**Unit-IV: Signal Processing in wireless systems**

Session -1 **Diversity technique**

Introduction :Diversity

Presentation by slides:

Activity: Role play

Call upon a 6 number of students.Divide them into two equal groups.First group act as transmitter and second group act as receiver.Instruct the transmitter group to pronounce a word like “wireless communication” simultaneously.Now ask the receiver group that whether they received correctly or not.Best voice is clearly reaches the receiver group.It indicates the principle of diversity.

* **Diversity** Principle,Micro diversity, Spatial Diversity

Temporal Diversity: Through Roll play it can be explained easily.Transmitter group has to pronounce the word like “diversity technique’ one by one. Now ask the receiver group that whether they received correctly or not.Best voice is clearly reaches the receiver group.It indicates the principle of time diversity.

Presentation by slides<http://freepdfdb.org/ppt/equalization-diversity-and-channel-coding-17384050.html>

* <http://www.eecs.berkeley.edu/~dtse/Chapters_PDF/Fundamentals_Wireless_Communication_chapter5.pdf> diversity

Conclusion : Quiz by Buzz round1.Principle of diversity

* Question and answer:
* 1. What are the techniques used to improve the received signal quality?
* Equalization, diversity and channel coding.

2. Write the function of diversity.

Diversity is used to compensate for fading channel impairments, and is usually implemented by using two or more receiving antennas.Diversity improves transmission performance by making use of more than one independently faded version of the transmitted signal.

3. Define spatial diversity?

The most common diversity technique is called spatial diversity, whereby multiple antennas are strategically spaced and connected to a common receiving system. While one antenna sees s signal null, one of the other antennas may see a signal peak, and the receiver is able to select the antenna with the best signals at any time.

**Session -2**

Recap: :Diversity

**Presentation by slides**: Frequency Diversity,Angle Diversity and Polarization Diversity

* <http://djw.cs.washington.edu/papers/mimo_for_dummies.pdf> journal
* <http://www.ll.mit.edu/publications/journal/pdf/vol15_no1/15_1mimo.pdf> book

Activity: Role play

Call upon a 6 number of students.Divide them into two equal groups.First group act as transmitter and second group act as receiver.Instruct the transmitter group to pronounce a word with different pitch level like “Digital communication” simultaneously.Now ask the receiver group that whether they received correctly or not.Best voice is clearly reaches the receiver group.It indicates the principle of frequency diversity.

Conclusion: Recall by keywords

1.Principle of frequency diversity

2.Concept of angle diversity

3define polarization diversity.

4.Applications of each diversity.

**Session-3 Macro diversity ,Signal combining techniques**

Activity: Switched Diversity, Combining Diversity

“See and Identify” Presentation slides Through block diagram differentiation identify the technique.

* <http://www.eecs.berkeley.edu/~dtse/Chapters_PDF/Fundamentals_Wireless_Communication_chapter5.pdf>diversity

G. L. Stuber, *Principles of Mobile Communications, 2nd Ed.* Kluwer Academic Publishers , 2001.

wides.usc.edu/teaching/textbook

Conclusion: Learner led presentation

Divide the students into 4 groups.Instruct them to prepare questions and answer about Macrodiversity ,Signal combining techniques. Let them interact with each group.

**Session -4 Transmit Diversity**

Introduction :Transmit diversity

presentation by slides

* [**http://freepdfdb.org/ppt/equalization-diversity-and-channel-coding-17384050.html**](http://freepdfdb.org/ppt/equalization-diversity-and-channel-coding-17384050.html)

Conclusion: Recall by keyword

Transmitter Diversity

- Transmitter Diversity with Channel State Information

- Transmitter Diversity with0ut Channel State Information

**Session -5 Linear Equalizers**

**Introduction: Equalizers**

* Presentation by slides: **Linear Equalizers**
* [**ftp://ftp.esat.kuleuven.ac.be/sista/moonen/reports/lecture5.ppt**](ftp://ftp.esat.kuleuven.ac.be/sista/moonen/reports/lecture5.ppt) **equalizer**
* [**http://wireless.ece.ufl.edu/twong/Notes/Comm/ch4.pdf**](http://wireless.ece.ufl.edu/twong/Notes/Comm/ch4.pdf) **ISI**
* [**ftp://idc18.seu.edu.cn/Pub2/EBooks/Books\_from\_EngnetBase/pdf/2167/05.pdf**](ftp://idc18.seu.edu.cn/Pub2/EBooks/Books_from_EngnetBase/pdf/2167/05.pdf)**PRoakis book for equaliser**
* [*www.wiley.com/go/molisch*](http://www.wiley.com/go/molisch)
* Zero-Forcing Equalizer

Conclusion by Rapid fire

**1.** What is the need of equalization?

Equalization can be used to compensate the inter symbol interference (ISI) created by multipath within time dispersion channel.

2. What is equalizer?

The device which equalizes the dispersive effect of a channel is referred to as anequalizer.

3. Define adaptive equalizer.

To combat ISI, the equalizer coefficient should change according to the channelstatus so as to track the channel variations. Such an equalizer is called an adaptive equalizer since it adapts to the channel variations.

4. Write the major classifications of equalizers

**Linear equalizers**: If the output d(t) is not used in the feedback path to adapt the equalizer. This type of equalizers is called linear equalizer.

**Non-linear equalizers**: If the output d(t) is feedback to change the subsequentoutputs of the equalizer.

5. Write the advantages of lattice equalizer.

(i) It is simplest and easily available. (ii) Numerical stability.

(iii) Faster convergence. (iv) When the channel becomes more time dispersive, the length of theequalizer can be increased by the algorithm without stopping the operation.

(v) Unique structure of the lattice filter allows the dynamic assignment.

**Recap by key words**

* Presentation by slides
* **www2.egr.uh.edu/~zhan2/ECE4371/ECE4371\_class14.ppt zero forcing equalizer**
* [**https://www.cresis.ku.edu/~rvc/documents/862/862\_eqproject.pdf**](https://www.cresis.ku.edu/~rvc/documents/862/862_eqproject.pdf) **MMSE equalizer**
* [**http://www.ece.gatech.edu/research/labs/sarl/tutorials/ECE4606/27-Equalization.pdf**](http://www.ece.gatech.edu/research/labs/sarl/tutorials/ECE4606/27-Equalization.pdf) **equalizer ppt**
* Conclusion: questions and answer

1. Write the expression for MMSE of DFE.

The minimum mean square error of DFE is given by

2



A DFE has significantly smaller minimum MSE than an LTE.

2. What are the factors used in adaptive algorithms?

(i) Rate of convergence (ii) Misadjustment (iii) Computational complexity (iv) Numerical properties

**Session -6 Decision Feedback Equalizers**

Recall by keywords

* Linear
* Non-linear
* MMSE
* Zero forcing
* Presentation by slides
* [**http://pdf.aminer.org/000/275/666/adaptive\_transversal\_filters\_for\_multipath\_compensation\_in\_microwave\_digital\_radio.pdf**](http://pdf.aminer.org/000/275/666/adaptive_transversal_filters_for_multipath_compensation_in_microwave_digital_radio.pdf) **adaptive equalizer**
* [**http://www.wahyul.community.undip.ac.id/files/2010/07/ADAPTIVE-EQUALIZERS.pdf**](http://www.wahyul.community.undip.ac.id/files/2010/07/ADAPTIVE-EQUALIZERS.pdf) **adaptive journal**

**Conclusion by Questions and answers:**

1. Write the basic algorithms used for adaptive equalizations.

(i) Zero forcing (ZF) algorithm. (ii) Least mean squares (LMS) algorithm.

(iii) Recursive least square(RLS) algorithm.

2. Write the advantages of LMS algorithm.

(i) The LMS equalizer maximizes the signal to distortion at its output within the constraints of the equalizer filter length. (ii) Low computational complexity and (iii) Simple program.

3. What are the factors used in adaptive algorithms?

(i) Rate of convergence (ii) Misadjustment (iii) Computational complexity (iv) Numerical properties

4. What are the non-linear equalization methods are used?

Three very effective non-linear methods are used in most 2G and 3G systems.

(i) Decision feedback equalization(DFE) (ii) Maximum likelihood sequence estimation(MLSE)

(iii) Maximum likelihood symbol detection.

5. Define adaptive equalizer.

To combat ISI, the equalizer coefficient should change according to the channel status so as to track the channel variations. Such an equalizer is called an adaptive equalizer since it adapts to the channel variations.

Session -7 **Channel coding**

Recap: Source Coding methods

Activity:Asking questions

1. What is source coding?
2. List the various types of source coding.
3. Salient features of source coding

* Presentation : Block code and convolutional code

Board activity

Presentation: [*www.wiley.com/go/molisch*](http://www.wiley.com/go/molisch)

* [**http://www.slideshare.net/mansri123/linear-block-code**](http://www.slideshare.net/mansri123/linear-block-code)
* [**http://www.strongsec.com/zhw/EEC\_4.pdf**](http://www.strongsec.com/zhw/EEC_4.pdf)
* **ce.sharif.edu/.../Chapter%208%20-%20Code%20Generation.ppt**

**Conclusion :**Rapid fire

* .Define block codes
* Define convolutional codes
* Hamming distance
* Minimum distance
* Euclidean distance
* Cyclic codes

**Session -8 Channel coding**

* Recap by key words
* block codes
* convolutional codes
* Hamming distance
* Minimum distance
* Euclidean distance
* Cyclic codes

Presentation by slides:Turbo codes , LDPC codes and TCM codes

* [**http://shannon.cm.nctu.edu.tw/comtheory/chap10-1to10-7.pdf**](http://shannon.cm.nctu.edu.tw/comtheory/chap10-1to10-7.pdf)**all CODES**
* [**www.csee.wvu.edu/~mvalenti/documents/TurboLDPCTutorial.ppt**](http://www.csee.wvu.edu/~mvalenti/documents/TurboLDPCTutorial.ppt) **TURBO**
* **orion.math.iastate.edu/linglong/Math690F04/HammingCodes.ppt HAMMING**
* **cmrr-star.ucsd.edu/psiegel/pubs/07/ldpc\_tutorial.pptLDPC**
* [**www.comlab.hut.fi/studies/3320/3320%20cyclic%20codes.ppt**](http://www.comlab.hut.fi/studies/3320/3320%20cyclic%20codes.ppt) **CYCLIC CODE**
* [**http://shannon.cm.nctu.edu.tw/comtheory/chap10-1to10-7.pdf**](http://shannon.cm.nctu.edu.tw/comtheory/chap10-1to10-7.pdf) **ERROR CORRECT CODE**

Conclusion: Recall by keywords

* + Turbo codes
  + TCM
  + LDPC codes

**Session -9 speech coding**

* Introduction : Speech coders

Presentation by slides: <http://www.scribd.com/doc/77544748/LPC>

<http://www.mirlabs.org/nagpur/paper16.pdf> journal

<http://eeweb.poly.edu/~yao/EE3414/speech_coding.pdf>

<http://www.lsv.uni-saarland.de/Vorlesung/Digital_Signal_Processing/Summer06/dsp06_chap12.pdf>

Conclusion:Recall by keywords

1. Define Encoder.

The analog-to-digital converter, located on the transmitter, is also known as theencoder or simply coder.

2. What is Decoder?

The digital-to-analog converter, located in the receiver is known as the decoder.

3. Define CODEC.

The word CODEC is derived from coder/decoder.Coder (or) encoder = analog-to-digital converter.Decoder = digital –to-analog converter Simply it is the combination of coder and decoder.

4. What are the major classifications of speech coders?

a) Waveform coders b) Vocoders(Voice Coder)

5. Define waveform coders.

Waveform coders essentially used to reproduce the time waveform of the speech signal as closely as possible. They are designed to be source independent and can hence code equally well a variety of signal.

6. Define vocoders.

Vocoders is a circuit used for digitizing voice at a low data rate by using knowledge of the way in which voice sounds are produced. A vocoder is an example of lossy compression applied to human speech.

7. What are the types of speech signals available?

a) Voiced b) Unvoiced.Voiced sound: (“m”,”n”,”v” pronunciations) are a result of quasiperiodic vibrations of The vocal chord.

Unvoiced: (“f”,”s”,”sh” pronunciations) are fricatives produced by turbulent air flow through a constriction.

8. Write the vocoders parameters.

The parameters associated with vocoders are the voice pitch, the pole frequencies of the modulating filter, and the corresponding amplitude parameters.

9. Give the advantages of vocoders.

a) It achieves very high economy in transmission bit rate. b) Less robust.

10. What are the types of vocoders available?

a) Linear predictive coder (LPC) b) Channel vocoders c) Formant vocoders d) Cepstrumvocoders and e) Voice-excided vocoders.

11. What is LPC vocoder?

Linear predictive coders (LPCs) are belongs to the time domain class of vocoders.Thisvocoders attempt to extract the significant features of speech from the time wave form,this is a low bit rate vocoders.

12. Write the applications of CELP.

(i) Advanced DSP and VLSI technology, real-time implementation of CELP codec’s are possible.

(ii) The CDMA digital cellular standard (IS-95) proposed by QUALCOMM uses a variable rate CELP codec at 1.2 to 14.4 kbps.

13. Mention the advantages of CELP?

(i) CELP can provide high quality even when the excitation is coded at only 0.25 bits per sample.

(ii) These coders can achieve transmission bit rates as low as 4.8kbps.

14. What are the factors, we are considering to select speech codec’s for mobile communications?

Factors must be considered are

(a) Compression (b) Overall system cost (c) Capacity (d) End-to-end delay (e) The algorithmic complexity of the coder

(f) The dc power requirements (g) Compatibility with existing standards and (h) Robustness of the encoded speech to transmission errors.