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Rate Adaptation for Time Varying Channels Using Distributed Relay Selection

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Abstract: **Fixed systems used in cooperative communication suffer from multiplexing loss and low spectral efficiency due to the half duplex constraint of relays. To improve the multiplexing gain, successive relaying is proposed. This allows concurrent transmission of the source and relays. However, the severe inter-relay interference becomes a key challenge. Here Rate Adaptation for Time Varying Channels Using Distributed Relay Selection is proposed, which is capable of adapting the relay's rate using distributed relay selection.**

Keywords: **Adaptive Modulation and Coding, Distributed Relay Selection, Rate less Coding.**

I. INTRODUCTION

Space diversity have wide range of advantages in the field of communication, and as one kind of space diversity techniques, multiple input–multiple output (MIMO) has been incorporated into recent wireless standards. The basic idea is that single-antenna mobiles in a multi-user scenario can share their antennas in a manner that creates a virtual MIMO system. Several important milestones in this area have been achieved, leading to a flurry of further research activity. The mobile wireless channel suffers from fading, meaning that the signal attenuation can vary significantly over the course of a given transmission. Transmitting independent copies of the signal generates diversity and can effectively combat the deleterious effects of fading. In particular, spatial diversity is generated by transmitting signals from different locations, thus allowing independently faded versions of the signal at the receiver. Cooperative communication generates this diversity in a new and interesting way. Cooperative wireless communication concerned with a wireless network, of the cellular or ad hoc variety, where the wireless agents, which we call users, may increase their effective quality of service via cooperation. Since it is difficult to equip handheld devices with multiple antennas due to size, cost, or hardware limitations, the concept of cooperative relaying has been proposed to generate a virtual antenna array. The basic idea of cooperative relaying in wireless networks is that some nodes that overheard the information transmitted from the source node relay it to the destination node instead of treating it as interference. Since the destination node receives multiple independently faded copies of the transmitted information from the source node and relay nodes, cooperative diversity is achieved. Recently, cooperative relaying has been considered as a promising technique and has been involved in the standard of IEEE 802.16j and expected to be integrated in Third- Generation Partnership Project Long-Term Evolution multi hop cellular networks. Relaying could be implemented using an amplify-and-forward, decode-and-forward (DF), or distributed space-time-coded (STC) scheme. In the STC scheme, the unfixed number of participating antennas and the synchronization difficulties make it a challenging scheme for implementation

II. RELATED WORK

Channel aware ordered successive relaying CAO-SIR [1] was the pioneer related work of this paper. User cooperation was firstly proposed by Sendonaris for CDMA wireless cellular networks [2],[3]. Laneman studied the diversity order and DMT of various cooperative diversity schemes including fixed relaying, selection relaying, and incremental relaying from an information theoretic perspective [4],[5]. It was shown that amplify-and-forward (AF) and selective decode-and-forward (DF) protocols achieve the maximal diversity gain, which is equal to the number of nodes participating in cooperative transmission. Based upon network path selection, a simple cooperative diversity protocol without the need for relay signal synchronization or space-time coding was proposed in “A simple cooperative diversity method based on network path selection,”[6] .The above works mainly focused on two timeslot relaying protocols, where relays listen to the source in the first timeslot and forward its message in the second timeslot. Such two-timeslot scheduling is proposed to meet the half duplex constraint, i.e. a node cannot transmit and receive simultaneously in the same frequency band. As a result, these relaying protocols will suffer from a significant multiplexing loss. In particular, their multiplexing gains are upper bounded by 1/2. To recover this multiplexing loss, AF and DF based successive relaying was proposed in pioneering works “Towards the optimal amplify-and-forward cooperative diversity scheme,” [7] and “Recovering multiplexing loss through successive relaying using repetition coding,”[8] . Its core idea relies on the concurrent transmissions of the source and its relays. More specifically, the source transmits to one relay, while another relay transmits to the destination simultaneously. In this protocol, it takes less than two timeslots to send one message in average. As a result, its multiplexing gain is greater than 1/2, while the half duplex constraint is also satisfied. However, it was also noticed that successive relaying may create severe inter-relay interference. It may suffer from poor reliability unless the inter-relay interference is effectively mitigated. The interference cancellation method for AF based successive relaying was extensively studied in “Towards the optimal amplify-and-forward cooperative diversity scheme,”[7] , “AF two path half duplex relaying with inter-relay self interference cancellation: Diversity analysis and its improvement,”[9], and “Efficient iterative SIC and detection for two path cooperative block transmission relaying,”[10]. The fundamental idea of CAO-SIR relies on previous work on Network Interference CancEllation, also referred to as NICE [11]. In particular, if the channel gain from a source to an interfered node is greater than that from the source to its relay, the interfered node is capable of decoding the source’s message encoded at an appropriate data rate. Then the interfered node may utilize the priori knowledge on the source’s message to thoroughly cancel the relay’s interference, when the message is forwarded by the relay. Based upon NICE, a novel joint relay ordering and rate adaptation scheme is proposed for CAO-SIR [1]. In particular, relays will forward the source’s messages successively in the reverse order of their source-to-relay (SR) channel gains. In other words, the poorer a relay’s SR link is, the earlier it transmits. Once the transmission order of each relay is determined, the source further adapt the data rate of the message forwarded by each relay for the relay’s SR and relay to- destination (RD) link quality. The proposed rate adaptation scheme assures that each relay reliably decodes the source’s signal and obtains priori knowledge on the messages to be forwarded in proceed timeslots. In this context, existing system present a rate adaptation aided successive cancellation for both relays and destinations, which is capable of cancelling the inter relay interference thoroughly. In practice, the implementation complexity of the proposed cancellation method is equal to that of Decision Feedback Equalizer (DFE). After the rate adaptation aided interference cancellation, each relay forwards a packet from the source to the destination as if there is no interference at all. This observation motivates us to formulate an equivalent parallel relay channel model, based on which CAO-SIR [1] is further optimized and analyzed. More specifically, we optimize the power allocation and relay selection in CAO-SIR [1]. A double water-filling policy and a one-dimensional search algorithm are presented for power allocation and relay selection respectively, to maximize the throughput and outage probability of CAO-SIR at arbitrary Signal-to-Noise Ratio (SNR). By borrowing the idea of DMT analysis for OFDM systems

III. TIME VARYING SYSTEMS

Rate adaptation for the time varying channels using distributed relay selection was to recover one of the major disadvantage of CAO-SIR[1] is that once one of the relays undergone a failure, the entire system will fail. Where relay selection and rate adaptation is distributed among various relays which can withstand the relay failure. Here proposes and analyzes a practical scheme that forms a virtual antenna array among single antenna terminals, distributed in space. The setup includes a set of cooperating relays which are willing to forward received information toward the destination and the proposed method is about a distributed algorithm that selects the most appropriate relay to forward information toward the receiver. The decision is based on the end-to-end instantaneous wireless channel conditions and the algorithm is distributed among the cooperating wireless terminals.

Rate adaptation for the time varying channels using distributed relay selection is a modified work on channel aware ordered successive relaying known as the basic CAO-SIR [1]. The CAO-SIR [1] is a spectral efficient cooperative communication method. In contrast to conventional successive relaying, where the transmission order and the forwarded message rate of various relays are both fixed, CAO-SIR [1] carefully adapts both the relay’s transmission order and data rates to the relay's link qualities. Relaying on the idea of NICE [11], the joint channel aware relay ordering and rate adaptation mechanism assures that both the relays and the destination are capable of thoroughly mitigating the inter relay interference induced by successive relaying. One of the major disadvantage of CAO-SIR [1] is that once one of the relays undergone a failure, the entire system will fail. To recover the disadvantage of CAO-SIR [1], a new system known as Rate adaptation for the time varying channels using distributed relay selection was proposed. Where relay selection and rate adaptation is distributed among various relays which can withstand the relay failure. First, distributed relay selection and ordering methods are desired to reduce the protocol overhead of CAO-SIR [1]. Second, when practical Adaptive modulation and coding is adopted to realize rate adaptation, decoding error along with error propagation in successive interference cancellation should be taken into account. Finally, more attentions can be paid to CAO-SIR [1] for arbitrary time-varying channels, where opportunistic scheduling and rate less coding may be potentially helpful.

Rate adaptation for the time varying channels using distributed relay selection consists of a set of cooperating relays which are willing to forward received information toward the destination and the proposed method is about a distributed algorithm that selects the most appropriate relay to forward information toward the receiver. The decision is based on the end-to-end instantaneous wireless channel conditions and the algorithm is distributed among the cooperating wireless terminals. The key idea behind these protocols is to create additional paths between the source and destination using intermediate relay nodes. In particular, Sendonaris, Erkip, and Aazhang, proposed a way of beam forming where source and a cooperating relay, assuming knowledge of the forward channel, adjust the phase of their transmissions so that the two copies can add coherently at the destination. Beam forming requires considerable modifications to existing radio frequency (RF) front ends that increase complexity and cost. Laneman, Tse, and Wornell assumed no channel state information (CSI) at the transmitters and, therefore, assumed no beam forming capabilities and proposed the analysis of cooperative diversity protocols under the framework of diversity-multiplexing tradeoffs. Their basic setup included one sender, one receiver, and one intermediate relay node and both analog as well as digital processing at the relay node were considered. The protocol is distributed and each relay only makes local channel measurements. Relay selection is based on instantaneous channel conditions in slow fading wireless environments. No prior knowledge of topology or estimation of it is required.

The relay nodes monitor the instantaneous channel conditions toward source and destination, and decide in a distributed fashion which one has the strongest path for information relaying, well before the channel changes again. In that way, topology information at the relays (specifically location coordinates of source and destination at each relay) is not needed. The selection process reacts to the physics of wireless propagation, which are in general dependent on several parameters including mobility and distance. By having the network select the relay with the strongest end-to-end path, macroscopic features like "distance" are also taken into account. Moreover, the proposed technique is advantageous over techniques that select the best relay a priori, based on distance toward source or destination, since distance-dependent relay selection neglects well-understood phenomena in wireless propagation such as shadowing or fading: communicating transmitter-receiver pairs with similar distances might have enormous differences in terms of received SNRs. Furthermore, average channel conditions might be less appropriate for mobile terminals than static. Selecting the best available path under such conditions (zero topology information, "fast" relay selection well below the coherence time of the channel and minimum communication overhead) becomes non obvious and it is one of the main contributions of this work. More specifically, the relays overhear a single transmission of a ready-to-send (RTS) packet and a clear-to-send (CTS) packet from the destination. From these packets, the relays assess how appropriate each of them is for information relaying. The transmission of RTS from the source allows for the estimation of the instantaneous wireless channel between source and relay at each relay.

VI. CONCLUSION

One of the major disadvantage of CAO-SIR [1] is that once one of the relays undergone a failure, the entire system will fail. To recover the disadvantage of CAO-SIR [1], Rate adaptation for the time varying channels using distributed relay selection is proposed. Where relay selection and rate adaptation is distributed among various relays which can withstand the relay failure. First, distributed relay selection and ordering methods are desired to reduce the protocol overhead of CAO-SIR. Second, when practical AMC is adopted to realize rate adaptation, decoding error along with error propagation in successive interference cancellation should be taken into account. Finally, more attentions can be paid to CAO-SIR for arbitrary time-varying channels, where opportunistic scheduling and rate less coding may be potentially helpful .As future work, the scenario in which a node is not present near to an optimal node to transfer the data is considered. If this is the case, our communication will be disrupted.

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