

CHAPTER

2

IMPLANTABLE ANTENNA FOR IMPLANTABLE MEDICAL DEVICE

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2.1 INTRODUCTION

The use of communication tools in implantable medical devices (IMDs) has been a notable advancement in healthcare technology over decades. The successful implementation of communication tools contributes to countless benefits for patients who are suffering from serious illnesses like cancer, diabetes, and congestive cardiac failure. Prior to the introduction of communication tools to the IMD, they depended on the power supplied by the wired-connected external stations. Therefore, the introduction of implantable antenna as an alternative has proven to be a lifesaver for millions, providing minimally invasive solutions that enhance longevity and reliability. Not only that, the ability of the implantable antenna to aid wireless communication among the internal IMD and external monitoring systems facilitates the data transmission in real-time, as shown in Figure 2.1. As a result, the medical personnel can remotely diagnose and treat the users by providing personalized therapy. Hence, the implementation of implantable antenna indirectly enhanced the standard of medical, diagnosis, and treatment.

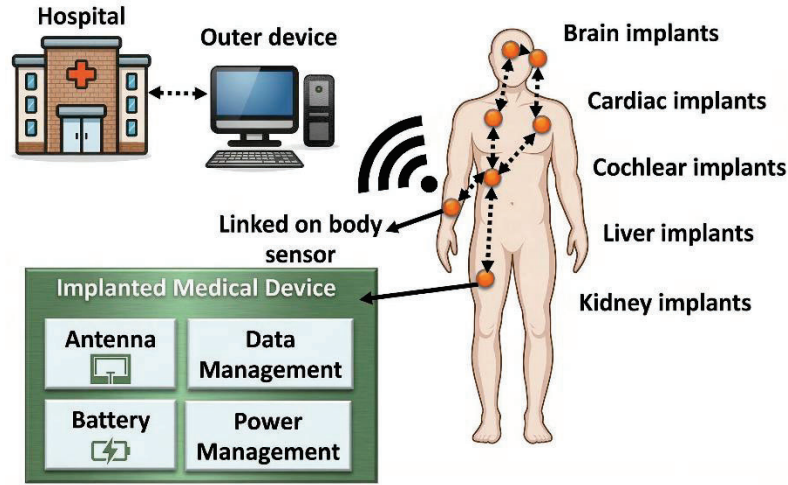


Figure 2.1 Working principle and components of implantable medical devices (Source: Zaki et al., 2023)

These advantages increase the demand for implantable antenna and have attracted researchers' attention to implement antenna in various IMD. For instance, the implantable antenna covers a wide spectrum of applications, such as brain, cochlear, cardiac, liver, and kidney implants, which enable them to detect and monitor distinct types of physiological parameters of the body. As an example, the implantable antenna is used to regulate the heart rate via pacemaker (Sharma et al., 2022) monitor intraocular pressure (Chow et al., 2011), blood glucose level, blood pressure, temperature, and respiratory rate. However, it must be noted that the implantable antenna must be designed meticulously according to their desired function, and the possible effects of the biological tissues need to be considered. Therefore, this chapter provides a foundation for understanding the operation of implantable antenna. In addition, its operating frequency bands, components, type of antennas, and performance parameters are presented, while the effect on the human body will be discussed in Chapter 3.

2.2 WORKING PRINCIPLE OF IMPLANTABLE ANTENNA

The working principle of an implantable antenna encompasses a series of steps that require interactions between the external monitoring device or base station and the implanted device within the human body. The process begins with the generation of a signal by the radio frequency (RF) circuitry of the base station. Upon signal generation, the carrier frequency will be selected based on the desired application of the IMD. The operating frequency bands will be discussed further in Section 2.3. Then, the RF signal will be transmitted via the external antenna that is connected to the base station, as shown in Figure 2.2. The transmitted signal travels via air and penetrates through the human body. Subsequently, the implantable antenna within the IMD receives and processes the RF signal to collect the requested physiological data. Similarly, the implantable antenna transmits the response signal that propagated through the body into air, which then captured by the base station to extract the data. Lastly, the computer will display the data for the medical personnel to further process and analyze.

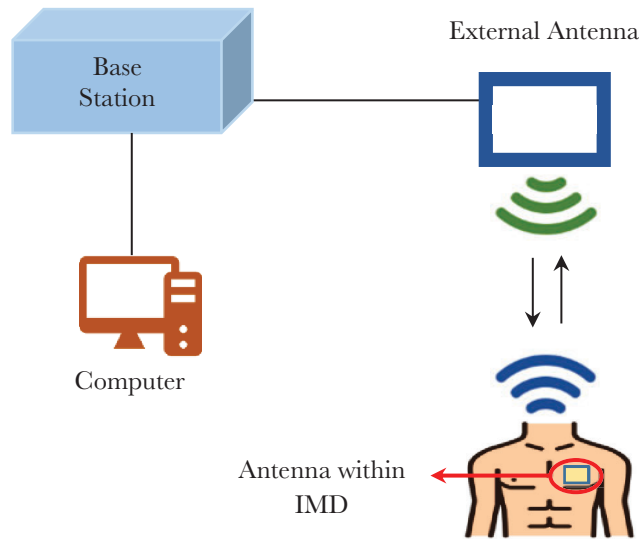


Figure 2.2 Working principle of implantable antenna