Term Paper Proposal:

Cooperative Strategies and Capacity Theorems for Relay Networks

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1. **Topic Importance:**

The topic of relay networks is a very hot area of research in these days. The relaying concept can be defined as the process when a node (relay) receives a signal from other node (source) and then transmits it to a third one (destination) [1]. This technique occupies its importance from various sides: when two nodes are communicating and their channel goes in a deep fade, the relay node will provide the system with a different better link to continue communicating. Also, using this technique in wireless systems provides spatial diversity [2]. This is achieved when the relay node works as an additional antenna for the source node. By this way, the problem of having multiple antennas on the same mobile station is solved. Another advantage for relaying networks is that they increase the coverage area without the need for high power transmitters.

2. **Problem Identification:**

In this work or study, we will present some relaying techniques or strategies used in the wireless networks and cellular system [3]. These techniques were originally proposed by authors in [4]. The first one is the decode-and-forward (DAF) and the second is the compress-and-forward strategy [5]. Various theorems for the capacity and rates of such networks will be analyzed. Also, the study presents different models of channels used in such wireless systems, like the broadcast relay channels (BRCs) and the multi-access relay channels (MARCs). For the first strategy, its main types will be shown and explained: irregular encoding/successive decoding, regular encoding/sliding-window decoding, and regular encoding/backward decoding. The second strategy will also be analyzed with some mixed strategies. As an example, the following Figure shows two simple configurations for relay networks.

![Figure 1: Simple schemes of relay networks: (a) 1-node relay network; (b) 2-relay node network.](image-url)
3. **Methodology:**

The paper under study is very rich in theorems and analysis of relay networks from the side of information theory. The studying of this paper will start by introducing the model of the relay network and reviewing the basic bound of capacity for such networks. Then, we present the two types of channels that are analyzed in this study which are the MARC and the BRC models. After that, we go to the main strategies used in relaying process: the DAF and the CAF. Make full analysis for them and introduce their main configurations and relations. If the time permits, we may go deep for some scenarios such as: the effect of fading, number of antennas, and the number of hops in relaying networks.

4. **Expected Results:**

After finishing this study, the following points are expected to be understood:

- The concept of relay network and its importance and applications in wireless networks and cellular systems.
- The different models of relay networks and channels.
- The capacity bounds and some important relations regarding the relay networks in information theory field.
- The two main strategies of relaying, the DAF and the CAF and all the analyses regarding them in relay networks.
- If the time permits, other topics and issues may be introduced such as, the effect of fading, number of antennas, number of relays on the role and behavior of the relay networks will be proposed.
5. **References:**


