Jononi: An Intelligent Assistive System for expecting mothers

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***Abstract*—In this article, we introduce Jononi, an intelligent assistive system designed to address the challenges of managing maternal health during pregnancy. Jononi, which combines wearable technology and a user-friendly mobile application, enables expecting mothers to actively participate in their prenatal health management by monitoring vital signs on a regular basis and providing comprehensive prenatal care information. Jononi aims to improve maternal healthcare outcomes and emergency response mechanisms, potentially saving lives, by encouraging self-care and reducing reliance on healthcare professionals for minor concerns.**

***Index Terms*—Jononi, intelligent assistive system, maternal healthcare, wearable device, healthcare, prenatal care, remote monitoring, emergency detection, health literacy.**

I. Introduction

Maternal health is a critical issue around the world, with expecting mothers facing numerous difficulties in managing their health during pregnancy. Managing the complexities of pregnancy can be overwhelming, from keeping track of vital signs to getting timely medical help. To address these issues, we present Jononi, an intelligent assistive system designed to empower pregnant women and revolutionize maternal healthcare. The complexities of managing maternal health during pregnancy are central to the problem statement. Expecting mothers often struggle to monitor their vital signs and track their health progress accurately. Furthermore, it may be difficult for some people, especially those who live in remote or underdeveloped areas, to get timely medical assistance. The issue is further complicated by the lack of knowledge and awareness about prenatal care, which has a negative impact on maternal health outcomes and raises the risk for both mothers and their unborn children.

Jononi provides a novel solution to these problems by combining wearable technology and an easy-to-use mobile application. Jononi empowers expecting mothers to actively participate in their prenatal health management by monitoring vital signs such as body temperature and heart rate on a regular basis. Furthermore, the incorporation of manual input for height and weight allows for seamless compatibility with existing healthcare infrastructure.

One of Jononi's primary goals is to improve health literacy among pregnant women. The extensive FAQ section of the mobile application gives mothers the knowledge they need to spot and address potential health issues by providing useful information on prenatal care, common discomforts, and warning signs. Jononi encourages self-care and lessens reliance on medical professionals for minor issues, empowering expecting mothers to take charge of their health.

Improving maternal healthcare outcomes is the main goal of our project. By addressing the difficulties in keeping track of vital signs and getting timely medical help, Jononi hopes to close the gaps and guarantee that expecting mothers get the care they require when they require it. Jononi improves emergency response mechanisms by integrating smart alarm systems and a dedicated SOS feature, speeding up response times and possibly saving lives.

II. Literature Review

In the absence of a comprehensive digital health support system like Jononi, expecting mothers may have significant difficulties tracking their health throughout pregnancy. Traditional methods of tracking vital signs and reporting symptoms to healthcare providers may be ineffective, especially in resource-constrained settings. This can lead to delayed diagnosis or treatment, which can lead to poor maternal health outcomes and higher morbidity and mortality rates among pregnant women. Additionally, expecting mothers, especially those who live in rural areas with little access to healthcare services, may find it burdensome to travel far for routine checkups or to seek medical attention for minor symptoms. As a result, implementing cutting-edge digital health solutions like Jononi has the potential to enhance maternal health outcomes and lessen health disparities.

According to Brown et al. [1], while there are many pregnancy apps available, only a small percentage of them are of high quality, and most only cover a limited range of pregnancy-specific nutrition topics. To assess the effectiveness of pregnancy-specific nutrition apps for Android, the authors used specific keywords to search the Google Play Store and then examined the app's title, app store description, and downloaded version. They used the Mobile Application Rating Scale (MARS) to rate the quality of the apps and reported the presence of nutrition-related topics. The authors established a list of specific nutrition topics that are crucial during pregnancy based on their expertise. They then investigated whether

pregnancy-specific dietary information was available to expectant mothers in Australia, focusing on the topics covered by the Institute of Medicine's (IOM) pregnancy weight gain recommendations, which included advice to reduce caffeine consumption, advice to reduce or avoid alcohol consumption, food safety during pregnancy, fish consumption during pregnancy, and the IOM's pregnancy weight gain recommendations [1].

Sadavarte and Bodanese [2] describe the development of a pregnancy companion chatbot that provides advice and support throughout the pregnancy using Amazon Web Services and the Alexa platform. The chatbot employs a combination of artificial intelligence and natural language processing techniques to respond to pregnancy-related questions, track pregnancy milestones, and provide information on prenatal care. The authors conduct user surveys to demonstrate the chatbot's effectiveness, and the results show that users like the system. This paper discusses the design and implementation of a pregnancy companion chatbot, which can be a useful resource for pregnant women. M. C. Maduwantha and V. Vithana [3] created a mobile application to assist pregnant women. This application includes a chatbot powered by artificial intelligence (AI). The AI chatbot communicates and guides the mother in a way that gives the impression that they are conversing with their unborn child [3]. Pregnant women's vital signs can now be monitored with a low-cost, portable hardware device that has cuff-free blood pressure, heart rate, and body temperature sensors [5].J. Pervin et al. [6]created a targeted text messaging strategy for clients in order to increase the use of antenatal care as part of the establishment of an electronic registry for maternal and child health. Almost no respondents cited antenatal care as a preventive kind of care, and they only saw it as necessary in the case of difficulties [6]. When asked to pick between a phone call and a text message, study participants said they preferred phone calls but thought text messaging was a workable alternative [6].

In summary, the Jononi intelligent assistive system has the potential to revolutionize maternal healthcare by offering expectant mothers a complete, approachable, and easily accessible solution. By leveraging the power of wearable devices, mobile applications, and cloud computing, Jononi empowers pregnant women with real-time health monitoring and emergency assistance, improving their overall health outcomes and ensuring a safe and healthy pregnancy.

III. Concept Design and Architecture

A. System architecture

The proposed system architecture of Jononi comprises a wearable device that captures vital signs such as body temperature and heart rate and transmits this data to a corresponding mobile application. The user manually enters their height and weight into the app, which calculates the mother's body mass index (BMI). The application also includes a comprehensive FAQ section that addresses frequently asked questions and concerns about pregnancy and maternal health. In addition, an alarm system is built into the app to alert the user in case of an emergency. Furthermore, the system includes an SOS feature that allows the user to contact emergency services in the event of a critical situation. Overall, Jononi's system architecture is intended to provide expectant mothers with a user-friendly and effective digital health support system, thereby improving maternal health outcomes. The overview of the proposed system's architecture is presented in Figure 1 which shows the link between the physical and logical levels.

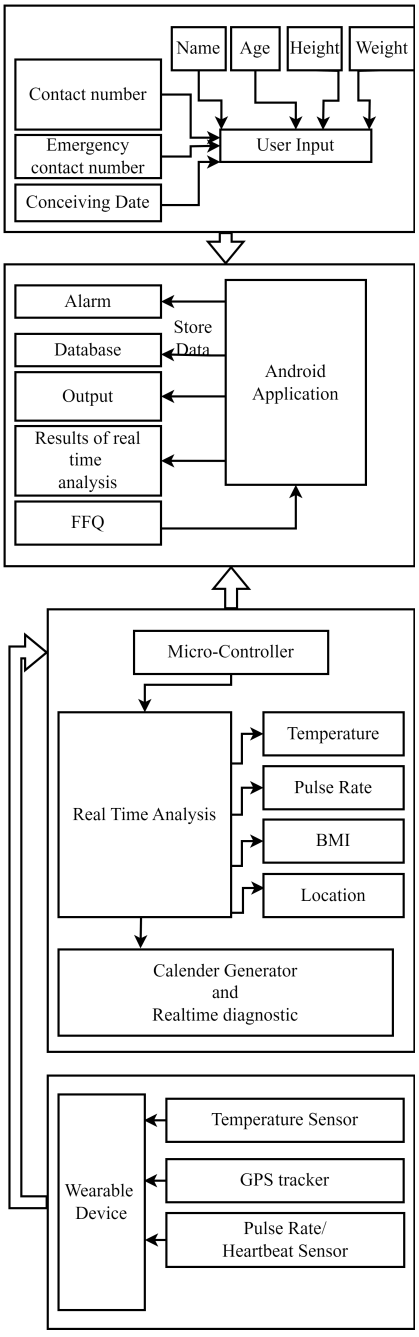

Fig. 1. An overview of the system architecture.

B. workflow diagram

The workflow diagram of Jononi demonstrates the seamless flow of information between the user, the wearable device, and the mobile application in Figure 2. The first step involves the user wearing the wearable device that captures their vital signs, such as body temperature and heart rate. The device then transmits this data to the mobile application, which processes the information and displays it on the user interface. The user manually inputs their height and weight into the application, which calculates the BMI of the mother. The application also includes a comprehensive FAQ section that addresses common questions and concerns related to pregnancy and maternal health. The system also includes an alarm system that alerts the user in case of an emergency situation, such as high blood pressure or irregular heart rate. In addition, the SOS feature enables the user to contact emergency services in the event of a critical situation.

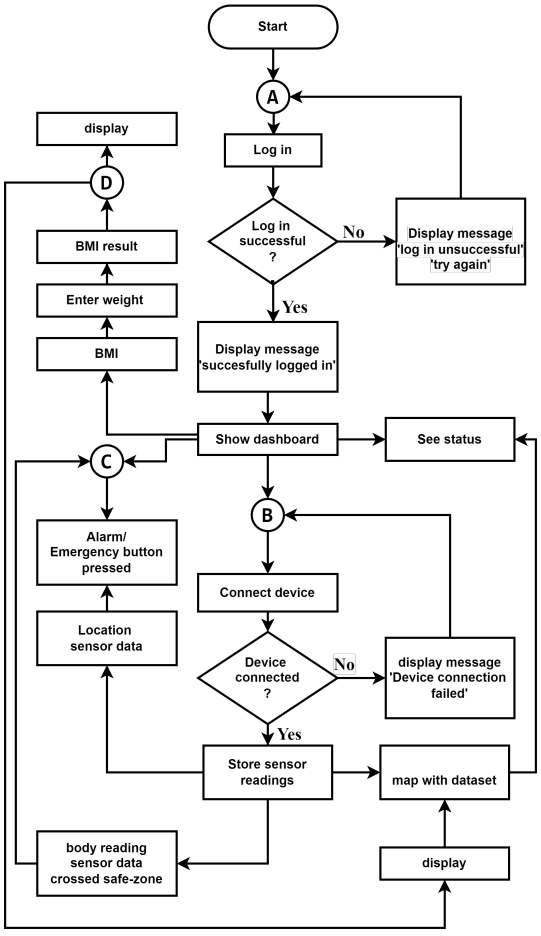

Fig. 2. System workflow diagram.

IV. Methodology

The proposed system includes both the hardware and software parts.

A. Hardware Development

Raspberry Pi is used in the hardware to connect and process data from the heart rate sensor,LM35 temperature sensor, and GY-GPS6MV2 GPS sensor.

The Raspberry Pi collects data from the heart rate and temperature sensors to capture the pregnant mother's vital signs. These sensors provide real-time measurements, which are then processed by the microcontroller. The Raspberry Pi connects to the corresponding mobile application via Bluetooth, ensuring data transmission. In the event of an emergency, the Raspberry Pi has a GPS sensor that can track the pregnant mother's location. The emergency detection mechanism activates the GPS sensor when triggered, allowing the device to capture accurate location data. This data is then transmitted to the connected mobile application, ensuring prompt emergency response and assistance. This methodology ensures the efficient and accurate monitoring of maternal health parameters, as well as the early detection of emergency situations. The combination of hardware and mobile applications allows for the collection, processing, and transmission of vital health data. The Raspberry Pi serves as a trustworthy intermediary, facilitating communication between wearable sensors and mobile application. This methodology ensures the efficient and accurate monitoring of maternal health parameters, as well as the early detection of emergency situations.

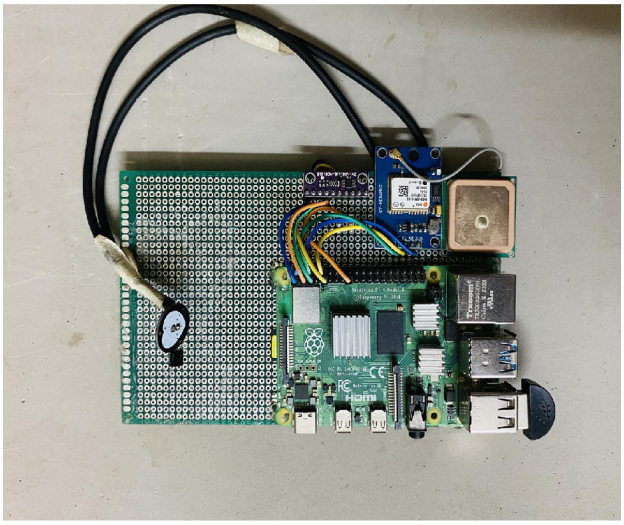

Fig. 3. Proposed System Hardware.

B. Software Development

The Jononi system's software was created using a variety of tools and platforms. Front-end development was done in Java, which allowed for the creation of a user-friendly and intuitive interface. The mobile application, created specifically for pregnant mothers, allows them to control the device and access various information. In addition, a machine learning model called XGBoost was used to analyze sensor data and provide real-time feedback on the health condition. The front-end development was done in Java, while Firebase served

as the back-end development platform for the mobile app. Firebase is a web application development technology that eliminates the need for server-side programming, resulting in faster and more efficient development.

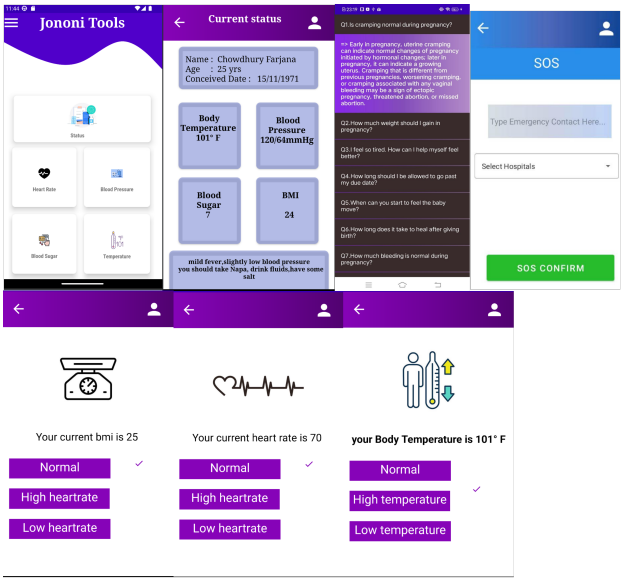

Fig. 4. UI of Proposed Mobile Application.

The hardware system communicates with the software via the mobile application. The system's front end, developed in Java, provides pregnant mothers with an accessible and user-friendly interface. The mobile application serves as the device's command centre, allowing users to monitor data and respond to emergency situations. The system's backend is powered by Firebase, allowing efficient data storage, retrieval, and synchronization across all clients. The user interface features a comprehensive dashboard with device management controls, as well as a dedicated status page that provides mothers with real-time information about their health status. The universal and user-friendly nature of the app makes it useful for mothers. The Jononi system provides a comprehensive solution for optimizing maternal health outcomes by seamlessly integrating hardware and software components.

V. EVALUATING THE PROTOTYPE

The functional accuracy and usability of the suggested system were assessed through an evaluation study. A test case scenario was created and run five times for each of the system's main functionalities. Table I displays the average delay in seconds and the percentage of success rate. All other functionalities passed the tests, with the exception of measuring body temperature.

Different algorithms were used to predict the risk levels of the health parameters fetched from the device. Among them, XGBoost has the highest accuracy of 91.33%. The model predicts the risk level based on low-risk, mid-risk and high-risk. The output is shown on the status page and a doctor-recommended suggestion is also given according to the risk

TABLE I
RESULTS OF THE EVALUATION STUDY (FUNCTIONAL ACCURACY TEST)

Name of task	**Result of task (%success)**	**Observational Time Period (M±SD)**
T1: Measure Pulse rate	100%	3.26 ± 0.91
T2: Measure Body Temperature	80%	2.14 ± 1.67
T3: Check the current location	100%	1.34 ± 1.36
T4: Give SOS message	100%	1.6 ± 0.63

TABLE II
PERFORMANCE OF ML MODELS

Model	Accuracy	Precision	Recall	F1 Score
XGBoost	91.33	91.33	91.33	91.23
Decision Tree	87.30	87.09	87.11	87.19
Random Forest	89.58	89.50	89.48	89.34
LGBM	90.43	90.21	90.18	90.20
SVM	88.78	88.33	88.29	88.47

level.Table II shows the accuracy, precision, recall, and f1-score values of the different algorithms.

The only user group for which the evaluation tasks were created was expecting mothers. Ten people were requested to participate as test subjects. The participants in the evaluation study were first given a brief presentation outlining the purpose of the study. Second, the proposed system was explained to them, and they each had the chance to use it for about 10-12 minutes from their own point of view. In order to complete the tasks, participants were invited to use the system. Additionally, they were asked to comment on the effectiveness and usability of the suggested system and offer any suggestions they may have had. Table III gives a summary of the information that was recorded. The findings revealed that each participant was able to complete the assigned tasks with comparatively few attempts (see Table 3). For example, 5 out of 10 participants in the tasks asked no questions of the researchers who were watching them. The number of attempts yielded a similar result. All tasks were completed in less than or around half a minute. The system's functionality, usability, and overall performance were all said to be good by participants. According to them, anyone can learn the system quickly.

VI. DISCUSSIONS AND CONCLUSIONS

Finally, Jononi, an intelligent assistive system, offers a ground-breaking solution to the challenges that expectant mothers face in managing their maternal health during pregnancy. Jononi empowers pregnant women to actively participate in their prenatal health management by combining wearable technology and an easy-to-use mobile application. The system monitors vital signs such as body temperature

TABLE III
RESULTS OF THE EVALUATION STUDY (SYSTEM USABILITY)

User Group	Task	Number of Attempts (M ±SD)	Task Completion Time (second) (M ±SD)	Number of times Asking help (M ± SD)
Expecting Mothers (n=10)	Task 01: Measure BMI, Body Temperature and Pulse rate.	1.2±0.4	5.3±1.06	0.2±0.4
	Task 02: Check the current location.	1.4±0.44	2.2±0.68	0±0
	Task 03: Check the health status	1.2±0.4	2.3±0.6	0±0

and heart rate on a regular basis and provides comprehensive prenatal care information. Jononi's goal is to improve maternal healthcare outcomes by encouraging self-care, reducing reliance on healthcare professionals for minor issues, and increasing health literacy among pregnant women. Furthermore, Jononi enhances emergency response mechanisms, possibly saving lives, by incorporating intelligent alarm systems and a specific SOS feature. Jononi has the potential to revolutionize maternal healthcare by ensuring a safe and healthy pregnancy for expectant mothers all over the world by closing gaps in healthcare access and offering real-time monitoring and assistance.

Numerous studies have been done to lessen the challenges facing expecting mothers in the area of health. In [9], authors proposed an application to smartly handle or assist pregnant women in their crucial time, to provide pregnant-related dietary guidelines. But the important health parameters were not analyzed in real-time in their application. Some studies worked on only a single application to guide and monitor mothers' health without analyzing the real-time value of the health parameters of their body, by simply asking questions in the application [10], [11].

Despite having multiple facilities, this system may fail to analyze health parameters due to the disconnection of bluetooth with the device. Power failure will shut the whole connection. Again, adding more health parameters with less complexity will make the device more sufficient. Future work will focus on overcoming these limitations and detecting more health parameters to make the device more sufficient.

REFERENCES

[1] H. M. Brown, T. Bucher, C. E. Collins, and M. E. Rollo, "A review of pregnancy apps freely available in the Google Play Store," Health Promotion Journal of Australia, vol. 31, no. 3, pp. 340-342, Jun. 2020.

[2] Sadavarte, S.S. and Bodanese, E., "Pregnancy companion chatbot using Alexa and Amazon web services," in 2019 IEEE Pune Section International Conference (PuneCon), Dec. 18 2019, pp. 1-5.

[3] M. C. . Maduwantha and V. Vithana, "'MumCare': An Artificial Intelligence Based Assistant", IJECER, vol. 1, no. 1, pp. 21–28, Jun. 2021.

[4] B. M. Chaudhry, L. Faust, and N. V. Chawla, "From design to development to evaluation of a pregnancy app for low-income women in a community-based setting," in Proceedings of the 21st International Conference on Human-Computer Interaction with Mobile Devices and Services, Oct. 2019, pp. 1-11.

[5] Dese, K., Ayana, G., Simegn, G. L. (2022). Low cost, non-invasive, and continuous vital signs monitoring device for pregnant women in low resource settings (Lvital device). HardwareX, 11, e00276. https://doi.org/10.1016/j.ohx.2022.e00276

[6] J. Pervin et al., "Developing targeted client communication messages to pregnant women in Bangladesh: a qualitative study," BMC Public Health, vol. 21, no. 1, pp. 1-13, 2021.

[7] K. L. Chan and M. Chen, "Effects of social media and mobile health apps on pregnancy care: meta-analysis," JMIR mHealth and uHealth, vol. 7, no. 1, pp. e11836, Jan. 2019.

[8] Mugoye, Kevin, Henry Okoyo, and Sylvester Mcoyowo. "Smart-bot technology: Conversational agents role in maternal healthcare support." In 2019 IST-Africa Week Conference (IST-Africa), pp. 1-7. IEEE, 2019.

[9] Tumpa, Sanjida Nasreen, Anika Binte Islam, and Md Tasnim Manzur Ankon. "Smart care: An intelligent assistant for pregnant mothers." In 2017 4th International Conference on Advances in Electrical Engineering (ICAEE), pp. 754-759. IEEE, 2017.

[10] Bachiri, M., Idri, A., Fernández-Alemán, J. L., Toval, A. (2016). Mobile personal health records for pregnancy monitoring functionalities: Analysis and potential. Computer Methods and Programs in Biomedicine, 134, 121–135. https://doi.org/10.1016/j.cmpb.2016.06.008

[11] Kulsum, M. U. (2019). Design And Development Of MGA System: A Maternity Guidance Light Weight Mobile Application. https://www.semanticscholar.org/paper/Design-And-Development-Of-MGA-System

[12] Kundu, S., Kabir, A., Islam, M. N. (2020). Evaluating Usability of Pregnancy Tracker Applications in Bangladesh: A Heuristic and Semiotic Evaluation. https://doi.org/10.1109/r10-htc49770.2020.9357061

[13] Kennelly, M. A., Ainscough, K., Lindsay, K. L., Gibney, E. R., Carthy, M. M., McAuliffe, F. M. (2016). Pregnancy, exercise and nutrition research study with smart phone app support (Pears): Study protocol of a randomized controlled trial. Contemporary Clinical Trials, 46, 92–99. https://doi.org/10.1016/j.cct.2015.11.018

[14] Bjelica, D., Bjelica, A., Despotović-Zrakić, M., Radenković, B., Barać, D., ogatović, M. (2020). Designing an IT Ecosystem for Pregnancy Care Management Based on Pervasive Technologies. Healthcare, 9(1), 12. https://doi.org/10.3390/healthcare9010012