Chapter 6
AI at the Womb's Edge: Transformative Technologies in Fetal Monitoring

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ABSTRACT

Fetal monitoring is a critical aspect of prenatal care, aimed at assessing the well-being of the fetus during pregnancy and labor. Traditional fetal monitoring techniques, such as cardiotocography (CTG) and ultrasound, have been instrumental in reducing perinatal morbidity and mortality. However, these methods have limitations in accuracy, reliability, and interpretation. In recent years, the integration of artificial intelligence (AI) technologies into fetal monitoring systems has shown promising results in enhancing diagnostic accuracy and improving patient outcomes. This chapter provides a comprehensive review of the advancements in AI-powered fetal monitoring techniques, including machine learning algorithms, deep learning models, and computer vision approaches. The review also discusses the challenges, opportunities, and future directions in the field of AI-powered fetal monitoring.

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1. INTRODUCTION

Fetal monitoring is a cornerstone of prenatal care, providing critical insights into the well-being of the fetus during pregnancy and labor. The ability to assess fetal health and detect signs of distress is paramount in ensuring safe deliveries and reducing perinatal morbidity and mortality. Over the years, various techniques have been developed and utilized for fetal monitoring, ranging from traditional methods such as cardiotocography (CTG) and ultrasound, have been the cornerstone of obstetric practice for decades, providing valuable information about fetal heart rate (FHR), uterine contractions, and fetal movements. However, these methods have inherent limitations in terms of accuracy, reliability, and interpretation, prompting the exploration of more advanced technologies to enhance diagnostic capabilities and improve patient care.

In recent years, there has been a growing interest in leveraging artificial intelligence (AI) technologies to augment fetal monitoring practices. AI, encompassing machine learning, deep learning, and computer vision, offers the potential to analyze vast amounts of fetal monitoring data with unprecedented speed and accuracy, thereby enabling more precise assessment of fetal well-being and the early detection of abnormalities or signs of distress. This integration of AI into fetal monitoring systems represents a significant paradigm shift in obstetric care, with the potential to revolutionize the way fetal health is monitored and managed.

This comprehensive review aims to explore the advancements in AI-powered fetal monitoring techniques, elucidating the principles, methodologies, applications, challenges, and future directions in this rapidly evolving field. By examining the current state-of-the-art technologies and their implications for clinical practice, we seek to provide insights into the transformative potential of AI in enhancing prenatal care and improving perinatal outcomes.

1.1 Traditional Fetal Monitoring Techniques

Before delving into the realm of AI-powered fetal monitoring, it is essential to understand the foundational principles and limitations of traditional fetal monitoring techniques. Two primary methods have long been employed in obstetric practice: cardiotocography (CTG) and ultrasound imaging.

Cardiotocography (CTG)

CTG, introduced in the 1950s, remains one of the most widely used methods for fetal monitoring. It involves the simultaneous recording of the fetal heart rate (FHR) and uterine contractions, typically using external sensors placed on the maternal