Sehat Sathi

A smart wearable ECG device designed for Rural India.

Kutch, Gujarat

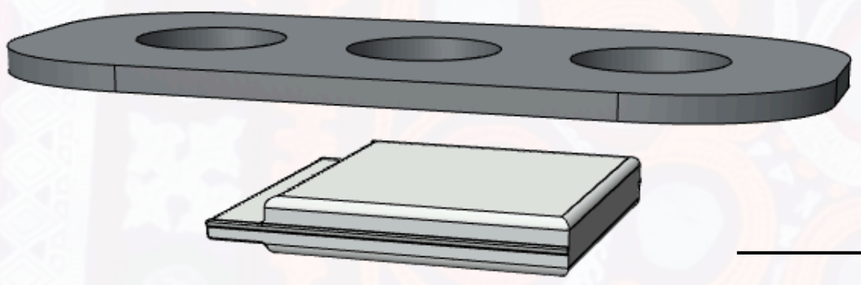
Evolution of Prototypes

In rural India, healthcare accessibility is a significant challenge, with only 30% of medical professionals serving 60% of the population. My design project addresses this issue through an innovative wearable AI-powered ECG monitoring device. This device brings healthcare to people, making it more accessible and less stigmatized.

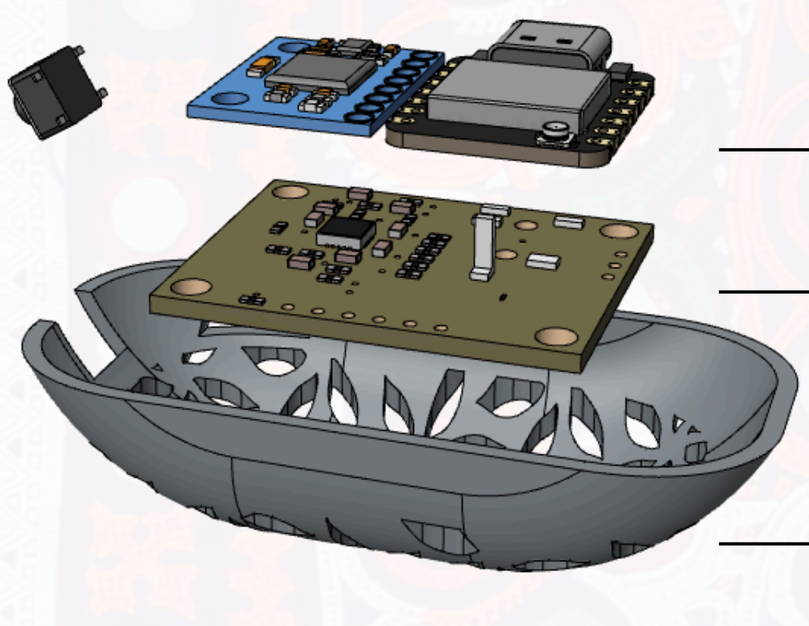
The device features real-time ECG and activity monitoring, with an AI system that detects anomalies and alerts users. Its design, inspired by the cultural aesthetics of the Kutch region in Gujarat, blends seamlessly into the local culture, making it more acceptable and assimilating for users.

Sustainability and cultural sensitivity were key considerations in the design process. The device is detachable, enhancing sustainability by allowing it to be shared within the community and protected during garment washing, aligning principles of sharing and extending product lifespan. Additionally, the design is culturally sensitive with user interactions and system flow carefully designed to be user-friendly and effective.

This project demonstrates the power of design in addressing real-world problems, highlighting the responsibilities of designers to create innovative, sustainable, and ethically sound solutions. By integrating advanced medical technology with cultural sensitivity, this wearable ECG monitoring device aims to transform healthcare accessibility in rural India.



Detaching mechanism and connections
Magnets are used for wearing this device, which also serves as contact points for electrodes for ecg sensor. It is designed so that user can take out the device and easily wash their garment, and charge the device.



Powerful processor
Device is powered by xiao esp32s3, a AI enabled board which runs a machine learning algorithm. It is connected to a 6axis IMU and an ECG sensor, and has haptic feedback.

Motifs that lights up to communicate
The motifs and colors for the light are selected from region, which helps to customise and locate the device within the context of region. This helps in de-stigmatising the healtcare by embedding the device within culture in rural India.

Interactions
Interactions of the device include haptics that can be used to alert user, button and rgb matrix that is used to communicate system status like when user needs to see doctor, or to reward user for goals are achieved .

Real-time ECG and Activity Tracking
With the help of ML on device, it can perform real time anomaly detection and live activity classification to alert user of any anomaly in advance.

Tejas Patel z5454574 Design studio 2 Art and Design, UNSW.

SEHAT SATHI

: Smart wearable ECG for Rural India

Tejas Patel - z5454574

DDES9017 - Design Studio 2

UNSW SYDNEY

ACKNOWLEDGEMENT

I acknowledge the Gadigal people of the Eora Nation, the traditional custodians of the land on which I studied. I pay my respects to their Elders past, present, and emerging, and recognise their enduring connection to this land.

I would also like to acknowledge my peers along with Richu, Roshni, Saumya, Ivan, Jayneel, Shrutidhar and Maitri for their constant support and feedback throughout the course. I would like to thank my tutor Gerhard Bachfischer, lecturers: Prof Stephen Loo and Dr Patricia Flanagan, and all the support staff at UNSW. It was my privilege to work alongside with all these wonderful people.

INTRODUCTION

Cardiovascular disease (CVD) is a leading cause of mortality worldwide, and its impact is particularly severe in rural India. Despite having lower traditional risk factors, the rural population experiences disproportionately high rates of major cardiovascular events, with over half of these cases going undiagnosed (Kalra et al., 2023). This project aims to address these healthcare challenges by developing a smart, culturally sensitive wearable ECG diagnostic device tailored for the rural communities in Gujarat.

The primary objective of this project is to provide accessible and reliable heart health monitoring for villagers who face significant barriers in accessing urban healthcare facilities. By leveraging advanced point-of-care (POC) technology and machine learning algorithms, the device facilitates early detection and diagnosis of cardiovascular issues, enabling timely medical intervention and improving health outcomes (Konwar & Borse, 2020; Maini et al., 2021).

INTRODUCTION

This initiative aligns with the United Nations Sustainable Development Goal Target 3.4, which focuses on reducing premature mortality from non-communicable diseases through prevention, treatment, and promotion of mental health and well-being. By enhancing healthcare access and quality for underserved populations, this project not only aims to improve individual health outcomes but also contributes to broader public health goals in rural India.

Through innovative design and technology integration, the project seeks to transform the management of cardiovascular health, offering a sustainable and culturally appropriate solution to one of the most pressing healthcare challenges in rural India.

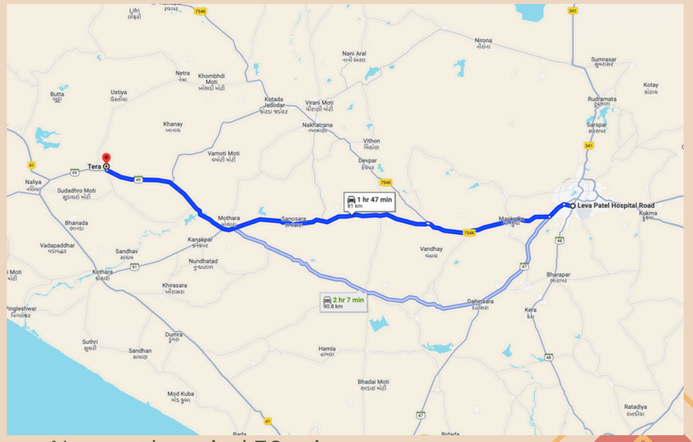
LOCATION

For this project, the focus is on villages in Kutch region in Gujarat, where healthcare accessibility remains a critical challenge. Approximately 57.4% of Gujarat's population resides in rural areas, where healthcare infrastructure is less developed compared to urban centers. Despite recent improvements in healthcare facilities, such as a 41% increase in primary health centers, rural regions still face significant disparities in access to medical care.

The project's target location is the villages in Gujarat, where the population often experiences barriers in accessing timely and adequate healthcare. These areas are characterized by limited transportation options and long distances to healthcare facilities, which exacerbate the challenges of managing cardiovascular diseases. The geographical diversity, from coastal areas to inland villages, requires a tailored approach to healthcare delivery, emphasizing the need for portable and culturally appropriate solutions like the wearable ECG device.

- High Emotion Intelligence

- Rich handicrafts culture



- Nearest hospital 70 mins away

TARGET USER

Primary user

Needs:

Accessible Healthcare: Villagers need a reliable and accessible means to monitor their heart health without having to travel long distances to urban healthcare centers.
Early Detection: Early detection of cardiovascular issues is crucial to prevent severe health complications.
Cultural Appropriateness: There is a stigma attached to visiting hospitals, so the device needs to be culturally appropriate to ensure its use.

User Journey Map:

Initial Awareness: Learning about the device through community health workers.
Acquisition: Receiving the device from a local clinic or health worker.
Daily Use: Regularly wearing the device and monitoring heart health.
Data Review: Checking alerts and data on the device.
Consultation: Visiting a local health worker if anomalies are detected.

(Image source : Canva)

Secondary user

Dr. Meena, a community health worker who travels between villages to provide basic medical services. The secondary users are local healthcare practitioners, including community health workers and local doctors, who provide medical services in rural areas.

Needs and Pain Points:

- Data Collection and Analysis: Practitioners need tools to collect and analyze health data from patients efficiently.
- Remote Consultation: The ability to send patient data to specialists for remote consultation and diagnosis is essential, especially in areas with limited access to cardiologists.

(Image source : Canva)

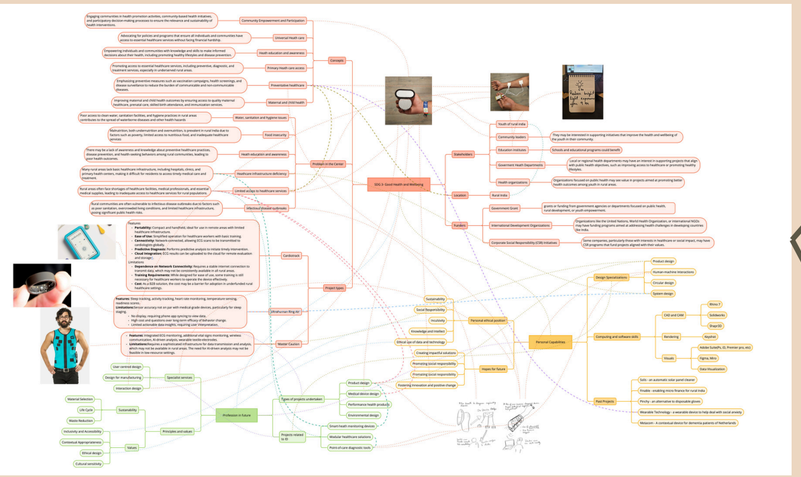
Stakeholders:

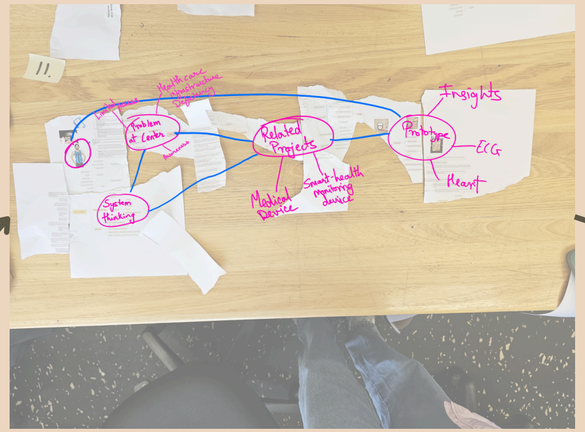
- Primary Users: Villagers in rural India.
- Secondary Users: Local healthcare practitioners.
- Healthcare Providers: Hospitals and clinics providing remote consultations.
- NGOs and Government Agencies: Organizations supporting healthcare initiatives in rural areas.
- Community Leaders: Influential figures in villages who can advocate for the device's use.

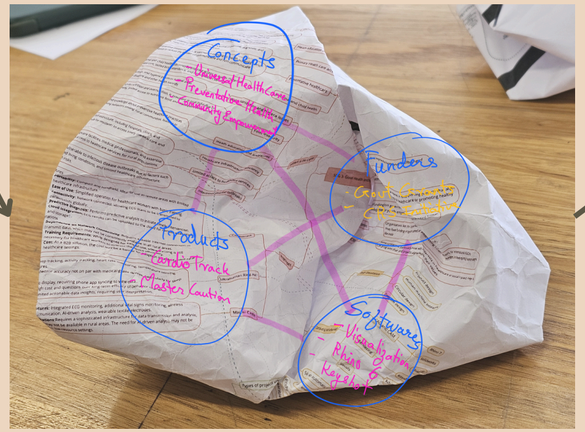
(Image source : Canva)

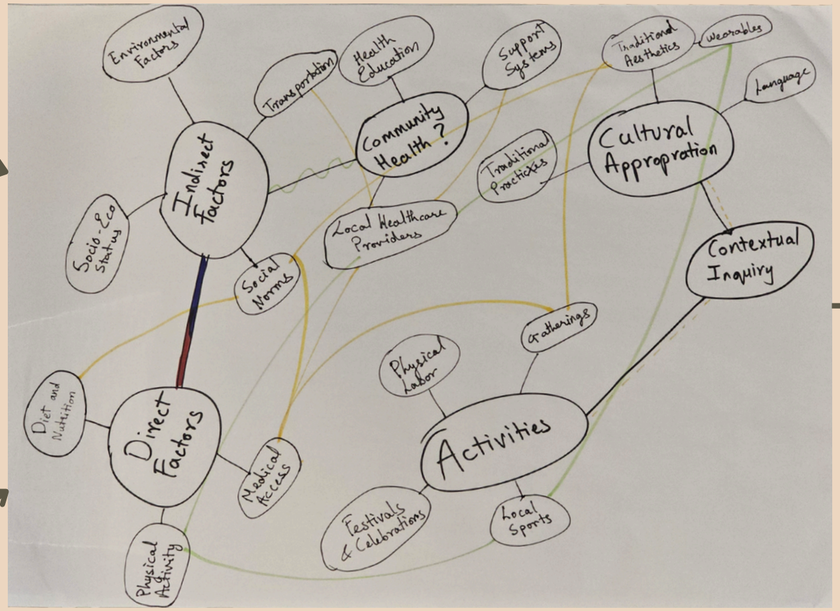
CONCEPTUAL MAP

(Synthesising)

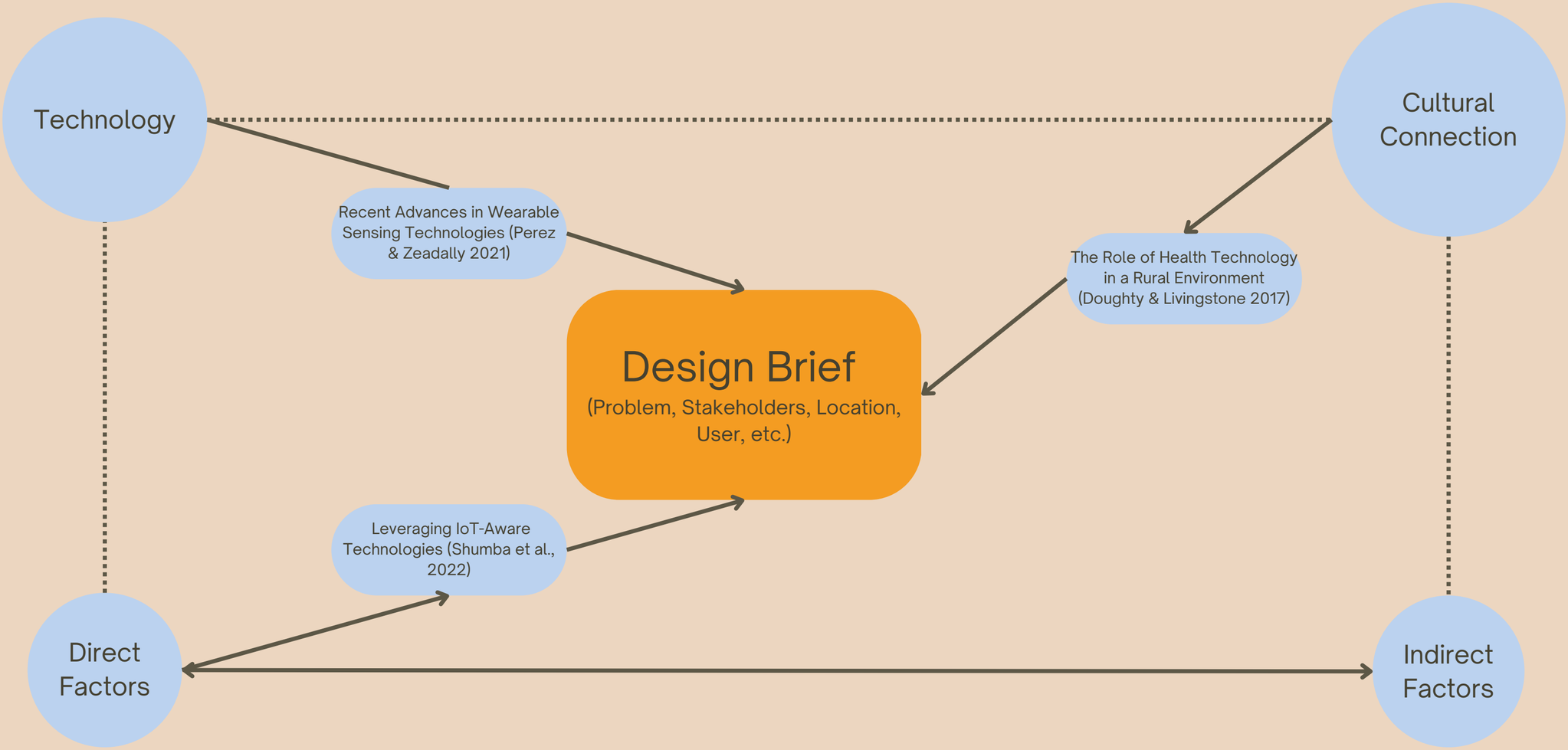








CONCEPTUAL FRAMEWORK



RELEVANT PRECEDENTS

(D-Heart n.d.)

D-Heart Portable ECG Device

Overview:
Cardiotrack is a portable, rechargeable, and Bluetooth-enabled 12-lead ECG device designed for easy use in various settings, including rural areas. It features a long-lasting battery and enhanced signal connectivity, making it suitable for remote healthcare applications.

Strengths:

- Portability
- Connectivity
- Battery Life

Weaknesses:

- Complexity: The 12-lead setup may be complex for non-specialist users, requiring training for effective use.
- Cost: While portable, the cost of the device and its maintenance may still be prohibitive for widespread adoption in low-income rural areas.
- Data Management: Reliance on Bluetooth and internet connectivity may pose challenges in regions with poor network infrastructure.

RELEVANT PRECEDENTS

VivaLNK Wearable ECG Monitor

Overview: VivaLNK offers a wearable ECG monitor designed for continuous cardiac monitoring. The device is lightweight, adhesive, and can be worn comfortably for extended periods, making it suitable for remote and rural healthcare applications.

Strengths:

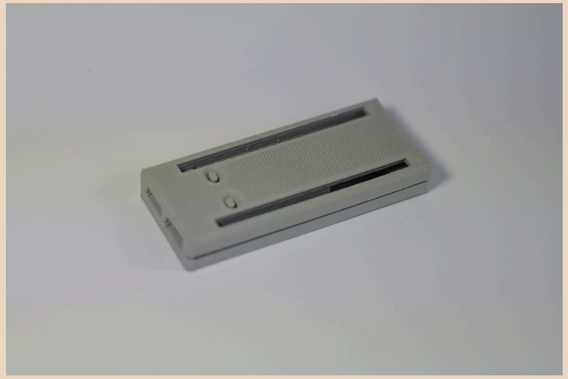
- Continuous Monitoring
- Comfort and Usability
- Data Integration

Weaknesses:

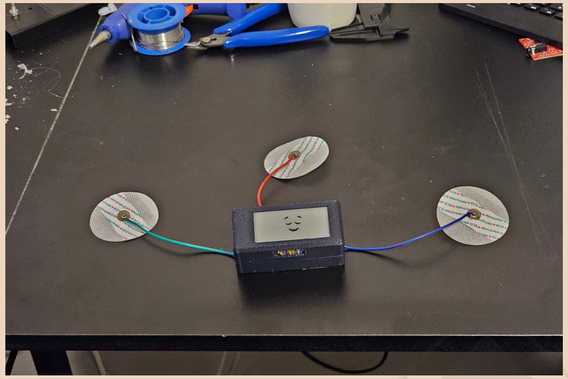
- Battery Life: Continuous monitoring can drain the battery quickly, requiring frequent recharges.
- Cost: The cost of the device and its consumables (adhesive patches) may be prohibitive for widespread use in low-income rural areas.

(Vivalink n.d.)

PROTOTYPING



(Prototype v1)

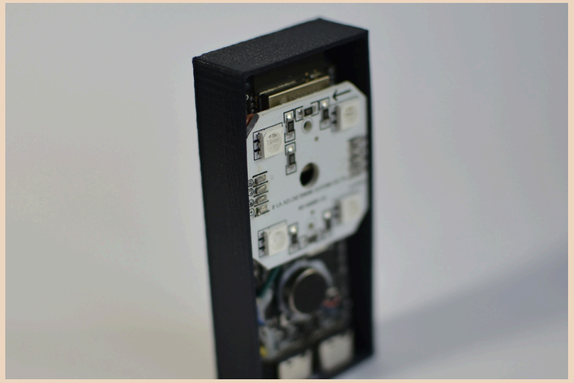


(Prototype v2)

The initial prototype was a 3D-printed case covering the board and sensor, followed by testing digital e-ink displays due to their non-emissive properties. The primary purpose was to serve as a communication tool between the device and the user. Drawing inspiration from emotionally durable design principles, I opted to showcase animated emojis instead of data to convey the device's emotions.

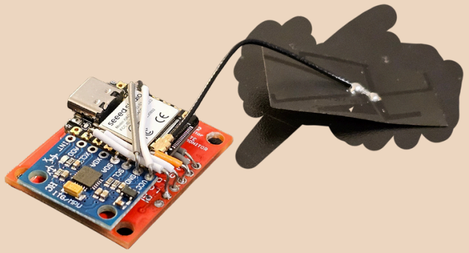
After presenting the prototype in Assessment 1, I began working towards reducing the size and making it more wearable. I was able to shrink it’s size by removing connectors and tidying up the wiring. This prototype also performed realtime activity tracking based on small sample of training data.

(Prototype v2.2)

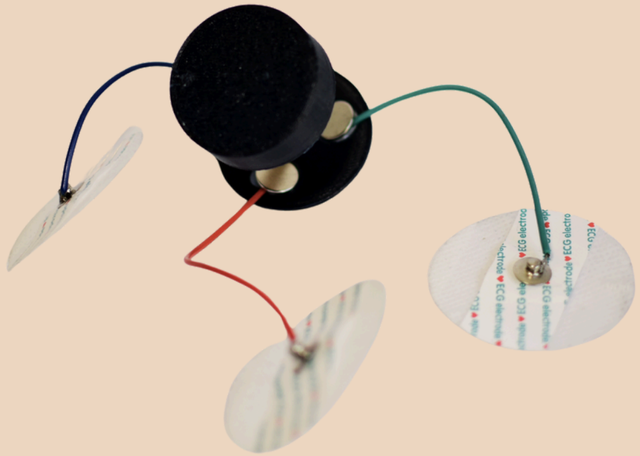


(Prototype v2.2)

(Evolution of Prototype v2 to Prototype v3.2)



(New processor and wiring to reduce size)



(Prototype v3.1)

After realising I could not reduce to size any further with the screen, I decided to experiment on a different direction. I chose to use a latest processor, and with help of AI, I was able to get a functional code to work with. This was also when I was curating interactions based on cultural context. I settled on a RGB light to replace screen, and added button and haptic feedback. I also experimented with attaching mechanism, as by this time I was trying to make device detachable for ease of use and maintance.

PROCESS DIARY

How can I address cultural safety?

Cureus. 2023 May; 15(5): e38934.
Published online 2023 May 12. doi: 10.7759/cureus.38934
PMCID: PMC1025
PMID: 3731

Journal Article

Navigating Cultural Diversity in the Selection of Cardiovascular Device Treatments: A Comprehensive Review

Monitoring Editor: Alexander Muacevic and John R Adler

Md. Rockyb Hasan,[1] Tahsin Tabassum,[2] Tanzin Tabassum,[3] Mohammed A Tanbir,[1] Mahzabin Kibria,[4] Mahidul Chowduary,[5] and Rajesh Nambiar[6]

Author information · Article notes · Copyright and License information PMC Disclaimer

Abstract

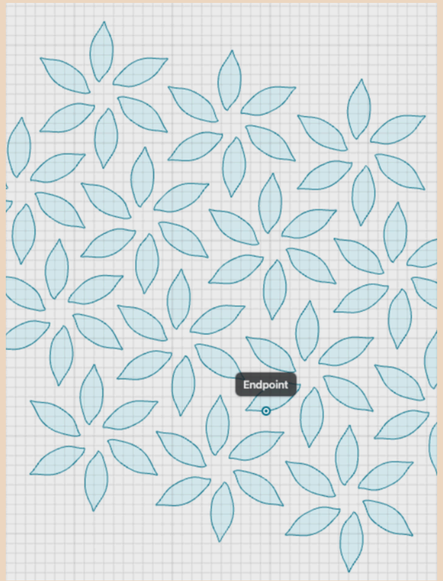
Go to:

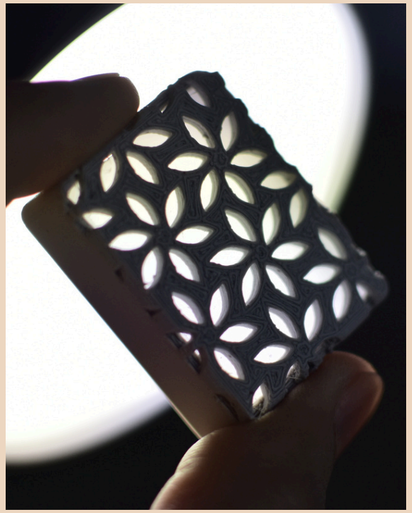
In cardiology, patients' cultural beliefs, linguistic differences, lack of knowledge, and socioeconomic status can create barriers to choosing device treatment. To address this issue, we conducted a thorough literature review using online databases such as PubMed, Google Scholar, and Texas Tech University Health Sciences Center's research portal. Our review found that cultural, religious, and linguistic barriers can contribute to patients' apprehension and reservations about device placement. These barriers can also impact patients' adherence to treatment and clinical outcomes. Patients from lower socioeconomic backgrounds may have difficulty accessing and affording device-based treatments. Additionally, fear and inadequate understanding of surgical procedures can deter patients from accepting device treatment in cardiology. To overcome these cultural barriers, healthcare providers must raise awareness about the benefits of device treatment and provide better training to overcome these challenges. It is crucial to address the unique needs of patients from different cultural backgrounds and socioeconomic statuses to ensure they receive the care they need.

Journal Article

Handicrafts?

Patterns from embroidery





After fixing on the new smaller size and interactions, I worked on connecting this device with culture by using motifs from the regional handicrafts. Thru making interactive motifs, we can de-stigmatise

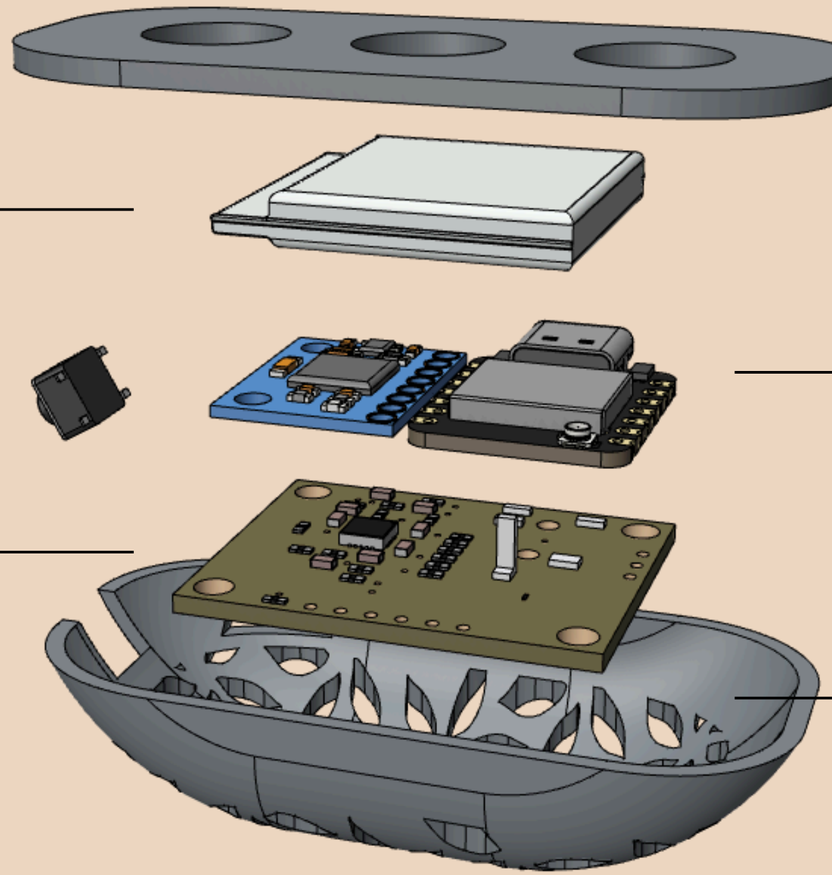
medical device in rural villages. By this time I also upgraded led so that I could animate to create effects and signals that user can associate with. During this part I also experimented with finishes and color.

(Evolution of Prototype v3.3 to v4)

FINAL DESIGN

Interactions
Interactions of the device include haptics that can be used to alert user, button and rgb matrix that is used to communicate system status like when user needs to see doctor, or to reward user for goals are achieved .

Real-time ECG and Activity Tracking
With the help of ML on device, it can perform real time anomaly detection and live activity classification to alert user of any anomaly in advance.



Detaching mechanism and connections
Magnets are used for wearing this device, which also serves as contact points for electrodes for ecg sensor. It is designed so that user can take out the device and easily wash their garment, and charge the device.

Powerful processor
Device is powered by xiao esp32s3, a AI enabled board which runs a machine learning algorithm. It is connected to a 6axis IMU and an ECG sensor, and has haptic feedback.

Motifs that lights up to communicate
The motifs and colors for the light are selected from region, which helps to customise and locate the device within the context of region. This helps in de-stigmatising the healtcare by embedding the device within culture in rural India.

Potential locations to attach the device

BIBLIOGRAPHY

D-Heart. (n.d.). D-Heartcare. Retrieved June 27, 2024, from https://www.d-heartcare.com/en-euDahiya

E. S., Kalra, A. M., Lowe, A., & Anand, G. (2024). Wearable Technology for Monitoring Electrocardiograms (ECGs) in Adults: A Scoping Review. Sensors (14248220), 24(4), 1318. https://doi.org/10.3390/s24041318

Doughty, K., & Livingstone, A. (2017). The Role of Technology in Addressing Health and Social Care Needs and Opportunities in a Rural Environment. The Journal of Corporate Citizenship, 68, 67–81. https://www.jstor.org/stable/26629191

Kalra, A., Jose, A. P., Prabhakaran, P., Kumar, A., Agrawal, A., Roy, A., Bhargava, B., Tandon, N., & Prabhakaran, D. (2023). The burgeoning cardiovascular disease epidemic in Indians – perspectives on contextual factors and potential solutions. The Lancet Regional Health - Southeast Asia, 12, 100156. https://doi.org/10.1016/j.lansea.2023.100156

Konwar, A. N., & Borse, V. (2020). Current status of point-of-care diagnostic devices in the Indian healthcare system with an update on COVID-19 pandemic. Sensors International, 1, 100015. https://doi.org/10.1016/j.sintl.2020.100015

Maini, E., Venkateswarlu, B., Maini, B., & Marwaha, D. (2021). Machine learning–based heart disease prediction system for Indian population: An exploratory study done in South India. Medical Journal Armed Forces India. https://doi.org/10.1016/j.mjafi.2020.10.013

BIBLIOGRAPHY

Neri, L., Oberdier, M. T., van Abeelen, K. C. J., Menghini, L., Tumarkin, E., Tripathi, H., Jaipalli, S., Orro, A., Paolocci, N., Gallelli, I., Dall'Olio, M., Beker, A., Carrick, R. T., Borghi, C., & Halperin, H. R. (2023). Electrocardiogram Monitoring Wearable Devices and Artificial-Intelligence-Enabled Diagnostic Capabilities: A Review. Sensors, 23(10), 4805. https://doi.org/10.3390/s23104805

Perez, A. J., & Zeadally, S. (2021). Recent Advances in Wearable Sensing Technologies. Sensors, 21(20), 6828. https://doi.org/10.3390/s21206828

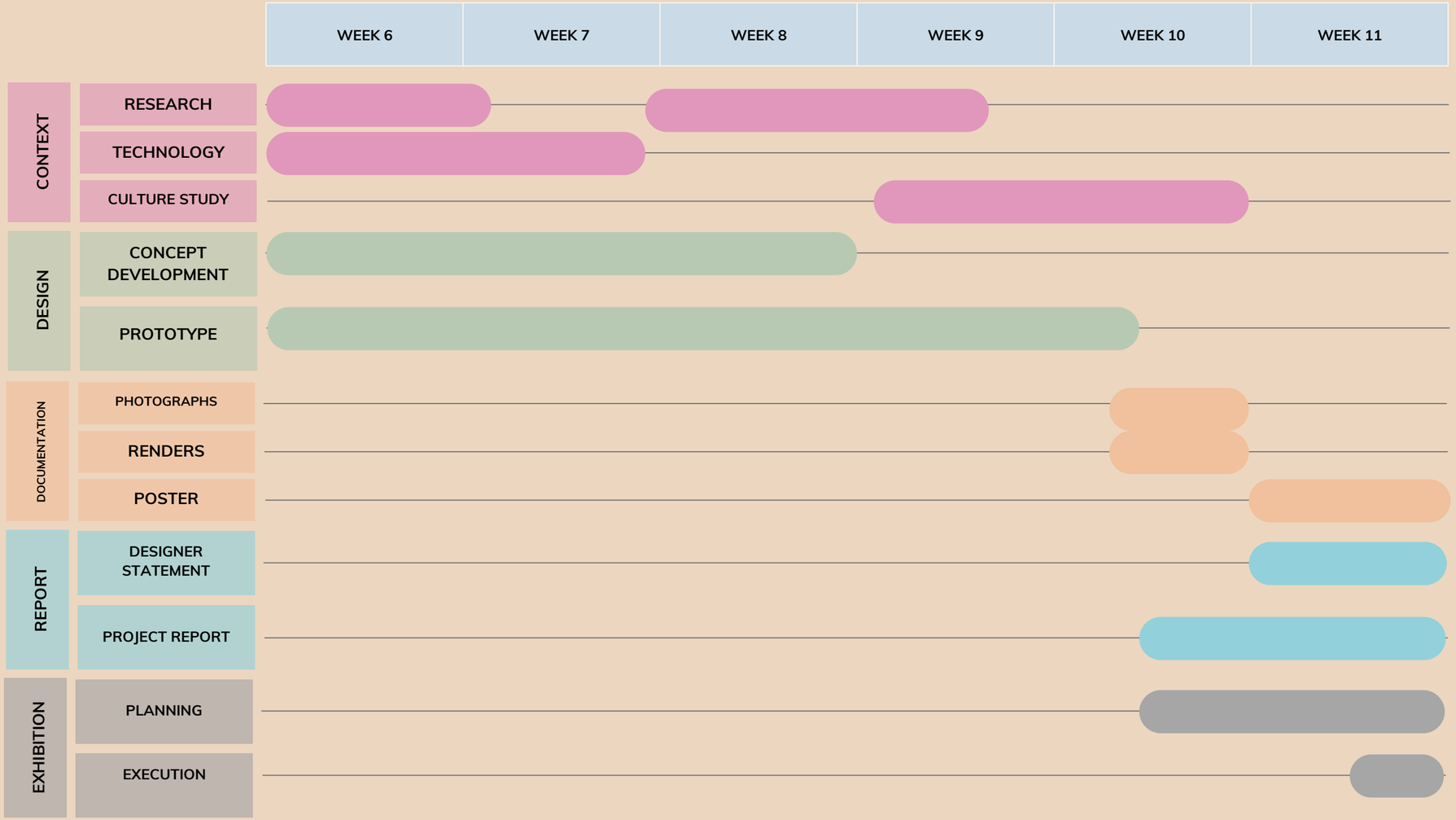
References24/72-Hour ECG Recorder with Screen. (n.d.). Wellue. Retrieved June 27, 2024, from https://getwellue.com/products/ecg-recorder-with-screen

Shumba, A.-T., Montanaro, T., Sergi, I., Fachechi, L., De Vittorio, M., & Patrono, L. (2022). Leveraging IoT-Aware Technologies and AI Techniques for Real-Time Critical Healthcare Applications. Sensors, 22(19), 7675. https://doi.org/10.3390/s22197675

Vivalink. (n.d.). Rural Healthcare. Vivalink. Retrieved June 27, 2024, from https://www.vivalink.com/rural-healthcare

GANTT CHART - TEJAS PATEL

DESIGN STUDIO 2



DESIGNER’S STATEMENT

- TEJAS PATEL

I am Tejas Patel, an Industrial/Product Designer based in Sydney. Born and raised in Gujarat, India, I was deeply influenced by my cultural heritage. My fascination with creating tangible objects led me to pursue a Bachelor's degree in Industrial Design. During my undergraduate studies, I discovered my passion for creating meaningful product interactions, which motivated me to further my education with a Masters in Design at UNSW.

My design philosophy centers on creating meaningful solutions through creative problem-solving. While I adhere to the principle that form follows function, I also believe in the harmonious integration of form and function within a given context. This approach allows me to create designs that are not only functional but also culturally resonant and aesthetically pleasing.

My final design project addresses the healthcare accessibility issues in rural India, where 60% of the population resides but only 30% of medical professionals practice. The project involves the development of a wearable, AI-powered ECG monitoring device. This med-tech innovation aims to bring healthcare to people instead of requiring them to seek it out, thus making healthcare more accessible, less overburdened, and destigmatized. Key features of the device include real-time ECG and activity monitoring, anomaly detection and user alerts, and a design inspired by the cultural aesthetics of the Kutch region in Gujarat, allowing the device to blend seamlessly into the local culture.

The inspiration for this project stemmed from the stark disparity in healthcare accessibility between urban and rural India. By creating a device that integrates advanced medical technology with cultural sensitivity, the project aims to address the critical need for accessible healthcare in rural areas.

DESIGNER’S STATEMENT

- TEJAS PATEL

The innovative aspects of my design project include real-time ECG and activity monitoring, providing immediate health insights, and an AI-powered system that can detect anomalies and alert users, potentially saving lives. Additionally, the design and form are inspired by the Kutch region's cultural aesthetics, helping to destigmatize health devices and encourage their use. The strengths of the project lie in its strong cultural connection, suitability for rural conditions with onboard processing capabilities, and the ability to enable remote health monitoring, reducing the need for frequent hospital visits. However, there are also weaknesses to consider, such as limited battery life, which may be insufficient for extended use in remote areas without reliable electricity, the initial cost of the device, which might be a barrier for widespread adoption in economically disadvantaged communities, and the challenges of ensuring the privacy and security of health data in a wearable device.

One of the major sustainability considerations in my design process was the decision to make the wearable device detachable. According to the butterfly diagram from the Ellen MacArthur Foundation, the innermost loop is *share*. By designing the device to be detachable, it can be shared within the community, enhancing its sustainability. Additionally, this design choice protects the device when washing the garment, thereby extending its lifespan. Ethically, situating the device within the cultural context was paramount. A robust-looking medical device might discourage use, so the design was made to be culturally sensitive. Moreover, the user interactions and system flow were designed with the user's comfort and ease of use in mind, ensuring that the device is both effective and user-friendly.

DESIGNER’S STATEMENT

- TEJAS PATEL

The sustainability and ethical considerations in my design process have reinforced my belief in the significant role and power of design in society. Designers have the responsibility to create solutions that are not only functional and aesthetically pleasing but also culturally sensitive and sustainable. In an increasingly uncertain future, designers must prioritize ethical considerations and sustainability to create products that positively impact society and the environment.

This course has profoundly influenced my design process and philosophy. It has provided me with the tools and knowledge to approach design challenges with a holistic perspective, considering not only the functional and aesthetic aspects but also the cultural, ethical, and sustainability dimensions. For instance, the course content on sustainable design practices inspired the detachable feature of my wearable device. Additionally, the emphasis on user-centered design helped me create a product that is both culturally resonant and user-friendly.

In conclusion, my journey through this course and the development of my final design project have been transformative. They have deepened my understanding of the power and responsibility of design in addressing real-world problems. As a designer, I am committed to creating solutions that are innovative, sustainable, and ethically sound, contributing positively to society and the environment.