Advances in Computer Science and Information Technology (ACSIT)
Print ISSN: 2393-9907; Online ISSN: 2393-9915; Volume 2, Number 10; April-June, 2015 pp. 87-91

http://www.krishisanskriti.org/acsit.html

Contextual Information Collection and Interpretation of Activities by Personal Sensing for user's Aid using Smartphone

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Abstract—*Everyone carries a smartphone these days and they are embedded with various sensors such as accelerometer, gyroscope, proximity, microphone, camera, WIFI etc. these sensors are used in various fields for their application such as health monitoring systems, navigation systems and many others. Smart sensing system uses non-invasive technique for continuous collection of user's contextual data which is then used to infer activities of user. Activities recognized are used for three type of purposes: first is to increase the efficiency of user through activities like automatic call picking, Wi-Fi mouse, second is to ensure the safety of user and the mobile unit by activities like Unauthorized access, Touch pressure detection, Phone half in half out of pocket, Noise alert, Morse code and third is to increase the performance of the system by activities like Close environment detection, Back surface detection, Process kill. System internal processing goes through three stage of data collection, processing of data and inference of activities. Continuous background sensing and processing leads to battery consumption and performance issues. So a smart sensing system increases the efficiency as well as security of both user and the system.*

Index terms*: Smart sensing, context awareness, Personal sensing;*

1. INTRODUCTION

Pervasive computing rigorously utilizes the concept of context aware computing. It is possible because of the various sensors which are embedded in mobile phones. Sensors have the issue of usability which is a result of invasive techniques but smart sensing avoids the participation of user after an initial interaction. System is called as intelligent if all this work is done automatically by the system with minimum or no user involvement. Such type of system is called passive or non-invasive system. Empirical methods studied over the years and refined to make the human computer interaction are used in smart sensing to make it efficient and productive. Implementation and usage for such purposes can be required by an individual or a group (community), personal sensing. All such activities use smart sensing where continuous sensing of users' contextual environment is done so that activities can be detected, inferred and ultimately actions taken in respect to various activities. There are three phases of computation and execution on the sensing functionality. The first stage consists of the data collection. Here it is very important for the sensors related to activities to collect all the proper and required data for further usage. The various sensors required are proximity, camera, GPS, Wi-Fi, touchscreen, microphone and magnetometer.

Table 1: Different sensors and their functionalities

SENSOR TYPE	DETAILS OF EACH SENSOR
PROXIMITY SENSOR	WITHOUT ANY PHYSICAL CONTACT IDENTIFIES(DETECTS) THE PRESECNCE OF NEARYBY OBJECT
MICROPHONE	DETECTS THE SOUND NEARBY AND CONVERTS IT INTO ELECTRICAL SIGNAL
MAGNETIC SENSOR	IT DETECTS MAGNETIZATION OF MATERIAL AND MAGNETIC FIELD AT A POINT IN SPACE
Wi-Fi	IT HELPSTHE VARIOUS SYSTEMS(E.G. MOBILE PHONES,COMPUTER) TO CONNECT TO EACH OTHER AND MAKE A NETWORK
TOUCHSCREEN	HELPS CONTOL AND GIVE INPUT TO INFORMATION PROCEESSING SYSTEM THROUGH SIMPLE OR MULTI-TOUCH GESTURES
IMAGE SENSOR (CAMERA)	IT HELPS TO DETECT AND RELAY INFORMATION RELATED TO AN IMAGE
GPS	HELPS IN NAVIGATION SYSTEM BY PROVIDING THE LOCATION AND TIME INFORMATION OF A POSITION ON OR NEAR EARTH

The second stage is to process the collected data through various sensor methods(like on Sensor Changed) by applying various algorithms and procedures on data to achieve the purpose of feature extraction which is used to recognize the type of activity that is occurring in the microenvironment of the mobile phone. Once such events are identified then the required application working on that particular context is provided with all the detail of the event occurring so that proper action can be executed for e.g. if an incoming call is detected by the system then it can automatically pick the call after computing the user's need of response i.e. if the user wants to respond then the proximity will change from a far position to a nearby position. Once such predicament is detected by the system it responds automatically by picking up the call. All these events are detected to increase overall efficiency, performance and security of the system and the user.

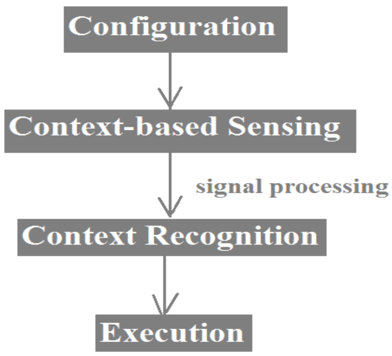

Fig. 1: System flow

Various activities identified for increasing efficiency of user are as follows: automatic call pick up, smartphone is also as mouse and webcam using Wi-Fi also security of system by wrong pattern detection, secure messaging using Morse code, aid user by detection of touch pressure(during distress situation), noise alert for health monitoring and protection of phone by alerting user if it's about to fall from bag or pocket and performance of the system is increased by detection of phone in a closed environment and stopping unnecessary process of light blink, recognition of the backing surface so that vibration or ringing mode can be activated accordingly, unnecessary processes which have been inactive for long duration of time are stopped.

2. BACKGROUND

Over the years the use of context aware sensing has changed from being from single sensor application to multisensory application because of the usability issue of sensing system which doesn't give reliable and accurate accumulation of data to infer different events through a single sensor. Smart sensing system has changed what humans perceive as only physical world functionalities like observation and action into a virtual reality. This has promoted the concept of human and computer interaction into new level where a computer is capable of observing the user activities by detecting the changes in user's contextual environment and performing counter measures according by execution of the respective application. Sensing can be done for an individual where it is called personal sensing, when it is done for a selected few it is called as group sensing and when it done for a large group with a same agent or usage requirement then it called community sensing. One more usage problem that has been observed through research over the years is the intrusive systems which create interruptions to the natural flow of work of the user. Thus it's divided into two categories: active and passive. Where on one hand active sensing requires the participation of the user frequently which is an invasive technique creating interruptions in user's work. On the other hand a passive system works continuously and automatically in the background and does not require participation of user expect a few times. Collection of user's activity data through sensor has been categorized in two ways: continuous; it requires the sensors to be active all the time and collect all the contextual data which is further categorized, classified, filtered and used in some application for e.g. a smart diary . Another method of sensing is event based sensing which collects the contextual data at a certain particular point or interval of time. This type of sensing is done when a particular event occurs. The most important part of a smart sensing system is feature extraction. For this purpose various machine learning technique (like Deep Learning (DL) techniques), training methods (supervised and unsupervised) and classifiers (like naïve Bayes, nearest neighbor etc.), filters (like feature map). The detected activities usually fall under one of these categories: social, environmental, health and transportation etc.

3. SYSTEM DESIGN

Smart Sensing System (SSS) has the functionality of integrating different modules son that together they can help in increasing the overall usability of the system by increasing the factors like performance, efficiency and security. All the various functionalities work together such that the system continuously observes changes in the event an accordingly execute respective tasks.

The various modules are as follows:

3.1 Increasing user efficiency

3.1.1. Proximity call. Third-order headings, as in this paragraph, are discouraged. However, if you must use them, use 10-point Times, boldface, initially capitalized, flush left, preceded by one blank line, followed by a period and your text on the same line.

Parameters used in the module are: near and far. The sensors continuously check the change in event by observing the change in value. Whenever a phone call event occurs, the Smart Sensing System checks for the change in event through value change. The far parameter defines an initial stage where the mobile unit is far from the user and in order for the call to be picked the value must change to near indicating close proximity to the user. Thus the call gets automatically picked up. This functionality makes the use of proximity sensor.

3.1.2. Wi-Fi webcam. This module utilizes the camera sensor fully by using it as an external device used along with some other machine like PCs and laptops if they don't have or have a faulty webcam. In such a situation the mobile unit can be configured so as to be used as a webcam. Both the primary as well as the secondary camera (back and front) can be utilized for this purpose.

3.1.3. Wi-Fi mouse. Much similar to the webcam module this one has the functionality to be used as a mouse (pointing device) in the absence or inoperability of one. This functionality makes use of camera as well where pixels position relevant to camera define the position of the pointer and accordingly work as a pointing device.

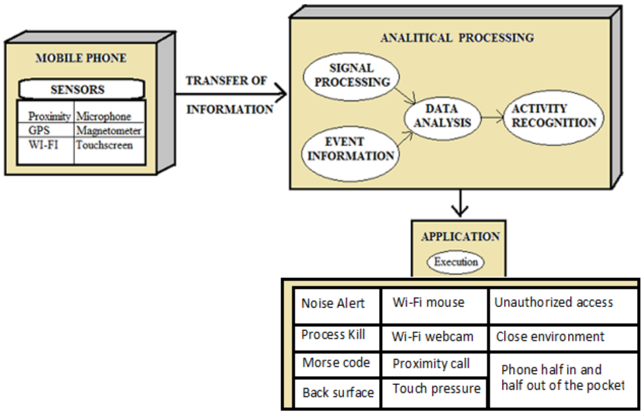

Fig. 2: Smart sensing system architecture

3.2 Security purpose (for mobile unit and the user)

3.2.1. Unauthorized access. This is one of the security modules designed for detection of attempt of unauthorized access to the user's system. If any such attempts are detected then the position of the mobile unit i.e. latitude and longitude position are sent through GPS to the phone number and the email id given by the user during configuration. If front camera is present then the photograph of that person is clicked automatically and sent to the email id.

3.2.2. Touch pressure. This module is for the security of the user. When providing the system settings the user provides a touch time which is the duration of the time for which the touch screen needs to be pressed in order to send a message, email to the phone numbers and email address provided by the user.

3.2.3. Phone half in and half out of the pocket. It works for the safety of the mobile unit when the mobile unit is not securely inside a close environment but has the risk of falling and being damaged. In this case proximity sensor detects the environment and alerts the user in case of the chance of the mobile unit falling.

3.2.4. Noise Alert. This module can be used for detection of the noise above a certain level. This level is given the value during settings by the user as a threshold value which is the noise level which when crossed alerts the same by sending message to the phone number provide by the user. It can be used as a help aid for patient care in hospitals and parents can use it to monitor their kids. This functionality makes use of microphone to capture and any sound in the vicinity of mobile unit and when the threshold value is crossed alert via message is sent to the provided phone number.

3.2.5. Morse code. This module utilizes blink or flash functionality for converting a plain text to Morse code. It works by saving all the letters as some series of dots and dashes which are different for each letter. Accordingly the number of times the light blinks to convey the message.

3.3 Increase system performance

3.3.1. Close environment. Inside a closed space it is redundant for certain functionalities to keep on running like the blinking of light to indicate a new message or missed call etc. if such functionalities are stopped automatically so as to save the power then it turn increases the performance of the system. For execution of this function proximity sensors are utilized.

3.3.2. Back surface. This module also removes the unnecessary tasks to increase the performance and save the energy of the Smart Sensing System. It uses the magnetic sensor to detect the type of surface on which the mobile unit is being placed and accordingly performs the required task. E.g.: when on hard surface it vibrates and on the soft surface it rings.

3.3.3. Process Kill. Every system has different processes present in it at a particular time some of these processes are running while others are idle. These consist of active activities and active processes and processes. Processes are those which are idle for long time they are removed so that system resources can be utilized efficiently, thus increasing system performance.

Various alert are used when the security of the mobile unit or the user are at risk.

4. ALGORITHM

RSA: it's an algorithm used for cryptography mostly used for transmitting data securely. It uses a pair of encryption keys; one for encryption and other for the decryption process. One is public key, used for encryption and private key for decryption. In smart sensing system RSA is used for encryption of the data that will be given as input by the user for configuring the system. This is done so that no unauthorized user is able to get access to the various applications of the smart sensing system and change their functionality like switching them off etc.

It includes the following phases:

- Key generation: First of all in RSA we have to choose two prime numbers: (p, q) at random with same length which are not known to anyone (i.e. are secret).
- Calculate: $m=p*q$ and $Ø(m) = (p-1)*(q-1)$; m is modulus for public and private key and Ø is Euler's totient function (secret).
- Take an integer e s.t: $1<e<Ø(n)$; e is public key exponent.
- Calculate $d \equiv e-1 \pmod{Ø(n)}$; i.e., d is the modular multiplicative inverse of e (modulo Ø(n))
- For encryption $c = m \wedge e \% n$
- For decryption $m = c \wedge d \% n$

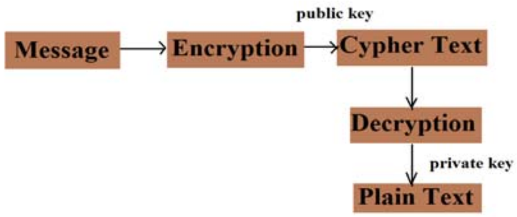

Fig. 3: RSA algorithm

5. SYSTEM IMPLEMENTATION

The second Smart sensing system is built on three levels of architecture. The first is the collection level where raw data is collected using an Android sensor framework which allows the system to easily access the input sensor data. A change in the events is monitored through one of the three types of sensors: Motion sensors, Environmental sensors, Position sensors which employ two methods onAccuracyChanged() and onSensorChanged() through SensorEventListener interface. Various classes are used to capture and observe the changes in sentient data (contextual). These are: Sensor, SensorEvent, SensorManager and SensorEventListener. When a change is detected in the sentient environment of mobile phone by a sensor, an event occurs. Whenever change occurs some parameters change and event occurs which has information about the raw data of sensor responsible for event occurrence, name of that particular sensor, time and accuracy of event. To register and unregister sensor event listener onResume() and onPause() methods are used. The second level after the data is collected is to analyze the data and recognize activities in order to provide the various high level applications with the required data as input. Information is extracted from the collected data the method of signal processing. When we need to decipher the extracted data we analyze it on data centric approach. Parsing is done to read the data to be analyzed. Data concerned with the applications (application-oriented) is stored in SQLite database.

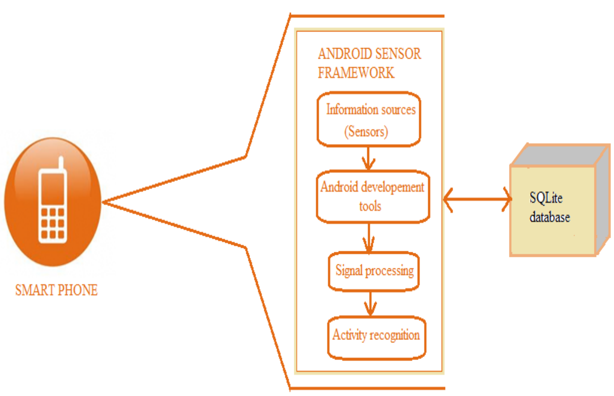

Fig. 4: System components

Smart sensing system requires:

- A smart phone embedded with sensors
- Android sensor framework
- Android development tools
- SQLite database

6. EXPERIMENTAL ANALYSIS

The Smart Sensing System gets access to the data collected via sensors through android sensor framework. The end result is an integrated system that uses various modules to increase security, performance and the efficiency of the system. Fig 5 shows the various applications which form the SSS (Smart Sensing System). Fig 6 shows the configuration details required by the system to work in accordance to the user's need. These are the values that are set by the user. Fig 7 shows the message sent by the security module which provides the location of the user by sending the latitude and longitude position of the user to the phone number provided by the user in the configuration stage. Fig. 8 shows the registration page which takes as input the user id and password which uses RSA algorithm for the purpose of encryption.

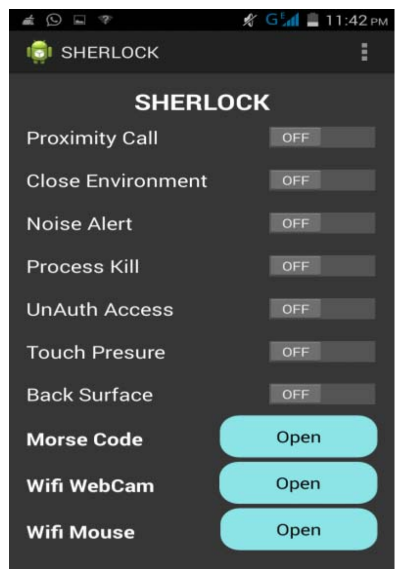

Fig. 5: Applications

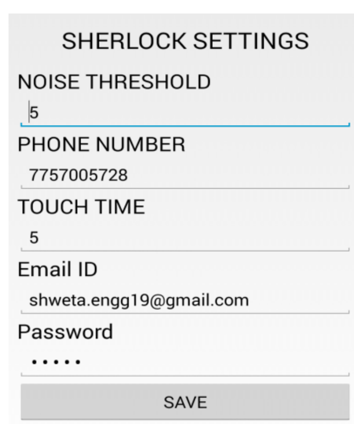

Fig. 6: Configuration

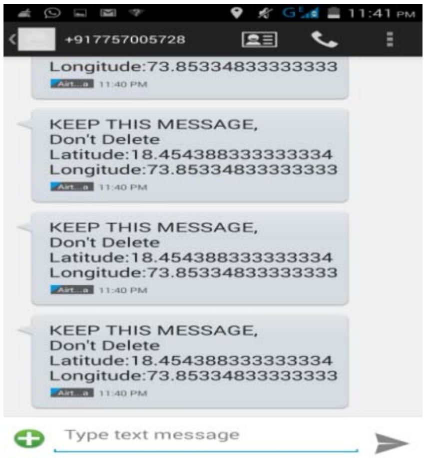

Fig. 7: Security message

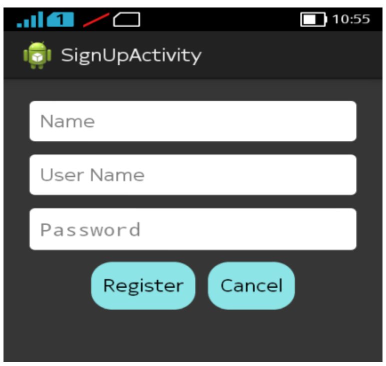

Fig. 8: User registration

7. CONCLUSION

Smart sensing system is a non-invasive technique for making the functionalities of a smartphone versatile and user friendly.it automatically detects the context of the mobile phone and collects the required data for event and activity recognition. The system identifies the b=need of the user by pervasive computing and continuous change in the microenvironment of phone in context to the usage pattern of the user and accordingly caters to the needs of the user. One of the main usability issue of the sensing system is avoided by using passive sensing i.e. intrusion of the system in the activities of the user. Another issue of the battery consumption is improved in the system by avoiding running of functionalities which are redundant and unnecessary making the system to utilize all the resources such as battery and memory storage to the full extent. During the situation of distress the system helps the smartphone user to provide with help and security. Same is true if the mobile phone is accessed by unauthorized personnel. This system increases the efficiency, performance and security of the mobile phone user and the phone itself.

8. ACKNOWLEDGEMENT

This project was possible due to the constant support of my guide Prof. S.R.Idate. I would also like to thank my family and friends for their encouragement without which this project would not have been possible.

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