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18_The Influence of Distance on Reception in Molecular Communication

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The Influence of Distance on the Reception in Molecular Communication

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Abstract - **Nanotechnology has greatly advanced the development of nano-communication networks capable of performing complex tasks. These networks allow communication between transmitting and receiving nanomachines through molecular communication and have numerous applications in the field of medicine, including targeted drug delivery. This method minimizes the possibility of adverse effects on healthy body parts by delivering the drugs directly to the affected area. The transmitting nanomachine releases the drug molecules, which are then absorbed by the targeted location. The distance between the transmitting and receiving nanomachines plays a crucial role in the accuracy and timeliness of drug delivery. This study investigates the effect of varying this distance on the reception of the molecules, the peak reception of molecules, and the time at which maximum reception occurs in molecular communication. We found that as the separation between the sender and the receiver increases, the number of molecules received decreases and the latency increases.**

Keywords—Nanotechnology, Molecular Communication, Targeted drug delivery, nanonetworks

I. INTRODUCTION

Nanotechnology covers wide-area applications at the nanoscale. Molecular Communication is one of the branches of nanotechnology increasing researchers' attention day-by-day due to the incapability of traditional communication, such as, electromagnetic and acoustic communication at the nanoscale [1]. In Molecular Communication, the molecules carry information as a carrier from the source to the receiver. The transmitter emits the molecules which propagate in the environment till they reach the receiver [2]. Applications of Molecular Communication are in a variety of fields including health, environment, military, and information communication theory [3]. In the field of medicine and health, molecular communication is found to be very effective due to its bio-compatibility [4]. Targeted drug delivery is a biomedical application of molecular communication, where drug particles are delivered to the diseased part, such as, cancer tumors avoiding their reach at the healthy part of the body. An accurate concentration of the drug molecules at the tumor site avoids toxicity of the drug due to heavy dosage [6 - 10]. A high transmission rate may cause the accumulation and loss of drug molecules. On the other hand, a low transmission rate may cause insufficient reception of drug doses at the tumor site in the required time duration, causing a lack of proper treatment. Accurate placement of the transmitter and receiver to receive sufficient dosage at right time is very important.

This study focuses on the examination of the influence of the separation between the sender and the receiver. The maximum reception is observed at different time instants varying transmitter and receiver distance. Results are then evaluated to find the perfect placement of the transmitter and receiver to achieve maximum system throughput. In this study, we are identifying what is the exact effect of distance on the intensity of received molecules, the period at which maximum reception occurs, and the peak reception of molecules.

II. LITERATURE REVIEW

Most research work in molecular communications has been based on the factors affecting the system's performance, such as channel capacity, delay, attenuation, noise, Inter-Symbol Interference (ISI), and amplification. Various models have been proposed and analyzed in the study, such as, diffusion-based, diffusion with drift, random walk, active transport models, random walk models with drift, and a collision-based model [11 - 13]. Al-Zubi et al. [14] have compared various reception methods for molecular communication. The performance of passive and completely absorptive receivers is estimated by analyzing the peak amplitude and peak time. Sharma et al. [15] analyzed the 3-Dimensional diffusion-based molecular communication system model. System performance is examined in terms of receiver characteristics, erroneous alarms, capacity, and possibility of average error. Lopez et al. [16] have presented a study on transmitters' location and desired signal strength. Islam et al. [17] address a drug release synchronization issue in the local drug delivery system having multiple transmitters. This study aims to reduce the transmission period error caused by the propagation lag. Zhao and team [18] have derived the minimum efficient intensity of drug particles from the minimum effective receiver capacity.

III. SYSTEM MODEL

Fig. 1 depicts the system model for molecular communication considered in this study. The system considered in this study consists of the transmitter as point source and spherical receiver located 'd' distance apart from each other in an aqueous environment. Molecules transmitted from the transmitter propagate via an aqueous environment by the process of diffusion modelled by Brownian motion.