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Study of User Interfaces for Wireless Applications with Wearable Device

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Abstract

Mobile computing is beginning to break the chains that tie us to our desks, but many of today's mobile devices can still be a bit awkward to carry around. In the next age of computing, there will be an explosion of computer parts across our bodies, rather than across our desktops. In this paper, we present a design for wearable device, which communicates and stores personal information of your smart phone. The wearable device is controlled through a dedicated app for Android and iPhone smart phones and the Smartphone pairs with the wearable device using Bluetooth and it is set to vibrate and lights up when the Smartphone receives a call, text, email, or calendar alert and is also capable for data transmission through USB.

Keywords— Bluetooth, Wearable Computing, Call alert.

I. Introduction

To deploy computer and network services that users might travel requires prohibitive expensive in infrastructure and maintenance. Hoverer the alternative: wearable computers. By carrying their own infrastructure, users guaranteed a certain level of service wherever they go. In the modern century Mobile phones have become an essential in our lives. They are used frequently in many situations and places ranging from home, work, outdoor, partying, restaurants, etc .Besides such a widespread use of mobile phones, some unpleasant experiences are also associated with them. Almost everybody has experienced missing some important calls, or disturbing others by a very loud phone ring in an improper situation [1]. These unpleasant cases are usually due to the fact that the call alert functionality is not proper for the actual situation of mobile phone's user. If the call alert is in "vibration" mode, or too low volume ring, the user may not realize the call alert if he is in a noisy place such as a restaurant or party, or just walking in a crowded street. The user may decide then to increase the ring volume; however this does not solve the problem. Soon when he is back at work or a quiet place, the loud ring starts disturbing his colleagues! This visionary paper concentrates on how instead of one single device, eg: cell phones will be broken up into their components and packaged as various pieces of wearables. It seems that everything we access today is under lock and key. Even the devices we use are protected by passwords. It can frustrate trying to keep with all of the passwords and keys needed to access any computer program. The whole concept behind this paper is to communicating with your Smartphone by means of wireless appliances. The other key factor of this concept is to stay fashionable at the same time it's a ring that connects to your Smartphone via Bluetooth and alerts you to certain notifications. Controlling call alert functionality can be a case of such adaption or adjustment. For instance in ambient noise level is measured using embedded microphone in mobile device, and loudness of the noise is then estimated. The call alert functionality is then adjusted based on a reverse relation with loudness of ambient noise. However, the main practical drawback in such an approach using embedded microphone is capturing ambient audio. As the phone is usually carried in a pocket or bag, audio information captured by the mobile phone's microphone is not always a proper representative of the ambient audio. Here the is equipped with light emitting diode(LED) that flash to indicate an incoming alert from your Smartphone and also equipped with vibration motor that vibrates for every incoming alerts.

II. Related Work

This paper proposes to create a small form factor device which can be used as a wearable computing device as a companion to another internet powered device. The objective of this work is to understand the various challenges involved in the design, power management and embedded software aspects of the device and to demonstrate whether such a device is feasible or not for widespread adoption. The analysesof various embedded devices at their disposal as well as the research has been taken carefully on various peripheral which are available and have selected those peripherals which satisfy their need for the power budget, processor usage, form factor and ease of use. The design which uses LED a display for showing the output, a low power processor and LiPo battery for powering the device, Bluetooth has been used for communicating with the other devices and the ring uses Wireless Markup Language and has created a suite of application for thedevice like clock faces, alarm, image viewer, calendar, to do list and alerts. In the end the design of wearable device that has certain features to interact with your Smartphone and also presents data in timely fashion despite the various difficulties and problems associated with it. The design of wearable device makes less crosstalk, EMI and interference which delivers faster transmission between mobile and wearable device

III. .System Architecture

Smart Ring hardware platform is a redesign of conventionalrings that has embedded sensors surrounding its perimeterand a tiny micro-controller unit having wireless data communicationcapability. The platform enables continuous sensingof data and alert of your mobile. Figure 1 is anArchitecture of Smart Ring– showing the componentsand their placements on the ring.

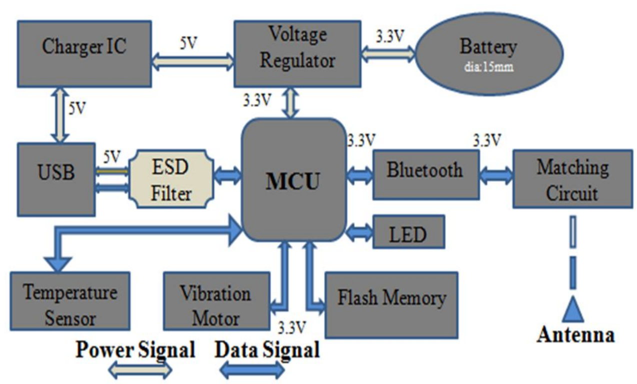

Figure 1: Hard Architecture of Smart Ring

- **Microcontroller:** The MSP430 CPU has a 16-bit RISC architecture that is highly transparent to the application. All operations, other than program-flow instructions, are performed as register operations in conjunction with seven addressing modes for source operand and four addressing modes for destination operand and the CPU is integrated with 16 registers that provide reduced instruction execution time. It has one active mode and six software selectable low-power modes of operation. An interrupt event can wake up the device from any of the low-power modes, service the request, and restore back to the low-power mode on return from the interrupt program, which is placed on the top of the ring. Micro-controller unit that operates all the components, processes sensing data to determine key events, and transmits the key information. The MCU is powered by a thin film battery and also powered through USB.

- **Bluetooth:** The transmitter is an all-digital, sigma-delta phase-locked loop (ADPLL) based with a digitally controlled oscillator at 2.4 GHz as the RF frequency clock. The transmitter directs modulate the digital PLL. The power amplifier is also digitally controlled. The transmitter uses the polar-modulation technique. While the phase-modulated control word is fed to the ADPLL, the amplitude-modulated controlled word is fed tote class-E amplifier to generate a Bluetooth standard-compliant RF signal and also offers classic support for audio and data applications requiring high throughput. Bluetooth LE chip is connected on top of the ring, which is used by the MCU to send key events wirelessly to the computing device.

- **Flash Memory:** AND Flash device is used to store the data up to 8GB, which interfaced with microcontroller using Serial Peripheral Interface. The NAND Flash memory array is programmed and read using page-based operations and is erased using block-based operations. During normal page operations, the data and cache registers act as a single register. During cache operations, the data and cache registers operate independently to increase data throughput.

- **Temperature Sensor:** Digital Temperature sensor is interfaced with microcontroller using I2C protocol which offers thermal management and thermal protection applications and also used to measure PCB temperature of the board location where the devices are mounted. The digital output from each temperature measurement conversion is stored in the read-only Temperature Register. The Temperature Register of the device is a 12-bit read-only register that stores the output of the most recent conversion. The first12 bits are used to indicate temperature with all the remaining bits equal to zero. The data format for temperature is listed in figure 2. Negative numbers are represented in binary twos complement format. Following power up or reset, the temperature register reads 0°C until the first conversion is complete.

TEMPERATURE (°C)	DIGITAL OUTPUT (BINARY)	HEX
128	0111 1111 1111	7FF
127.9375	0111 1111 1111	7FF
100	0110 0100 0000	640
80	0101 0000 0000	500
75	0100 1011 0000	4B0
50	0011 0010 0000	320
25	0001 1001 0000	190
0.25	0000 0000 0100	004
0	0000 0000 0000	000
–0.25	1111 1111 1100	FFC
–25	1110 0111 0000	E70
–55	1100 1001 0000	C90
–128	1000 0000 0000	800

Table 1: Temperature Data format

Shutdown Mode (SD): The Shutdown Mode of the temperature sensor devices allows the user to save maximum power by shutting down all device circuitry other than the serial interface, which reduces current consumption to less than 1µA. For the sensor devices, Shutdown Mode is enabled when the SD bit is 1. The device will shut down once the current conversion is completed. For SD equal to 0, the device will maintain continuous conversion and the device has additional features called a One-Shot Temperature Measurement Mode. When the device is in Shutdown Mode, writing 1 to the OS/ALERT bit will start a single temperature conversion. The device will return to the shutdown state at the completion of the single conversion. This is useful to reduce power consumption in the temperature sensor device and there is no need of continuous monitoring of temperature.

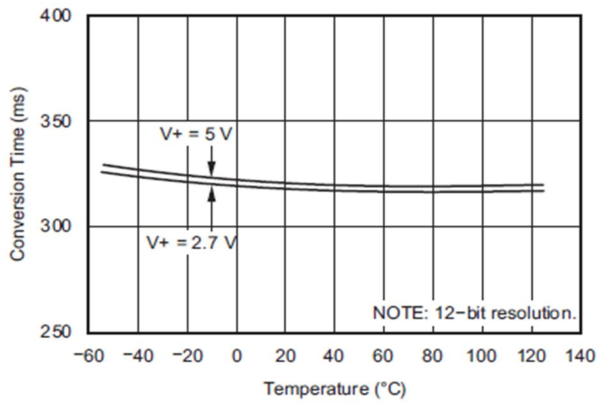

Figure 2: Conversion Time vs. Temperature

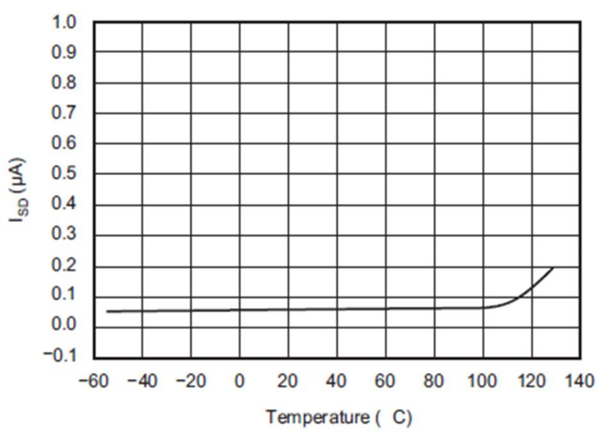

Figure 3: Shutdown Current vs. Temperature

- **Power:** The Smart Ring is powered from a 410 mAh battery in the bottom half of the band. To manage power consumption, the Smart Ring defines three modes of operation, each using more power than the previous while providing additional functionality. The Smart Ring moves between these different modes as necessary for the applications currently running. **Standby mode** is automatically entered when the Smart Ring loses contact with its network. In this mode, the sensors are completely powered down. The time between reassociation attempts is dynamically scaled such that the Smart Ring tries to reassociate frequently immediately after losing the network connection, but scales back to attempting every few minutes if multiple attempts fail. In Standby mode, the measured average current of e device draw is approximately 3.01mA. The Smart Ring can operate in standby mode for approximately 136 hours on a single charge. In **Active mode**, the environmental sensors are powered on every ten seconds and sampled. The resulting data are transmitted in a single packet via the wireless interface. In sensing mode, the low-power accelerometer is also enabled at a sample rate, with the CPU waking up every second to read the sensors. The integrated and average acceleration are transmitted and reset every ten seconds with the rest of the sensor data. This mode provides the sensor data necessary for applications such as personalized automatic and comfort control. In active mode, the measured current draw averages 186mA. The Smart Ring can operate in quiescent sensing mode for 2.25 hours on a single charge.

Module	Active Mode(mA)	Standby Mode(mA)
Microcontroller	4.95	0.0098
Temperature Sensor	16	0.5
Bluetooth	50	1
Vibration Motor	90	1.50
Flash Memory	25	0.01
Total	185.95	3.01

Table2: The current consumption of wearable device during active and standby mode

- **ESD Protection**: Electrical overstress is defined as damage to a product caused by exceeding data-sheet maximum ratings [10]. EOS usually leads to gross damage in an integrated circuit resulting from high-energy events such as electrostatic discharge, electromagnetic pulses, lightning, or reversal of power and ground pins. EOS failure mechanisms fall into the two broad categories of thermally induced failures and high electric-field failures. The duration of an EOS event may be anywhere from less than one nanosecond to one millisecond and longer. Long EOS events can lead to damage areas such as blown metal lines, cavities in the silicon, or discoloration of silicon due to local heating with a characteristic radius of 100µm or greater . This damage leads to either a reduction in IC performance or total circuit failure. In order to protect against this excess energy, a more robust design is required. System-level ESD protection can be implemented using discrete diodes or capacitors to act as a filter to protect system interconnects from external ESD strikes while maintaining signal integrity.

IV. System Design Implementation

The above figure represents design layout of wearable device in two layer PCB board in the dimension of 2.25mm x 0.75mm, which consist Microcontroller, Bluetooth, NAND Flash memory, Temperature Sensor and power management circuit etc.,

Printed circuit board design effort keeps growing as additional constraints such as rising clock frequencies, reduced area, increasing number of layers, mixed signal devices, and the ever increase in component numbers and densities. All of these factors combined have led to a steady rate of increase in development costs for the design. In this paper we analyzed and propose various statistics to estimate the layout effort required to develop PCBs. We quantify statistics such as area, placements of components, routing, space width between two traces and differential pair arrangement which reduces Electromagnetic Interference (EMI), internal noise, crosstalk, parasitic effect etc.,

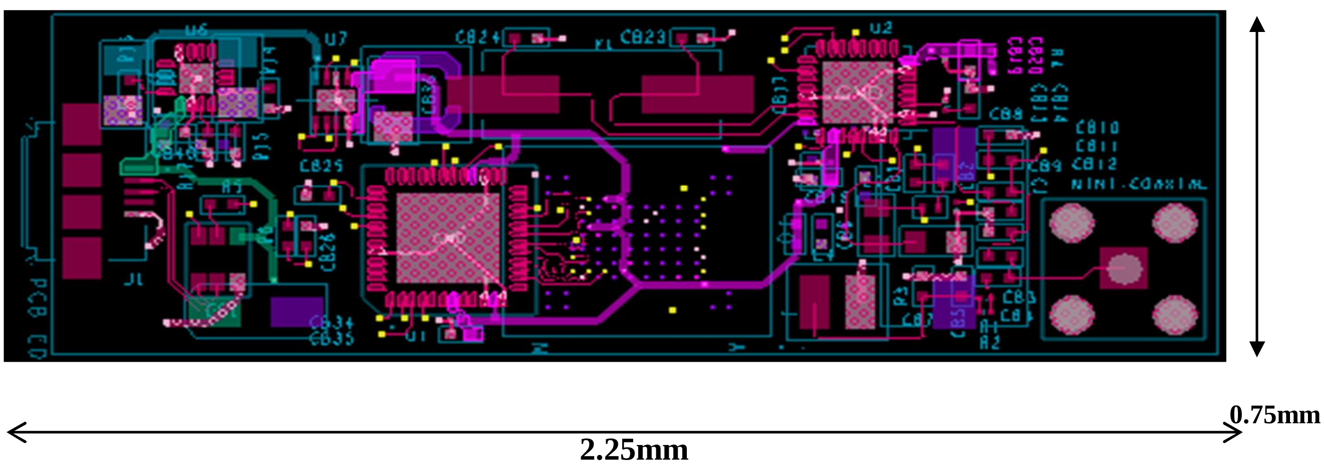

Figure 4: Design of Wearable Device in the dimension of 2.25 x 0.75mm

V. Future Work

Our wearable design prototype provides an excellent jumping-off point for future work. As a platform with unique affordances, there is an opportunity to develop additional interaction techniques. The design which is only capable of showing the notification of Smartphone's, so in near future we can implement call attending functions through your wearable ring without taking mobile from your packet. Another possible can be made by adding more features like adding a sensors, security, faster transmission rate and resolution to a wearable device that makes user friendly.

VI. Conclusion

Wearable technologies offer an exciting platform for new types of applications and have the potential to more tightly integrate computing within daily life. This paper describes the architecture, design and a platform for implementation of low power wearable device that enables wireless transmission at the rate of 1Mbps and capable of sensing the alerts of mobile at your finger tips. The device facilitates NAND Flash memory that can store up to 8GB and device is also has a facility of micro USB transmission. Our approach is inexpensive, potentially compact, and can complement existing inputs at reduced costs.

VII.References

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