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Challenging Issues of a Context-Aware Mobile Computing Framework

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***Abstract*—** Context-aware mobile technology has garnered lot of attention in recent times. Context-aware applications are self-regulating and self-monitoring. Building a context-awareness framework is a serious challenge. This paper presents an idea for the development of a context-aware mobile framework. The process of proposing such a framework is quite a challenging task because of the fact that this framework should consider many context-aware factors like location, temperature, time, noise levels etc. Context-aware applications have not been able to venture into every common man's arena. This paper has tried to make a sincere attempt to devise a model that will help to cater to all the requirements of building a context-aware mobile framework.

***Keywords*—** Context-aware, Ubiquitous, Pervasive, contextual information, Sensors, Actuators, Sentient, Stigmergy, pheromones

I. INTRODUCTION

Context-awareness applications derive their ideas from pervasive or ubiquitous computing. This further pervades into ambient intelligence that means being sensitive and responsive to the presence of people. With this kind of intelligence, computing seems to be possible anywhere and everywhere. The urgent and important need to access corporate data has led to the rapid increase in the remarkable growth of context-aware applications. Building a certain model on the basis of pervasive computing is nothing less than a challenge due to the fact that many changing environmental factors like: time of the day, noise levels, user's exact location, and even light is taken into consideration.

II. CONTEXT – AWARE APPLICATIONS – A PREVIEW

Computers are bad at common sense. They should be coupled with some data to comprehend the context. The intelligence to make computers work is hidden within the network. This allows users to carry out their activities seamlessly. A few instances are illustrated below to prove the real worth of these applications. [1].

Shopping Assistant is a device that helps customers to locate the items, review shopping catalogue, and conduct a comparative analysis. Furthermore, this device helps the customers who register themselves with the supermarket with additional discounts and offers as a bonanza for furnishing their personal details.

Office assistant applications are quite popular that interacts with visitors. Contextual information like visitor's identity is obtained by the device. It keeps a track of the busy and free schedules of the boss and fixes an appointment for the visitor.

Conference assistants are helpful to those delegates who attend conferences. The device considers a few common pieces of contextual information to guide the interested delegates which includes: user's topics of interest, geographical location of the conference/ meet etc. Upon the participant's entry into the conference room, the name of the presenter, topic of the presentation, and other related information is displayed to the participant. The entire proceedings of the conference can be recorded for future reference.

Cyber guide / Tourist devices are of immense help to people who look for guidance during their journey. These devices offer convenient help by updating the tourists about their current location, what are the places to be visited nearby etc. It works on the GPS model.

There are some location and information delivery devices that operate to provide information to users with the help of messages. Every message is location-sensitive. Whenever the recipient arrives at that particular location, the message is delivered to him.

III. VITAL ELEMENTS FOR CONSTRUCTING A CONTEXT-AWARE MOBILE FRAMEWORK

With no definite or a precise programming model available, context-aware applications are a tad too difficult to design. Programmers experience difficulties to write pieces of code even though the task is to build simple smaller applications. One of the primary reasons for the resulting complication could be the frequently changing environmental characteristics that directly tend to have a strong influence on the context-aware applications.

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Basically, a context-aware application model thrives on three important parts:

a) Sensors that capture contextual data.

b) The set of rules that govern the behaviour as per the conceptual data.

c) The Actuators that generate responsive actions.

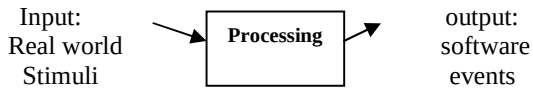
There is a need to provide loose coupling between objects to enhance object mobility within the context-aware framework. Object mobility is required in order to cater to the diverse deployment scenarios to which these applications would be exposed to.

IV. Towards a Sentient Object Model

The primary requirement for constructing a context-aware paradigm is to have a sentient object model in place. A sentient object model is nothing but an intelligent model that senses its environment through sensors and reacts through actuators. Sentient object model gathers information from the external environment and acts accordingly.

A sensor (in the context of a sentient object model) can be defined as:

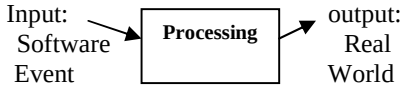
An entity that generates software events in response to real world stimuli as discovered by a hardware device



A Sensor

An actuator (in the context of a sentient object model) can be defined as:

An entity that produces changes in the real world events by accepting inputs from software events



stimuli

An Actuator

From the above definitions of sensors and actuators, a refined definition can be derived for a sentient object model.

A model capable of accepting and generating software events, that resides within the frame of sensor and actuator.

V. The 3 General Requirements of a Sentient Object Model.

a) Capturing the input.
b) Formulating the context.
c) Determining the consequence.

Let me throw some light on each of the above aspects:

a) Capturing the input: There are many ways of accepting inputs from sensors. Various signals emerging from these sensors can be combined to form a context-aware environment that provides the basis for the next consecutive step.

b) Formulating the context : Unfiltered sensor data needs to undergo major transformatiuons before it can become meaningful. After much thought-processing, a strong context-friendly model can be developed.

c) Determining the consequence: The primary quality expected out of a sentient object is Sagacity. There has to be a certain level of decision making ability in order to derive appropriate output.

As a matter of fact, the procedure to determine the output is far more complex than it can be thought of. The knowledge base comprises of certain rules termed as production rules to be encoded for future reference and usage.

VI. Challenges In Developing A Context-Aware Framework

Since a context-aware model relies heavily on environmental inputs, the sensors should act in co-ordination with the formulation of the context. This, in itself is a mighty challenge. Often, lot of objections are raised pertaining to the sensitivity aspects of the sensors. The biggest challenge is to achieve a seamless co-ordination between sensors and actuators.

The next bigger challenge happens to be filtering of information. The sensor can't pass all the acquired information for formulating the context. There is a requirement of a strong filtering mechanism. To begin with, this is the most critical phase. If there is any flaws reported during filtering, possibilities of wrong inferences being drawn may further complicate the process.

Problems may emerge when the model has to operate in an uncertain environment. There may be diverse dialects, timing failure may occur. The very obvious solution to this problem is to make the application reach a safe zone and resume its operation only after becoming consistent.

The degree of QOS these models are equipped with is what matters the most. If the environmental factors are consistent enough, then there is hardly any requirement to go through any major transformations. But, if there are any significant alterations found, the model should restructure itself to deal with the ongoing mutations.

Sensors are highly diverse and emerge from various sources that the act of filteration becomes quite tough to handle. The varied sources of inputs to be accepted by the sensors are scattered on many devices and these devices may not be safe.

VII. Inducing An Act Of Stigmergy Into The Context-Awareness Framework- A Mighty Challenge

There is a certain level of Stigmergy expected out of the context-aware framework. A perfect co-ordination is expected between sensors and actuators. To accomplish this, Stigmergy has to exist. Stigmergy is defined as the mechanism of communication between sensors and actuators. The principle adopted for Stigmergy is that the preceding action influences the next course of action that results in a more comprehensive, spontaneous and efficient systematic chain of consecutive actions.

VIII. Derivinging an inference for the consecutive Response resulting from Stigmergic behaviour

As a matter of fact, to predict the co-ordination of sensors and actuators, the ant colony optimization algorithm can be applied. This algorithm is based on the concept of Pheromones.

Pheromones can be defined as the chemicals released by organisms into its environment enabling communication between other organisms of similar species.
A similar procedure may be adopted by a context-aware mobile framework to establish a communication with its environment. It can be further explained along with the help of an equation and its related terms.
To maintain and propagate the context-sensitive data, I present below the equations derived from the ant colony algorithm.

Let 'm' and 'n' be the number of inputs supplied to sensors and actuators respectively. The intermediate solutions form a set called as solution space. Let there be several instances of pheromones referred to as 'pr_i' to build up a context-aware mobile framework.

At an instance i, P_{mn}^{i} can be defined as the probability of the movement that depends upon 2 factors:

a) The Inducement I_{mn}
b) The trail level T_{mn}

The state transitions happen whenever there is a change in propagating Context-sensitive information.

$$P_{mn}^{i} = \frac{(I_{mn})^{\beta} (T_{mn})^{\gamma}}{\sum (I_{mn})^{\beta} (T_{mn})^{\gamma}}$$

I_{mn} is known as the effect the preceding action has on the next course of action. The effect may be zero also. T_{mn} is like a deciding factor that determines whether the current action is needed or not.

IX. CONCLUSION

Developing a context-aware mobile framework remains as a challenge. This paper has made an attempt to provide a method to suggest a suitable Solution in the form of inducing Stigmergy behaviour. Hope the readers of this paper will be benefited to comprehend this ideology and build upon the same.

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My Profile Snapshot

I am Currently Working as Assistant Professor in Computer Science at Amrita Vishwavidya peetham, Mysore campus. I have 7+ years of teaching experience. My current area of specializations include Autonomic computing, Cloud computing, Service Oriented Architecture, Wireless and sensor networks. My related skills include: Exploring different arenas based upon my specialization and contributing significantly towards journals and conferences to improve my knowledge and exchange my ideas with the outside world.

