ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 5, May 2015

Passive Sensing for User's Activity Inference by Context Aware Computing using Smartphone

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Abstract: Today the concept of pervasive computing (ubiquitous computing) is growing rapidly in smartphones. It requires the device to be up and running all the time and constantly connected. In smartphones different sensors like proximity, microphone, magnetometer; GPS, WIFI, camera etc. are embedded in the device. These sensors are active all the time for the purpose of collecting all the user contextual data so it can be used further analysis. This system works on inferring the users microenvironment event change i.e. sensors analyse the input data and detect any events through the parameters.as these sensors have to run continuously it effects the battery consumption rate and all the sensors and processes affect the performance of the system as a whole.so the required measures to control these limitations like killing unnecessary processors. This system helps in increasing the efficiency of user by automatically deducing the events and taking actions for the same. So it's a non-invasive process with minimal user interference. User is immediately alerted to any events that requires user's attention. This system also has a security functionality to help protect user and the mobile unit as well.

Keywords: smartphone sensors, Context aware computing, ubiquitous computing, and inferring activities

I. INTRODUCTION

Smartphones now a days come with inbuilt sensors like proximity, magnetometer, camera, touch screen and microphone etc. These sensors are an inherent part of today's concept of pervasive computing which entails the functionality of continuous working of sensors all the time. Sensors have the capability of collecting data which is contextual (related with) to user's microenvironment (the area immediate around a cell phone about 10-15 centimetres). The basic functionality of this system is divided into three different levels i.e. the input layer, the core layer (processing of data) and the application layer.

(FIG 1) At the lowest level sensors are responsible for collection of contextual data and a detecting any change in the microenvironment. This collection is done by all the various sensors like microphone is responsible for collection of any data in the form of sound likewise proximity is responsible for collection of any data concerning movement around the mobile phone. Once or such type of data is collected it needs to be analysed and manipulated. This activity is done in the second layer where the output from the first layer i.e. raw data is taken as input to this layer. Here we need to find the type of activities is for that we need to detect the changes in the event. This is done by first understanding what parameters constitute the respective state of activities like when a phone rings the initial value of sensor reads out to be equal to "far" and for the automatic call picking functionality to work, the state needs to change from "far" to "near". These types of activities are detected on sensor change. As the events are detected they referred to the kind of activity done by the user. Once the activity is confirmed their application is executed. The third layer takes as input the activities identified at the second layer. The various applications at the third layer make use of different sensors for their execution for example noise alert makes user microphone.

All these sensors run simultaneously and as a result rate of battery consumption becomes very high. This in turn affects the performance of the system so the proposed system helps improve the performance and decrease rate of battery consumption by employing applications like back surface, close environment and process kill which eliminate the unnecessary tasks as much as possible so this system is non-invasive i.e. does not interfere or disturb the user and automatically, continuously help user work with mobile unit more efficiently.

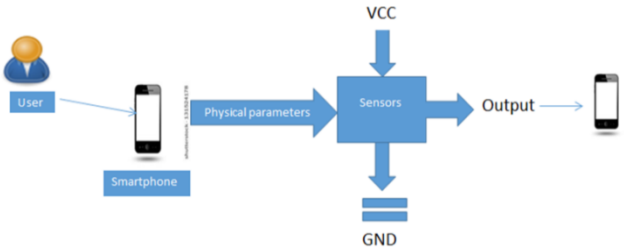

FIG 1: CONTEXTUAL AWARE COMPUTING SYSTEM

II. BACKGROUND

There are various researches on this topic [2-15]**.** Even if today the technological advancement in corporate sector as well as research sector has increased so much but still the area of sensors is in its beginning stage. However this stream is gaining more and more popularity because now day's sensors are available in embedded form in smartphones which makes them easily accessible and cost effective. One of the very first sensors introduced was accelerometer and the reason behind it was to enhance capability of system as well as experience of user. Many

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different type of sensors have been introduced over a period of many years for example accelerometer, proximity sensor, gyroscope, ambient light sensor, front and back camera, GPS, Bluetooth, Wi-Fi and microphone. Accelerometer are used to help in orientation functionality in smartphone and proximity, light sensors are used for detecting the context of user with mobile unit. Likewise GPS is used forlocalization, navigation etc. Sensors are used for helping in enhancement of mobile unit functionality as well as gathering of data for execution of various smartphone applications.

At the start there were no open interfaces for accessing the data captured by the sensors but now operating systems provide the user accessibility to the sensors, their control. Two types of participations of a user have been recognized over the year one is passive and the other is active.in passive contribution of user has no responsibility of doing any task manually as it is a noninvasive technique here in the smartphone sensors automatically collect and process the raw data. This has the disadvantage if some user's private data is broadcasted without the awareness of the user. Whereas in active contribution of user the need of manual work by users in the task of collecting data input is required. It reduces the reliability of data if the user is not interested and usually they find the notion tiring. Continuous sensing is a term used for the smartphone activity where the sensing is going on all the time in the background. Personal sensing, group sensing, community sensing are various types of sensing used for detecting various types of activities i.e. social, environmental, health and transportation etc.

The reason for the gaining popularity of smartphone sensors is that they are programmable and open source. Also they are very cost effective and do not need a user to carry around any external devices as they are embedded in mobile unit. They allow for the noninvasive techniques for collection and sharing of data. In the very beginning the sensors worked on a two steps process for execution i.e. detection and processing. Sensing presence is a concept where a smartphone automatically collects environmental data and categorizes it and ultimately shares it. With time many more methods and steps have been introduced to this basic concept. First step is usually called sense which consists of collection of data from the environment from the sensors. Then this data goes through preprocessing to find out the type of events by various learning algorithm (i.e. machine learning) and mining techniques (for extraction purposes) and classifiers like Decision Tree, , Support Vector Machine, Naıve Bayes and K-Nearest Neighbor. Data segmentation and training are also considered a part of this step. Through studies it was concluded that learning is of three types supervised, semi supervised, unsupervised. These three vary because of the level of involvement required from the user. External sensors can be used for finding the difficult and complicated activities but they tend to be expensive in implementation. In systems employing the use of sensors continuously there is a need to study the trade-off of continuous sensing with the goal of minimizing the energy cost while offering sufficient accuracy and real-time responsiveness to make the application useful.

III.SYTEM ARCHITECTURE

System architecture(FIG 2) of proposed system is given below. It makes use of android smartphone and its internal sensors. This system makes use of a mobile unit which has sensor embedded in it. These sensors take as input the contextual data of user. This data is used to infer the activities performed (phone call, message, back surface etc.) around and on the smartphone which helps the system perform various functionalities like automatic call picking, noise alert etc. In some security functionalities cases the user is alerted and in other SMS, email etc. are sent.

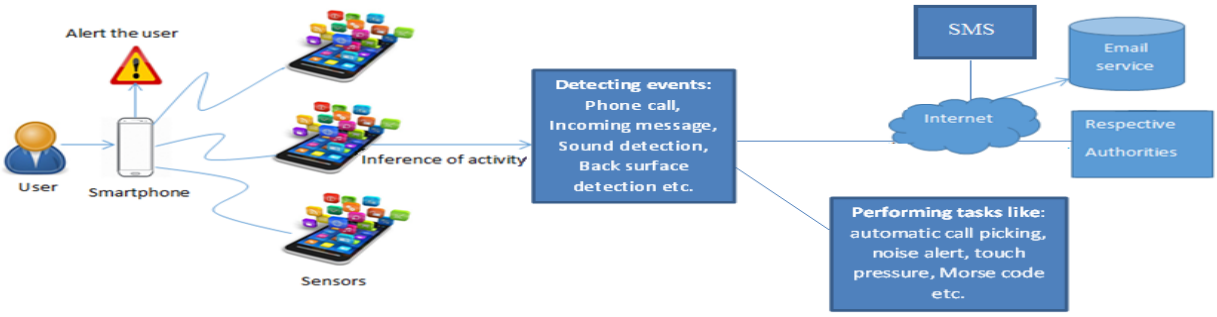

FIG 2: context aware computing architecture

IV.METHODOLOGY

In proposed system at the very start the user needs to provide the values of threshold for various sensors and their respective applications for example for noise alert the user needs to specify the threshold value at which the noise level is detected by the microphone so that appropriate action can be executed. Once this value is specified then there is no need of the interference from the side of the user so this type of sensing is called opportunistic or passive sensing [4]. The sensing mechanism occurs all the time in the background i.e. Continuous Sensing occurs and tasks and actions are performed according to the occurrence of the events. User interfaces i.e. mobile phones allow for the conversion of the physical world value of user's context to data that can be collected by the sensors and further more mining tasks are performed to extract information.

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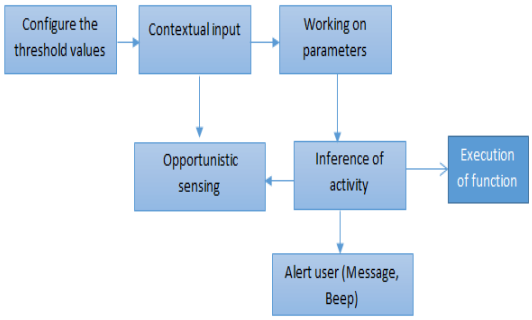

FIG 3:Activity Detection

Thus the interfaces nowadays have the characteristics of being open and programmable. Android provides various methods which can help work with sensor's data manipulation. These methods are event listener, onSensorEventListener, PhoneStateChanged, onSensorChanged, onBind, onAccuracyChanged, etc. these help in the manipulation of the data collected by the sensors. Once the data is collected various methods as stated above are applied on the data and the parameters of those methods are used to identify the type and the change in the events so that the different occurrences can be identified. Binding of the various functionalities occur so that the operating system is aware of the purposes and existence of any and such. The proposed system works on the principle of personal sensing which is employed and concentrate on a single user. Here date concerning that individual is collected and evaluated. This type of sensing is customized to cater the needs of a single individual and taking appropriate actions. Once the extraction of the information is done it can be used for utilizing in various applications of the proposed system. The two main concerns with the use of sensor technology are the battery consumption and context problem which are due to running of many sensors, processors, applications simultaneously. The solution to such problems is to do as follows: Firstly to deal with a problem concerning battery consumption we apply certain measures where the unnecessary tasks are stopped from their working state also performance is greatly increased by the deletion of processes which have been unused or idle for a long time. Context problem is a main aspect of limitation concerned with sensors where task of taking can be done by utilizing any sensor. For example the detection of back surface can be done by using accelerometer or magnetometer. Here magnetometer is being utilized for this functionality. There is another concern as two tasks are employing the same sensor, they result in a state of contradiction so for that purpose the applications utilizing the same type of sensor cannot be run simultaneously for example automatic call picking functionality works in contradiction with close environment detection function. So when one is up and running the other automatically gets turned off. The proposed not only takes care of the security of smart phone but also that of the user making it a help-aid system. This system works for increasing the efficiency and performance in the user. Starting with the activation, inference of event leads to identification of activities which requires the system to alert the user of the actions or any problem happening to the user smart phone.

V. APPLICATIONS

1. Can be used in hospitals if the patient wakes up and the medical staff, family can be alerted if no one is available on the location.
2. Can be used at home for alerting parents when the child is awake.
3. Helps users to automatically pick phone call.
4. For security of mobile unit and the user as well.
5. Increases efficiency and performance of user and the mobile unit.

VI. CONCLUSION

This paper describes methodology for context aware computing system. This system helps user in detecting all the changes that occurs in the user's microenvironment and automatically take actions concerning those events and changes. If the mobile unit or the user are in danger then the system aids automatically by sending alerts to the user or appropriate authority. Optimization of the battery consumption and performance are also done through this system. The sensors are responsible for collection of data as input and manipulation is done on the data to infer activities and events. Whenever such events occur they can easily be identified. Parsing on data is done to read it and various algorithms are used to extract events. Thus we conclude the system increases efficiency of user and performance of the system.

ACKNOWLEDGMENT

I thank Prof. **S.R.Idate** Dept. of Information technology, BVDUCOE, Pune for full support and continuous guidance for the duration of my research work.

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BIOGRAPHY

Monika Sharma is a final year MTECH (I.T.) student at Bharati Vidyapeeth Deemed University. She received her B.E (I.T.) degree from K.C.Bansal, Indore.Her areas of interest are Pervasive Computing and Smart Sensing.