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Embedded Processors for Wearable Applications

Introduction

Wearable smart devices are becoming increasingly common due to the combination of ubiquitous wireless communication, emerging cloud technology and affordable embedded processors. Many modern embedded processors are low power, allowing them to run for long periods of time without giving off excessive heat. This characteristic allows them to be worn comfortably. Modern processors are also available with built-in wireless modules, allowing easier prototyping capability. This paper compares the power, I/O, processing, memory, development platform and wireless communication specifications of two embedded processing modules, mDot and RFduino. The RFduino is listed for \$29.95 on Sparkfun's website, and the mDot, part number: MTDOT-915-X1P-SMA-1, is listed on Digikey for \$56.38.

Power and I/O

RFduino operates at slightly lower supply voltage, 2.1 to 3.6V, than mDot, 3.3 to 5V. It also draws significantly less current, 12mA maximum, than the mDot's 135mA maximum [1], [2]. This puts the maximum operating power of the RFduino at approximately 20mW and the maximum operating power of the mDot approximately 0.5W. The RFduino board comes with seven GPIO pins, six of which can be configured to be 6-bit analog inputs [3]. These pins can be configured as PWM, UART, SPI, and I2C, allowing for a variety of different sensor types to be interfaced with the module. The mDot module offers 16 digital I/O pins. Up to 11 of these can be programmed as analog inputs, and they can be configured as SPI, I2C, UART and USB.

Processing, Memory & Development

The mDot outperforms RFduino in terms of processing power. It has a clock frequency of 100MHz, 400kB of flash memory, and performs with floating point unit (FPU) single precision, whereas RFduino is clocked at 16MHz, has 128kB of flash memory [4]. Despite its much lower processing specifications, the RFduino has a cutting edge development platform called Simblee which sets it apart from its competitors. Simblee allows the user to create an interface in the Arduino programming language, which is a hybrid of C++, which shows up on a smart phone when the Simblee phone application is downloaded. This allows for application development without having to learn Android or iPhone specific coding languages. The mDot runs ARM's mbed OS and can be developed in C/C++ on

mbed's cloud compiler. However, to develop a project with a phone application it would be necessary to develop an Android or iPhone application using a different programming language.

Wireless Communication

Communication capability is the main functional difference between these two modules. mDot uses Long Range or LoRa modulation technology, and RFduino uses Bluetooth Low Energy or BLE. Each of these technologies have their own benefit. BLE operates in the 2.4GHz frequency band and has a higher throughput of 305kpbs, whereas LoRa operates in the 900MHz band only has a throughput ranging from .018 to 38.4 kbps [5]. This may be the most important discrepancy between the two modules when comparing them for use in a wearable technology. For applications where a sensor is continuously monitored, higher data rates will most likely be needed making BLE the clear favorite. BLE also has an adaptive frequency-hopping functionality which makes interference within the band less likely [6]. Both the 900MHz and 2.4GHz bands are classified as license-free ISM frequency bands, so unlicensed operation of these bands is typically permitted. This poses no barrier to development. LoRa has one major advantage: a much longer range. It has a range of anywhere from 2 to 20km, depending on the type of antenna, compared to just 280m for BLE [7]. For many wearable applications 280m should be enough distance needed to reach the receiving device.

Conclusions

For specialized long-range applications, the inclusion of LoRa may make the mDot the better choice. However for a higher percentage of applications the RFduino would be a better fit due to its higher throughput and decent signal range. The inclusion of the Simblee application also makes the RFduino attractive for those who aren't willing to take the time to learn more traditional iPhone or Android application development.

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