Debre Markos University

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Department of Software Engineering

Proposal Title: IOT based Pregnant Health Monitoring System

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Abbreviations

IoT =>Internet of Things

HSDP => Health Sector Development Programmes

MDGs => Millennium Development Goals

FHR => Fetal Heart Rate

ETD => estimated time of delivery

DT => Decision Tree

CNN=> Convolutional Neural Network

ML=> Machine learning

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CHAPTER ONE

1. INTRODUCTION

1.1. Background of the Study

Ethiopia is one of six nations that account for more than half of global maternal fatalities. Ethiopia aspires to reduce maternal mortality by three-quarters as part of its commitment to the Millennium Development Goals (MDGs), and maternal health development is a priority in its Health Sector Development Programmes (HSDP) (Federal Democratic Republic of Ethiopia, 2005).

Moreover, developing countries, many individuals live in rural locations where medical systems are not integrated to share information. As a result, pregnant women frequently miss early checks, increasing the mortality rates of babies and parents in both rural and urban settings. This scenario presents substantial medical concerns to women. An accelerometer sensor is being developed to identify aberrant positions in pregnant women, in order to address this issue(Priyanka et al., 2021).

Therefore, pregnancy is a critical period for both a woman's health and the well-being of her child. Ensuring proper precautions and steps for better health and a smooth delivery after nine months is essential. Leveraging technological advancements and the widespread use of devices in daily life, we've developed an Android mobile application to provide comprehensive support to women throughout their pregnancy journey(Ettiyan & Geetha, 2020; Priyanka et al., 2021).

Moreover, in all climates, IoT ensures safe and efficient treatment for pregnant women by eliminating pregnancy risks and adverse events. Additionally, it enhances privacy and addresses religious, legal, and societal concerns(Ettiyan & Geetha, 2020).

Moreover, A correlation between fetal heart rate (FHR) and embryo samples' estimated time of delivery (ETD) was established to create a model for normal FHR development. The significance of FHR in predicting pregnancy outcomes was confirmed through residual analysis. Machine learning techniques, including Decision Trees (DT), were employed to build prediction models(CH. GAYATHRI SOWMYA SREE et al., 2022).

Moreover, an IoT-based health monitoring system is developed to monitor maternal stress levels continuously during pregnancy. The system utilizes an online k-means algorithm to assess stress levels based on real-time heart rate data. A proof of concept is presented, evaluating system accuracy through a case study on maternal health. Twenty pregnant women

were remotely monitored for six months during pregnancy and one month postpartum to validate the effectiveness of the system(Oti et al., 2018).

In addition, supporting sensors integrated with IoT healthcare enable efficient analysis and collection of patients' physical health data, making IoT healthcare widely accepted. However, addressing the continuous availability of healthcare professionals and amenities in remote areas during emergencies is crucial for developing a flexible IoT-based health monitoring system. This system permits personalized treatment in specific situations, leading to reduced healthcare costs and waste while improving outcomes continuously(Misran et al., 2019).

Moreover, Maternal and child deaths from pregnancy-related complications remain a significant concern, especially in developing countries. Early detection of complications is vital in preventing many of these cases. However, factors such as long distances to health facilities, lack of knowledge, and poverty contribute to many expectant mothers in rural areas of developing nations neglecting their health during this critical period(Haliima et al., 2022).

The utilization of IoT in smart health applications is pivotal for distributed and intelligent automatic diagnostic systems. This study suggests an integrated approach to monitor maternal and fetal signals in high-risk pregnancies. It leverages IoT sensors, data analytics for feature extraction, and a 1-D convolutional neural network (CNN) classifier for intelligent diagnostic assistance(Marques et al., 2021). Therefore, to achieve these goals, an IoT-based Pregnant Health Monitoring System in Ethiopia has been created. This system consists of mobile applications for the pregnant lady, emergency contacts, and healthcare practitioner, as well as a web application and a wearable device. The wearable device tracks the pregnant woman's health information in real time.

1.2. Statement of the Problem

Pregnancy necessitates meticulous monitoring for the well-being of both the mother and the unborn child. Traditional methods relying on periodic visits to healthcare professionals may not suffice to detect complications promptly. To overcome this, an IoT-based Pregnancy Health Monitoring System (PHMS) is proposed, enabling continuous remote monitoring of vital health parameters throughout pregnancy. Therefore, the primary objective of this research is to develop an IoT-based Pregnancy Health Monitoring System that can accurately and efficiently monitor the health status of pregnant women in real-time. The research aims to address the following specific problems:

Moreover, traditional healthcare models rely on intermittent visits to healthcare facilities for prenatal check-ups. This approach may miss crucial changes in health status between appointments. The IoT-based PHMS seeks to enable continuous monitoring of vital health parameters such as blood pressure, heart rate, body temperature, and fetal heart rate. Moreover, Pregnancy complications such as preeclampsia, gestational diabetes, and fetal distress can have serious consequences if not detected and managed promptly. The PHMS aims to incorporate algorithms for early detection of such complications by analyzing trends in monitored parameters and issuing alerts to healthcare providers and expectant mothers when abnormalities are detected.

In addition, access to prenatal care can be limited in rural or underserved areas, leading to disparities in maternal and fetal outcomes. The IoT-based PHMS aims to bridge this gap by providing remote accessibility to prenatal monitoring services, allowing pregnant women to receive high-quality care regardless of their geographical location. Therefore, we will propose IoT-based Pregnancy Health Monitoring System will consist of wearable sensors, wireless communication modules, a central monitoring platform, and data analytics algorithms. So, Pregnant women will wear non-invasive sensors capable of continuously monitoring vital health parameters.

1.3. Research Question

RQ1: What are the usability and user acceptance factors influencing the adoption (PHMS) among pregnant women and healthcare providers?

RQ2: How does the integration of machine learning algorithms for data analysis in (PHMS) contribute to the accuracy and timeliness of detecting pregnancy complications?

RQ3: How does the implementation of (PHMS) impact the early detection of pregnancy complications and the overall health outcomes for expectant mothers and their unborn children?

RQ4: How to use sensor data to the machine learning algorithm?

1.4. Objectives

1.4.1. General Objective

The general objectives of the research are to design IOT based pregnant health monitoring system and a model for machine learning based analysis from a sensor data.

1.4.2. Specific Objectives

- Evaluate the effectiveness of the (PHMS) in detecting pregnancy complications such as diabetes, and fetal distress.
- Investigate the usability and user acceptance of the PHMS among pregnant women and healthcare providers, including factors influencing adoption and satisfaction.
- Analyze the role of machine learning algorithms integrated into the PHMS in enhancing the accuracy and efficiency of detecting abnormal trends in monitored health parameters.
- Measure the overall health outcomes for expectant mothers and their unborn children, including reduction in maternal morbidity, neonatal complications, and healthcare utilization.
- Build web based and mobile application to monitor the information the expectant mother.

1.5. Significant of the Study

Limited access to hospitals and challenges related to time and distance hinder regular pregnancy checkups. This situation increases the risk of complications such as bleeding, maternal sepsis, gestational diabetes, abnormal birth rates, and fetal mortality. Regular checkups are crucial for reducing these risks and ensuring the well-being of both mother and child(Priyanka et al., 2021). Therefore, the research will have the following significant.

- Exploring the effectiveness of (PHMS), this research addresses the issue of limited access to prenatal care due to factors like distance and lack of healthcare facilities. So, implementing such a system could extend healthcare services to remote or underserved areas, improving maternal and fetal health outcomes**.**
- Moreover, Investigating the impact of the PHMS on the early detection of pregnancy complications is critical for enhancing maternal and fetal safety. So, Early identification of issues such as diabetes, maternal sepsis, and abnormal fetal development can lead to timely interventions, reducing the risk of adverse outcomes.
- And also, by facilitating continuous monitoring of vital health parameters, the PHMS has the potential to mitigate risks associated with pregnancy complications, ultimately

reducing maternal morbidity and mortality rates. Similarly, early detection and intervention can lower the rate of fetal mortality and improve birth outcomes.

1.6. Scope of the Research

The study only will focus on the development and implementation of the IoT-based PHMS, including the design of wearable sensors, wireless communication protocols, data collection, storage, and analysis algorithms through web based and mobile application to get information of the pregnant women. While the study will primarily focus on the implementation and evaluation of the PHMS in a specific geographical location or setting, its findings and implications may have broader relevance to other regions facing similar challenges related to access to prenatal care and monitoring.

CHAPTER TWO

2. LITRATURE REVIEW

In recent years, there has been a lot of interest and research into developing new approaches to remotely monitoring parental care. Various learning techniques, including machine learning methods, Arduino system on GSM, deep learning, and various IoT approaches, have been used. This section highlights various areas of recent research in pregnant monitoring.

The paper presents a sensitive and lightweight IoT system for home monitoring of fetal motion and vital parameters, compared to expensive ultrasound scanning. It uses a GSM module to identify normal and abnormal rates(Priyanka et al., 2021). Moreover, based on the need to continuously monitor stress levels in pregnant women they developed a k-means algorithm that works in an online setting using streaming data from a wearable IoT device(Oti et al., 2018; Priyanka et al., 2021).

The article introduces a Smart Maternal platform using IoT technology, focusing on pregnant women, to reduce medical staff workload, enhance efficiency, and improve access to healthcare services, thereby enhancing maternal healthcare quality. The article introduces a Smart Maternal platform using IoT technology, focusing on pregnant women, to reduce medical staff workload, enhance efficiency, and improve access to healthcare services, thereby enhancing maternal healthcare quality(Marques et al., 2021; Nayak & Pal, 2021).

In addition, maternal health is crucial for women's well-being, but preventable causes contribute to 800 daily maternal deaths. Wearable sensors can monitor fetal ECG, heart rate, and maternal health parameters, mitigating pregnancy risks(Hiremath et al., 2015).Moreover, The ICU patient monitoring system uses Node MCU technology to collect data from sensors like blood pressure, heartbeat, and body temperature, providing real-time information to doctors via an IoT web interface(CH. GAYATHRI SOWMYA SREE et al., 2022). So, IoT is used in patient monitoring, enabling distributed devices to collect, analyze, and transmit real-time medical data to the cloud, facilitating context-based alerts and seamless internet access(K. et al., 2023; Kaur & Saarthak, 2022).

Moreover, older individuals are at high risk of falls, leading to immobility, illness, and death. An autonomous fall detection system using IoT technology and human-centered design can provide immediate medical attention, potentially lowering death rates by up to 80%(Tahir et al., 2022).

CHAPTER THREE

3. METHODOLOGY

3.1. Data Source

An IoT-based pregnancy monitoring system requires integrating various sensors, databases, and communication protocols to collect, transmit, and analyze data. Therefore, data for pregnant women are collected from different sensors. So, here are some of the sensors.

- **Biometric Sensors:** These can include wearable devices that track vital signs such as heart rate, blood pressure, body temperature, and respiratory rate. Devices like smartwatches or specialized pregnancy wearables can be used.
- **Environmental Sensors**: Monitoring environmental factors such as temperature, humidity, and air quality in the vicinity of the pregnant person can be crucial for ensuring a healthy environment. As a result, we will propose the following system architecture, Figure 1 depicts the proposed architecture.

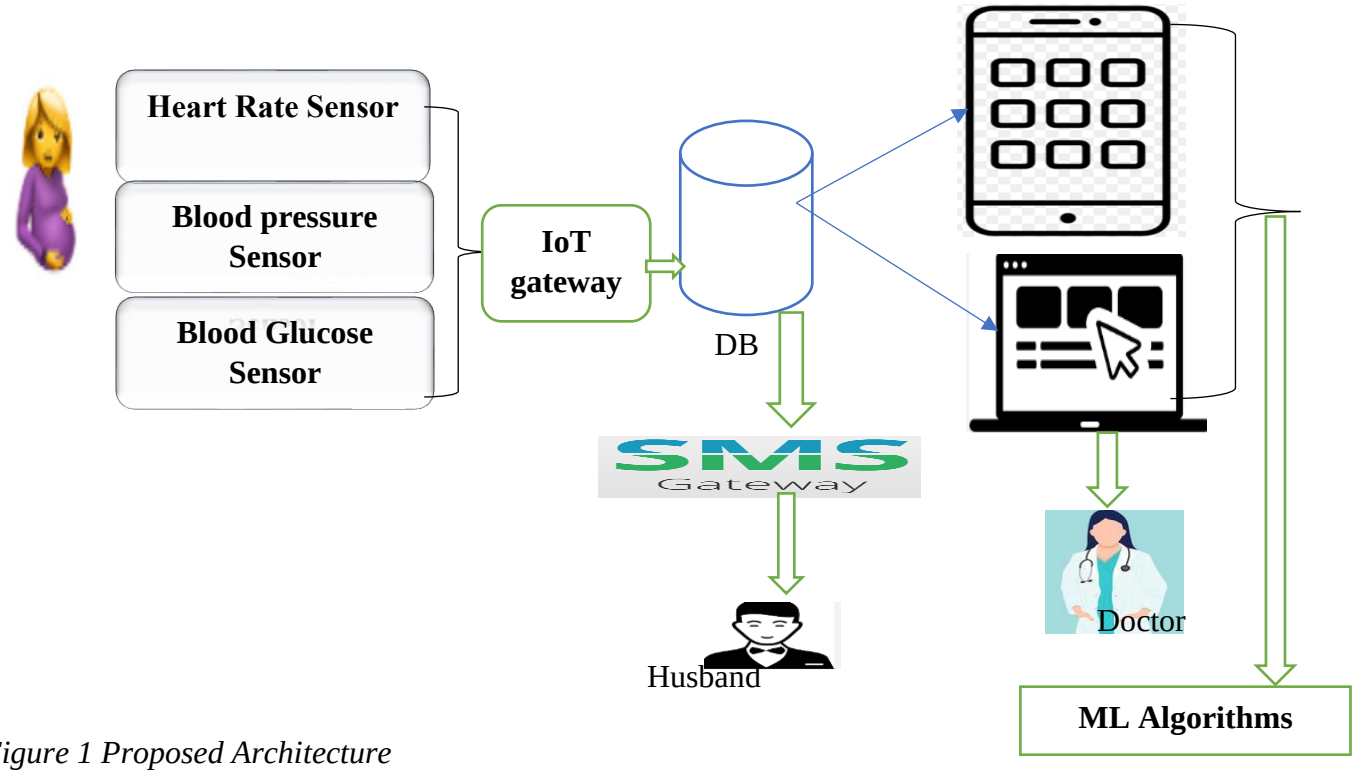

Figure 1 Proposed Architecture

3.2. Tools

With so many productive programming for mobile and web development available for designing IoT based solutions, we will look at some of the most popular software solutions for building your own IoT based System. As a result, the Flutter is for Mobile app development and Django for Web app will use Mango DB and SMS gateway that helps us to send SMS message for Husband if he is not literate for web and mobile app browsing, finally use ML.

TIME SCHEDULE

	IoT based Pregnant Health Monitoring																								
Tasks	February				March				April				May				June				July				
	Weeks				Weeks				Weeks				Weeks				Weeks				Weeks				
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	
Proposal writing																									
Sensor collection																									
Data analysis and interpretation																									
Literature review																									
Research methodology																									
Modeling of the algorithm																									
Experimental result and discussion																									
Writing conclusion, recommendations and future works																									
Documentation																									
Draft report submission																									
Final report submission																									

Table 1 Time Schedule

BUDGET BREAKDOWN

	Item	**Quantity**	**Single price**	**Total price (birr)**
Stationery material	Pens	1 pack	170	170
	Paper	2 pack	320	320
	Binding	3 times	12	36
	Printing	3 times	400	850
	Flash Disk	1	400	400
	Laptop computer	1	25000	25000
	Mobile Card	10	50	500
	Sensor	50	350	17500
Total				**44,776**

Table 2 Budget Breakdown

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