




# RESEARCH ON KEY DIGITAL MODULATION TECHNIQUES USING GNU RADIO

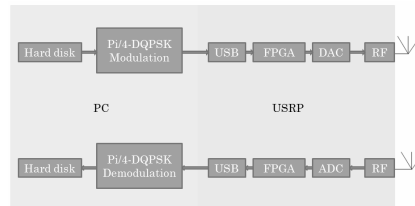
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## OUTLINE

- Objective
  - Experiment setup
  - Results
  - Discussion
  - Future work
  - Conclusion
  - References
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## OBJECTIVE

- Implement  $\pi/4$ -DQPSK to transmit a large amount of data

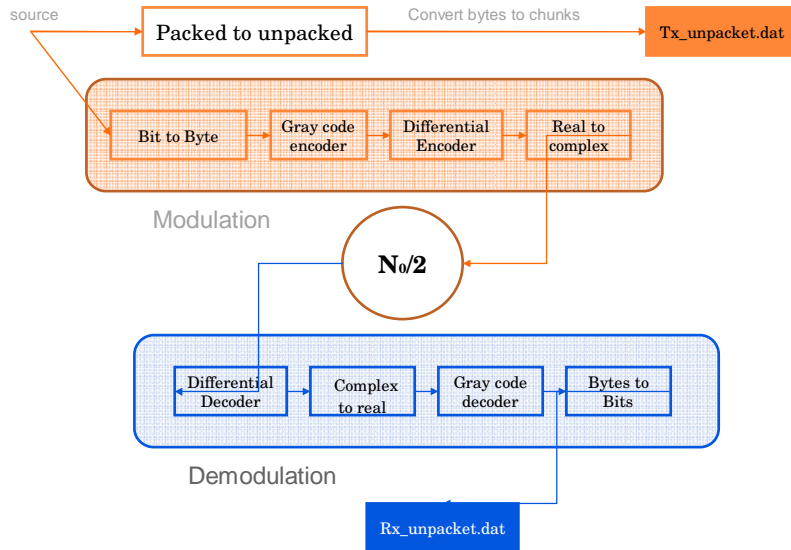


- Compare the performance of different modulation methods
    1. BER
    2. Spectrum
- DBPSK      DQPSK       $\pi/4$ -DQPSK

## EXPERIMENT SETUP

- Implement  $\pi/4$ -DQPSK
  - 00  $\pi/4$     01  $3\pi/4$     11  $5\pi/4$     10  $7\pi/4$
  - 1, pi/4-DQPSK.py was created based on DQPSK.py
  - 2, a new file odd\_psk.py was created to gray code the transmitted vector.
  - e.g. (0 1 2 3 3 2) corresponds to (1 3 7 5 5 7)
  - 3, 8psk constellation map was used for mapping.
  - 4, at the receiver, the input sequence was mapped to the constellation point using a single 8psk constellation map.

# BER



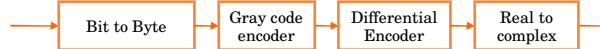
# BER

## ○ Source

- source was derived from a .wav audio file which was type converted to an integer
- vector.

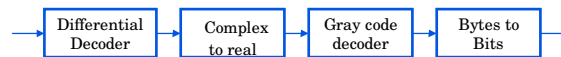


## ○ Sender



## BER

- Channel
  - Performance Analysis under AWGN Channel is necessary for AWGN is ubiquitous.



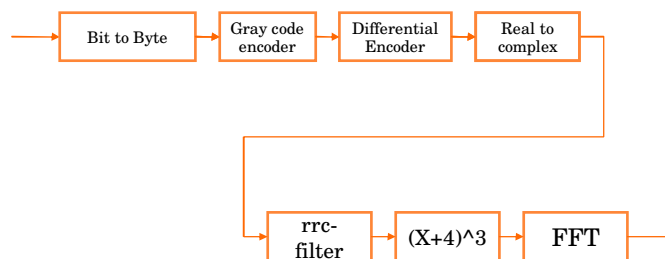
- Receiver

There is a unpacked to packed block following Bytes to Bits block to restore the original interger.

The output file named out\_int.wav can be played by 1<sup>st</sup> sound card.

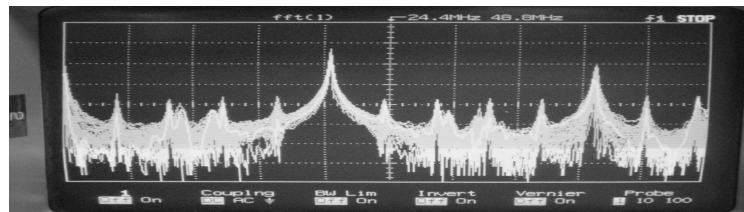
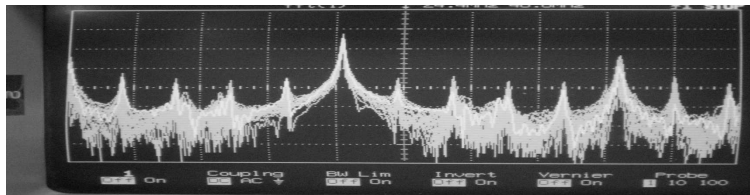
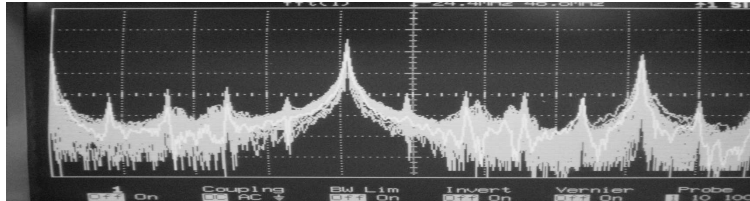
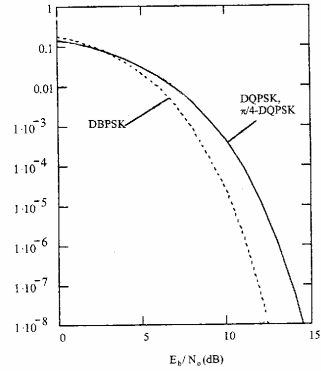
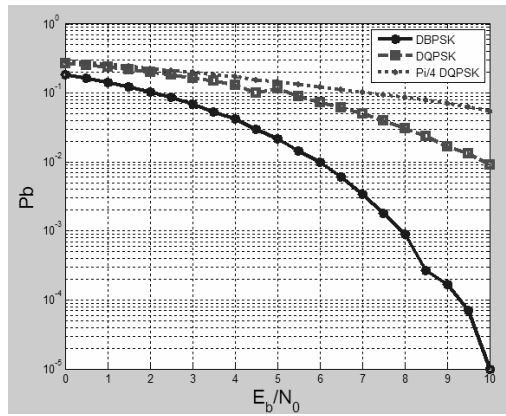


## Spectrum



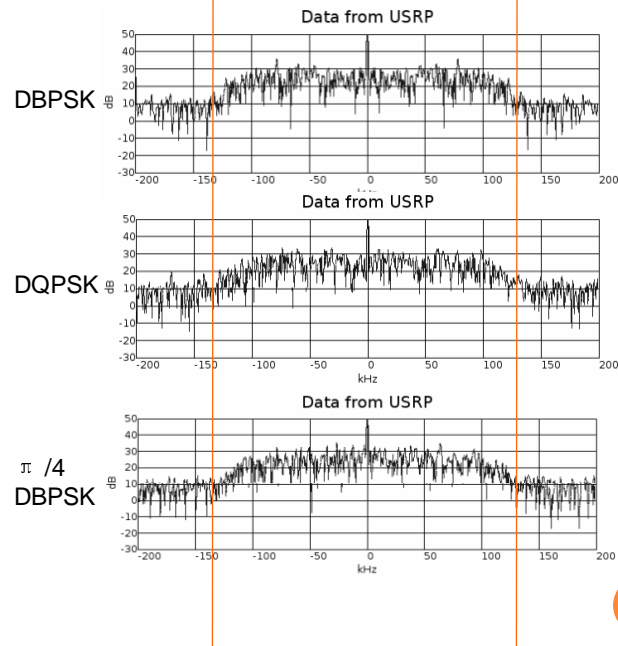
# RESULTS

## o BER



## RESULTS

### ○ Spectrum



## DISCUSSION

### ○ BER

- The BER charts for DBPSK and DQPSK are acceptable, while the chart for  $\pi/4$ -DQPSK deviates from the theoretical value.
- The main reason for this is that 8psk constellation was used as the decision device leading to smaller distance among those constellation points, which is suboptimal. For optimal receiver, two signal constellation should be used alternately from odd numbered symbol to even numbered symbol. This could be done by optimizing function: `gr.constellation_decoder_cb`.
- Spectrum
- The spectrum of  $\pi/4$  should be better than the others, but I cannot figure out why they looked same.

## FUTURE WORK

- 1, change pi/4 receiver to be optimal receiver.
- 2, transmit an audio file through two usrp daughter boards.
- 3, compare the quality of sound received from the Rx board and that got through computer simulation.



## CONCLUSION

- In this project, the concept of software radio was introduced with USRP as its hardware support and Python as its development tool.
- Then, we simulated a communication system with GNURadio Software and analyzed the BER performance of 3 digital modulation techniques, within which Pi/4-DQPSK had been implemented. We also tried to test their spectrum efficiency using FFT and Oscilloscope.
- At last, an audio recorder and an audio player were implemented so as to let you feel how White Gaussian Noise affects the quality of sound.



## REFERENCE

- 1 [http://en.wikipedia.org/wiki/Phase-shift\\_keying](http://en.wikipedia.org/wiki/Phase-shift_keying)
- 2 <http://www.wu.ece.ufl.edu/projects/softwareRadio/#Project%20paper>
- 3 <http://www.gnu.org/software/gnuradio/>
- 4 <http://www.nd.edu/~jnl/sdr/docs/>
- 5 <http://gnuradio.org/trac/wiki/UbuntuInstall>
- 6 Wireless Communication and Networking, Weihua Zhuang 2003
- 7 Digital Modulation Techniques (654 pages), Artech House, Boston/London, Fuqin Xiong. 2000
- 8 <http://www.swaroopch.com/byteofpython/>
- 9 DQPSK Format for Serial PHY, Marcus Duelk, Peter Winzer, 2006



END

- Questions?

THANK YOU !

