setting. A Web Service provider demonstrated the technical feasibility of this approach in terms of resource consumption, standard compliance, and performance. The approach truly paves scope for the client-server and distributed mobile information networks.

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Author Profile

Kishor S. Wagh.received the BE degree in Computer Engineering from North Maharashtra University, Jalgaon , Maharashtra, India, in 1996 and the ME in computer Engineering in 2006 from PICT, University Pune. He is Assistant Professor with the department of Computer Engineering, Marathwada Mitra Manadal's Institute of Technology, Pune. Currently pursuing his PhD in Computer Science and Engineering from SRTM University, Nanded. His research area includes Web Services, wired and wireless networks and could computing. He is member of CSI and Life member of ISTE.

Dr. Ravindra C. Thool received his BE, ME and Ph.D. in Electronics from SGGS College of Engineering & Technology, Nanded, Maharashtra, India, in 1986, 1991 and 2003 respectively. He is professor in Information Technology, in the same organization. His research area includes Computer Vision, Image processing, Wireless networking, Mobile computing and multimedia information systems. He has published several research papers in refereed journals and professional conference proceedings. He is member of IEEE and Life member of ISTE.