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Audio Jack Data Communication on Smartphones

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AUDIO JACK DATA COMMUNICATION ON ANDROID DEVICES

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ABSTRACT

Smartphones have several interfaces for data communication, USB, Wi-Fi and Bluetooth. They are relatively fast and efficient. However, most small sensor peripherals does not directly support those interfaces, a few of those which support those are pretty expensive. By creating this platform, devices like cubic-inch sensor peripherals may be supported by Android smartphones. Client devices harvest power and use bandwidth from the smartphone's audio jack interface. This platform enables a lot of small and cheap phone-centric sensor accessories which support plug-and-play operation. We are testing this platform on an Android 4.1 phone.
Based on frequency shift keying (FSK) modulation scheme, we have proposed a joint
power harvesting and communication technology that can simultaneously harvest power and transfer data with the same audio jack interface.
Keywords: Smartphone, Energy harvesting, Audio communications

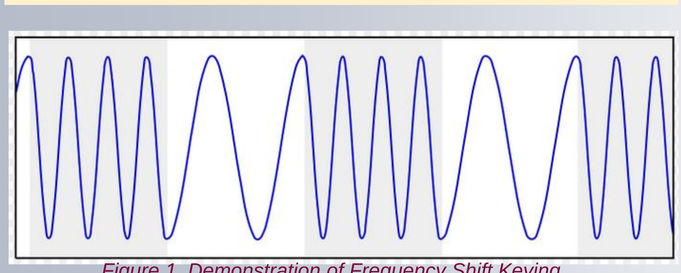

Figure 1. Demonstration of Frequency Shift Keying

INTRODUCTION

- Smartphone is the most commonly used personal electronic device, it's also a very powerful computing platform. Among many interfaces on the smartphone, only the audio port is universal. In this poster, I introduce an application that can transfer data and power simultaneously to a micro controller.

OBJECTIVE

- To make the smartphone a data communication device, the most affordable and commonly used interface is the audio port. We may connect low-power sensors directly to the audio port.
- In this case, the smartphone needs to do computing, communicating, and graphical user interacting.
- For the computing, nowadays mainstream smartphones are powerful enough to do those tasks.
- For the communicating, we are now using a micro controller to simulate the task which those low-power low-cost sensor do.
- Smartphones also have many built-in sensors like ambient light sensor, motion sensor, etc. We may use those including methods in the SDK to create user-friendly apps.

METHODS

Hardware
We selected ZTE N800 Android 4.1 smartphone for our research. It has Qualcomm Snapdragon S4 Pro Plus MSM8630 SoC, 1024 MB of RAM and 4 inch 480 by 800 display, which is well enough to perform all the tasks we need. On the other side, we use TI MSP430 to simulate our tasks.

Software Development Tool
We use official Android Developer Tools for Windows, Build: v22.3.0-887826 to develop all apps of smartphone.

Audio jack interface
The 3.5 mm audio jack interface the very common and widely used nowadays. Most personal electronic devices support this interface. The four rings are left channel, right channel, ground and mic.

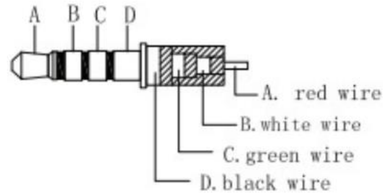

Figure 2. Structure of the 3.5mm audio jack interface

Software Flowchart
Two flowcharts are presented here, from both user's side and developer's side.

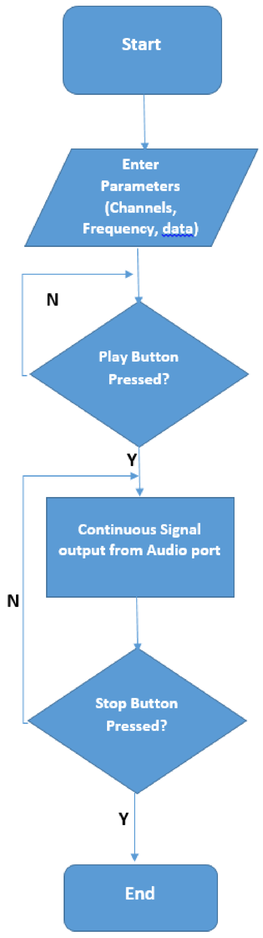

Figure 3. Flowchart of User interface

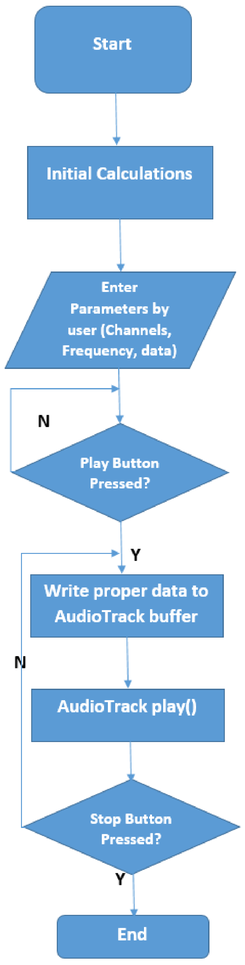

Figure 4. Flowchart of the app

RESULTS

Power harvesting results
In order to simultaneously harvest power and transfer data through audio jack interface, we have used the FSK scheme to modulate the data from the smartphone to the MSP430 microcontroller. More specifically, because not all smartphone can output a sinusoidal wave with a frequency higher than 20 kHz, we use 16 kHz to represent bit "1" and 20 kHz to represent bit "0".
Furthermore, to reduce the demodulation complexity in the microcontroller, the duration of the FSK symbol is set at about 2ms, which is equivalent to a data rate of 500 bit/s. This data rate is good enough for the data transfer from the smartphone to the Microcontroller. We also tested 1ms FSK symbol, which is equivalent to a data rate of 1K bit/s, the demodulation was successful as well.

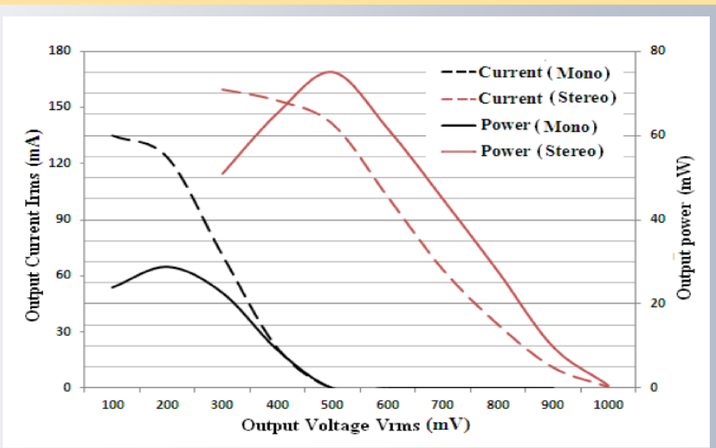

Figure 5. Output voltage, current, and power of the 3.5mm Audio jack interface, both mono and stereo channel configurations.

CONCLUSIONS

- Based on FSK modulation scheme, we have achieved a joint power harvesting and communication technology that can simultaneously harvest power and transfer data with the same audio jack interface.
- By setting the AC signals outputted by the right and left audio channels to have 180 degree phase difference, the newly proposed technology employs the stereo channel configuration to harvest power between the right and left audio channels at a certain data transfer rate.
- User is able to transfer any data they want from the smartphone, or sending power supporting signal only.

REFERENCES

[1] http://www.ti.com/tool/msp-fet430UIF
[2] https://developer.android.com/sdk/index.html?hl=i
[3] http://nanobionics.mntl.illinois.edu/mobosens/
[4] http://pdadb.net/index.php?m=specs&id=4982&c=zte_n800_awe