A Quantitative Analysis on the Comparative Study of various Error Correction Techniques

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***Abstract*— With the ever increasing pace of growth of the wireless communication industry, coping with transmission errors is becoming substantially important. The channel noise, fading, attenuation and interference caused in a transmission media impediments the quality of data that is being transmitted through it hence posing challenges for reliable data communication. In this paper, I wish to compare some of the major techniques of forward error correction using Block codes, Turbo codes, Cyclic codes, Reed – Solomon Codes and Convolutional codes. Some novel error correction techniques will also be studied and compared against the other techniques in literature. Quantitative analysis will be done by implementing the channel encoder and decoder in Matlab and performance will be quantified based on the response of the implemented systems for different Bit error rates and channel error models like the random error and the and burst error model. Bit correction at the decoder will be done by detecting the erroneous position followed by bit inversion and characteristics of input versus output BERs will be plotted for various different schemes.**

***Index Terms*— Block Codes, Burst Error model, Convolutional code, Cyclic code, Random Error model, Reed-Solomon code, Turbo code.**

I. Introduction

WIRELESS Communication has evolved prominently over the years and with the modern wireless communication techniques, the world is becoming a smaller place to live in. These communication systems are easy to setup, configure and install and provide mobility at a low cost. But since nothing comes for free, it is characterized by high bit error rates which can be brought about by random processes in the nature like noise, quantization errors, attenuation, bit synchronization errors, interference with other signals and distortion. Inspite of these factors which act as deterrents to the data quality, it is crucial to have error correction schemes in place for certain kinds of communication which have stringent reliability and quality requirements. This project aims at analyzing the different error correction schemes that exist in the literature, some of which could just be lying in the dusty library shelves while others are very extensively used in present day communication systems. Through this work, I intend to quantitatively decide the kind of error coding technique that will suit different kinds of wireless communication applications. This proposal report has been organized as follows. Section II marks out the flow of work that is to be followed, while the timeline, resources and man-hours related to this project is discussed in Section III and IV.

II. Project Plan

It is often very tempting to start working on a particular project in the initial stages without thinking much about the aftermaths, outcomes and results that ought to be obtained. But, a proper planning of the flow of work is critical in achieving success in a project. So project planning is a really fundamental step which should be done even before starting to work on it. I have formulated a plan to keep myself organized and also to make sure that even if I have to digress a little bit from the initial plan, it does not hamper the progress that I am making.

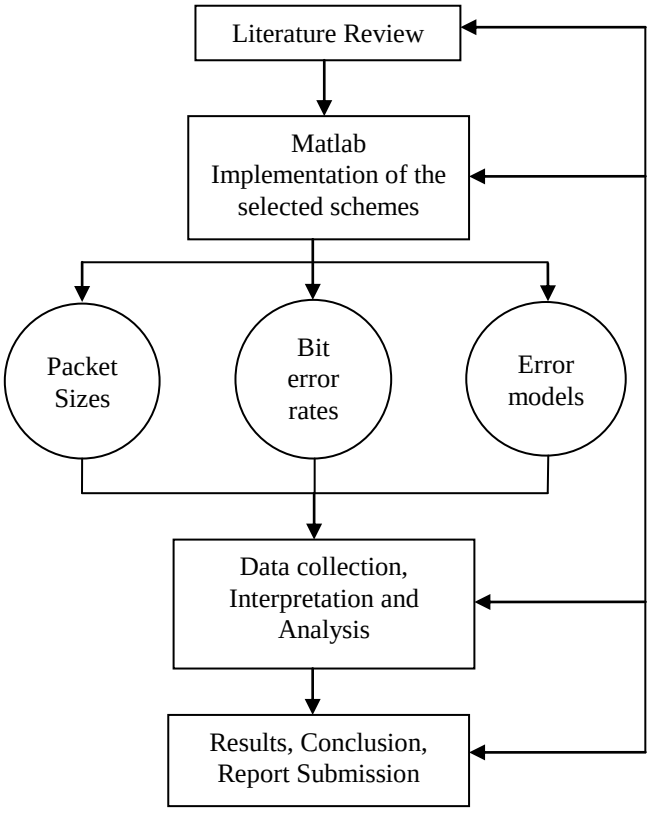

Fig.1. A flow chart depicting the flow of work to be followed

The project will be implemented as per the flow chart shown in Fig 1. Each stage block will be tied up with a milestone that is expected to be achieved. These milestones are discussed briefly. The simple yet effective feedback loops in the flow are to ensure verification during implementation.

A. Milestone 1: Literature Review

This milestone is for knowledge accumulation of various different error correction techniques like convolutional code,

group code, hamming code, Golay code, Reed-Solomoon code, Reed- Muller code, BCH code, AN code and Turbo code. Once a lucid understanding of these coding techniques is achieved, a decision will be made on the chosen codes to be implemented in Matlab.

B. Milestone 2: Matlab Implementation

Once the coding techniques to be analyzed are decided in the Literature review phase, the encoder and decoder for the same will be implemented in Matlab. This encoder and decoder will be tested for different testcases like error rates, channel error models and packet sizes and data will be collected for analysis.

C. Milestone 3: Data Interpretation and Analysis

The data collected after running the different testcases in Matlab will be quantified by plotting different graphs. It's a bit difficult to decide at present the graphs that will give a better picture of the code performance but some graphs which can be plotted to compare the coding schemes are Input BER vs Output BER, percentage of successfully decoded packets vs BER and comparison bar charts for comparison among the error correction techniques.

D. Milestone 4: Results Discussion and Conclusion

This is milestone is for summarizing results and drawing conclusions. The findings will be narrated in the results section and the results will be interpreted in the discussions section. Limitations of the coding schemes, if any, will be pointed out and finally all the findings will be summarized.

III. PROJECT SCHEDULE

The implementation of this project work has to be completed in a little less than 7 weeks. This calls for a proper scheduling to meet the requirements and quality goals within the assigned duration. I have divided the entire project into 10 phases and tried to allot a certain amount of time to each of these phases based on an educated estimate and my past experience with doing course projects. The Project work begins in work week 12 and will carried out through the end of the semester. Each of these phases will be linked up with certain milestones which are discussed in Section II.

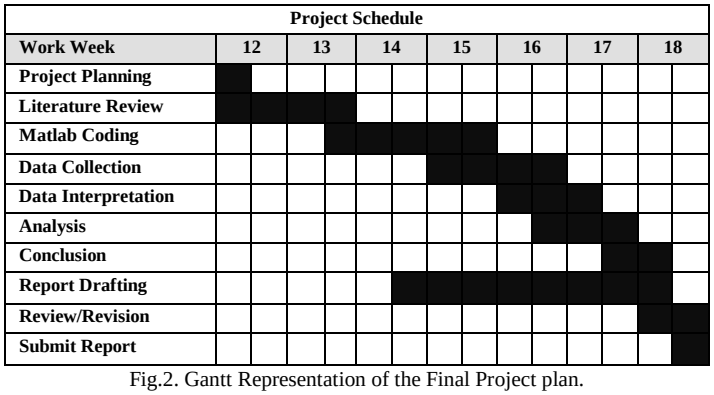

Fig.2. Gantt Representation of the Final Project plan.

I wish to emphasize that the Gantt chart shown in Fig 2 is just a representation of the timeline for the final project and the actual work may deviate from this plan, hence giving me the flexibility to adapt to circumstances. The work weeks shown in the Gantt chart are subdivided into two parts, just to have a better time breakdown in the chart. While other tasks may have dependencies, it can very well be noticed that there are some tasks which can be done in parallel to others, like report drafting, which saves time at crucial stages when the project will be close to completion. The idea is to successfully complete the project through proper planning and time management.

Task Duration Estimate (in hours)			
Task	**Optimistic**	**Realistic**	**Pessimistic**
Project Planning	3	5	8
Literature Review	12	15	20
Matlab Coding	20	30	40
Data Collection	5	10	15
Data Interpretation	8	12	15
Analysis	8	12	15
Conclusion	1	2	3
Report Drafting	8	10	15
Review/Revision	2	3	4
Submit Report	0	0	0
Total	67	99	135

Table I. Task Duration Estimates

Once the final project report is ready, foils will be prepared and a video tutorial will be recorded explaining the work that is done which will aid a better understanding at listeners' end.

REFERENCES

[1] Jatinder Singh and Jaget Singh, "A Comparative study of Error Detection And Correction Coding Techniques" in *2012 Second International Conference on Advanced Computing & Communication Technologies.*

[2] Wikipedia, "Forward Error Correction Techniques", Available: http://en.wikipedia.org/wiki/Forward_error_correction

[3] Zheng Yuan and Xinchen Zhao "Introduction of Forward Error Correction and its Application" *International School, Beijing University of Posts and Telecommunications.*

[4] Kamran Azadet and Mark Yu "Forward Error Correction (FEC) techniques for optical communications" *IEEE 802.3 High-Speed Study Group Plenary meeting, Montreal July 1999*.

[5] Ufuk DEMIR and Ozlem AKTA "Raptor versus Reed Solomon Forward Error Correction Codes" in *Proceedings of the Seventh IEEE International Symposium on Computer Networks (ISCN'06).*

[6] *Essentials of Error Control Coding,* John Wiley and Sons Ltd., Jorge Castiñeira Moreira and Patrick Guy Farrell, 2006.

[7] Aoife Moloney, "Channel Coding Lectures Notes". School of Electronics and Communications Dublin Institute of Technology.

[8] T. S. Rappaport, "Wireless Communications: Principles and Practice", Second Edition, 2002.

[9] J. G. Proakis, "Digital Communications", Fourth Edition, 2001.