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A Pervasive Microenvironment Sensinging Approach for Smartphones

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ABSTRACT

Smartphones have become an integral part of our daily lives. Traditionally smartphones were designed from a human-centric perspective. But to maximize the efficiency of modern day mobile phones, thinking from phone's perspective is important. Context awareness is increasingly gaining applicability in interactive ubiquitous mobile computing system. Sensor data can be put to use to develop a wide variety of context-aware applications in smartphones. We intend to work in the field of micro-environment, which is as the immediate environment of the phone up to 10-12 cm. Sherlock is a micro-environment sensing middleware platform which collects the data with the help of sensors in its current context and makes that information available for developer's use. We propose a sensor based application platform that studies phone usage and user habits to optimize it's behavior. The platform runs as a daemon process on a smartphone and provides fine-grained environment information to upper layer applications through programming interfaces.

Keywords: Micro-environment, Context-awareness, Daemon process, GPS, Accelerometer, Gyroscope, Ubiquitous, human-centric, Ambient light sensing.

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I. INTRODUCTION

Ubiquitous sensing of microenvironment has grabbed attention of researchers. Also with the technological advancement of cellphones a new platform for computing is quickly gaining popularity. Smartphones are embedded with a number of sensing devices such as an accelerometer, gyroscope, digital compass, microphone, GPS and camera. These sensors are now being used in various fields for human gesture and activity recognition based applications. These advancements are opening the doors to new areas of research. The application which we are developing is a unified framework which will be covering the major cases of phone usage, placement, altitude and interaction in practical uses with complicated user habits. Microenvironment can be defined as a relatively small area from which data can be acquired by smartphone sensors. Using this information the smartphone will be adapted accordingly. For example, surface detector sensor can be used for increasing the ringer volume when device is on soft surfaces. Likewise it can also be used for saving battery by keeping the screen off when smartphone is in closed environment such as in bag or in pocket. The previous efforts made in this field were based on human centric approach. Conversely our application aims to detect immediate surroundings with respect to the phone's perspective.We prototype an application on Android OS and systematically evaluate its performance with data collected. It achieves low energy cost, rapid system deployment and competitive sensing accuracy.

II. LITERATURE SURVEY

In the existing system, sensors broadcast data which is inaccessible to many applications. The existing system developed catches the sensors data to decide whether the device is in an open environment or closed environment. We are developing an application which gets the sensor data, parses that data and then converts it into ASCII format to fire multiple events.Sherlock is a framework built upon an investigation of phone usage and user habits. The framework covers the majority of phones states and consists of various modules like phone placement detection, phone interaction detection, backing material detection, ambient light sensing. It runs as a daemon process in the middleware layer. It employs sensors in the physical layer to record nature events and provides fine-grained environment information to upper layer applications. As a long-term middleware on smart phones, Sherlock optimizes energy consumption via a hierarchical, multistage architecture.

III. GAP ANALYSIS

The CPU share of our application stays at stable share of around 6 percent. This indicates that our system incurs negligible CPU share to daily Smartphone usage. The application consumes negligible energy, below 5 percent on an average. With time passing by, the cumulative energy consumption increases gradually, and finally ends up with 11.2 percent. The energy cost, remaining low as a whole, makes Sherlock affordable for Smartphone users, even with occasionally continuous detection. Sherlock's storage overhead varies with the phone habits of different people. Sherlock consumes at most 1.8MB storage per day and 1.3MB on average. . Further, the storage overhead is even smaller in reality, because Sherlock could delete the sensory data once the Microenvironment semantics have been deduced.

IV. SYSTEM ARCHITECTURE

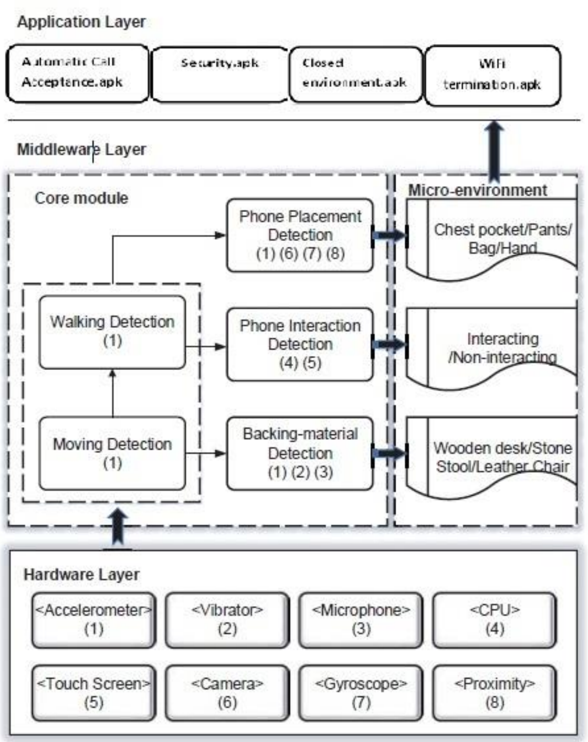

Figure 1: System Architecture

The system as a middleware platform can be divided into three layers as shown in Fig.1. The hardware layer represents a set of meticulously chosen sensors which facilitate smart sensing in the micro-environment. The core module is nothing but a context-aware middleware that conducts human-centric activities, recognizing contexts from device's perspective. The job of the application layer is to combine all functionalities and make them readily available to the user.

The major sensors in the hardware layer are as explained below:

Proximity Sensor: A proximity sensor is used for detecting the nearby objects without any physical contact. It emits a beam of electromagnetic radiation (infrared, for in- stance), and looks for changes in the field or return signal. There are different types of proximity sensors used for identifying different objects (e.g. metal, plastic). The maximum distance that this sensor can detect is defined nominal range. Proximity sensors have a highly reliable and long functional life because they don't include any mechanical parts and there is no physical contact between sensor and the sensed object. Proximity sensors are commonly used on Smartphones to detect (and skip) accidental touch screen taps when held to the ear during a call. The proximity sensors are implemented in Smartphones as Boolean sensors. It returns only two values NEAR and FAR.

Accelerometer: An accelerometer is an electromechanical device used to measure acceleration forces. The main function of accelerometer is to sense the changes in the orientation of smartphone with respect to datum and adjust the orientation to suits the viewing angle of operator. For example, when watching a video, it is preferable to have a landscape view rather than a portrait view, which can be easily achieved by changing the orientation of the phone to horizontal.

Gyroscope: A gyroscope sensor is used to detect orientation of device. It is calibrated to give a reading of zero when the device is kept on a plane horizontal surface. This sensor's function is to maintain and control the position, level or orientation based on the principle of angular momentum. When 'Gyros' used along with accelerometer senses motion from six axes i.e. right, left, up, down, forward and backward. It also detects the roll, pitch and yaw motions. Yaw, Roll and Pitch are the angular moments seen from three axes i.e. X, Y and Z.

Touch Screen: Touch screen is an electronic visual display which senses special stylus or pen and figures. Touchscreen can be used to control how and what should be displayed (e.g. by Zooming the text size, scroll them, for increasing volume etc.). It works in three components: The touch sensor is a panel with a touch responsive surface. The controller is a hardware that converts the voltage changes of sensor into the signal that are received by computer or any other device. Software, that informs the computers, Smartphones etc. about what is happening on the sensor and the information coming.

Ambient Light Sensor: This sensor optimizes the light of screen when it is exposed to normal light with different intensity. Ultimate function of ambient light sensor is to adjust the display brightness, which at the end saves the battery power.

The primary modules along with some application scenarios are explained as follows:
Motion Detection: This method uses raw accelerometer reading from smartphone and classifies the data to infer the phone's location with respect to the body. The walking direction would be the angle subtended by the walking vector and the compass direction of the gyroscope.

Local Placement Recognition:
As the name suggests, local placement detection deduces phone placements. The micro-environment involved is in-hand, in-bag, in-pocket, etc. The system first detects whether the phone is in hand by referring ambient illuminative conditions around the phone. If not, then, the app characterizes the unique moving patterns of the phone in different local placements with in-built accelerometer, by exploiting a Dynamic Time Warping (DTW) based time series matching scheme to recognize the specific local placement, i.e., in pants, in pockets or in bag.

Phone Interaction Detection:
This module defines user-phone interaction patterns such as browsing, calling, texting, etc. Although such interaction often occurs when the phone is in-hand, the phone interaction detection module emphasizes more on the semantic perspective. This plays a major role in process termination, avoiding unauthorized access and ambient light sensing.

Backing Material Detection:
This helps to differentiate between two main vibrational aspects, the phones mechanical motion and the acoustical features. Materials are said to be hard or soft materials. These are examined by an embedded accelerometer which classifies backing materials as leather, wood, glass and some others.

V. IMPLEMENTATION

Automatic call acceptance:
This simply refers to the smart ways to control your incoming calls via proximity sensor on your phone. When carried by a user, the phone is mostly placed in either semi-closed/open environments like in-hand, or closed environments such as in pocket and in bag. If the change sequence in the value of sensor from far to near occurs, then the incoming call is automatically answered.

Security using pressure sensor:
On activating this service, a customized button appears on the screen. On pressing this button for a stipulated period of time, an emergency call is automatically triggered to the configured number. Messages are sent discretely, without any human intervention. Needless to mention, GPS tracking plays an active role to provide real-time information of your location.

Mobile location and theft detection:
Unauthorized access application works under the phone interaction detection category. It uses the touch screen sensor to sense the pressure forces on the screen and returns action. In the field of security many applications can be developed where user can be notified about any unauthorized access. In this application, if the wrong password/pattern is entered by any user, the front camera automatically captures the photo which is saved in the DCIM directory. E-mail and/or SMS is sent from the owner's phone to notify any other person about the unauthorized access. The location information and the image will be stored on the email account.

Process killer to save battery:
This utility kills background processes when the device is identified to be stagnant. Backing surfaces being versatile, customization is required for the same. For instance, the processes will keep running uninterruptedly while the device is in the user's hand. Whereas on detection of other backing surfaces such as metal, wood, glass, etc. where the device is likely to be inactive, it terminates unnecessary background processes with the intention of battery optimization.

Ringer volume and vibration control:
This service works as a combination of the local placement detection and backing material detection methods. An in-built magnetic sensor analyzes the backing material of the device, which further facilitates surface characterization by providing parametric values. Possible use-cases can be: Phone vibrations will render non-functional when the backing material is a soft surface and consequently there is a noticeable increase in the ringer volume. In closed micro-environments like a purse, a bag, pocket, the screen light being inessential is turned off automatically. Incoming calls and messages are notified by increasing the ringer volume. Additionally, this promotes battery conservation.

Automatic Wi-Fi termination:
It often happens that user forgets to turn off the Wi-Fi when phone is not connected to any network. This increases the battery overhead. So we present a module to turn off the Wi-Fi, when the user is out of range for a specified timeout.

VI. CONCLUSION

The advent of sensors have revolutionized and optimized the overall use of modern day Smartphones. Sensor data can be exploited and employed for the development of a number of user-friendly services. To name a few, automation of call answering mechanism, pressure generated self-activated call, ringer volume adjustments, pre-programmed Wi-Fi termination, enhanced device security. This is a new approach in which all these features are included in a single application in a device-centric rather than a human-centric way.

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