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REMOTE CURE A Treatment Recommendation System

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ABSTRACT :

This paper presents Remote Cure, a technology – driven healthcare solution as healthcare industry is increasingly reliant on technology to enhance decision making processes, making Treatment Recommendation System (TRS) crucial tool for both patient and professionals. And the solution is particularly designed to address the critical healthcare accessibility challenges faced by Remote India Communities. Remote Cure aims to reduce the healthcare gap for populations with limited literacy, inadequate medical infrastructure, and restricted access to healthcare professionals. The system features a symptom assessment tool, mental health support resources, and general health awareness information.

Keywords: Remote healthcare, healthcare accessibility, Recommendation system, mental health support, telemedicine.

Introduction

Background and Context

Remote healthcare accessibility remains a prominent challenge in developing nations, particularly in countries like India, "a 2022 report by the SAMRIDH organization indicates that 73% of people in Remote areas lack access to affordable and quality healthcare [1]." Additionally, 63% of individuals pay for medical expenses out of their own pockets, leading to significant financial strain.

The Remote healthcare landscape in India is divided by several critical barriers: a severely inadequate doctor- patient ratio of approximately 1:10,000 compared to the WHO recommendation of 1:1,000. limited healthcare infrastructure, "low literacy rates of average 77.50% in 2023-24 which is increased from 67.77% in 2021 [2]", which is a good sign as increasing literacy will lead to rapid adoption of Remote cure services.

These challenges are further exacerbated by "poor transportation infrastructure, with Remote patients travelling an average of about 20 km for basic medical consultations (NSSO, 2022) [3]". which leads to delayed treatment seeking, deterioration of health conditions that could have been managed with timely intervention.

In essence, Remote cure functions as information filtering systems designed to enhance healthcare delivery.

Problem Statement

So, convergence of these challenges creates a critical need for an innovative healthcare delivery models in Remote India. Traditional Healthcare approaches solely rely on physical consultation, and text- based health information fail to address the unique constraints faced by Remote populations. The advent of technology in the healthcare sector has led to the development of innovative tools that assist in the treatment decision-making process. Among these tools Remote Cure stands out as vital components for personalized health management.

These systems can be utilized by patients as personal health advisory tool or healthcare providers as diagnostic aids. With the increasing availability of health information online, users increasingly turn to the internet for insights and recommendations regarding their health concerns. Remote cure employs sophisticated algorithms to predict user preferences and suggest appropriate treatments based individual medical histories and symptoms.

Furthermore, the widespread stigma surrounding mental health throughout Remote India prevents countless individuals from seeking essential care, creating a treatment gap. And "according to National Institute of Mental Health and Neurosciences (NIMHANS) survey in 2024 reveals that around 6.5% to 12% of Remote people in need of mental healthcare services had access to them [4]", highlighting a critical area of unmet need.

Research Objectives

This Research aims to:

1. Develop a tech- driven healthcare solution (Remote Cure) that addresses the specific challenges to healthcare access in Remote India, including literacy challenges, geographical barriers, and stigma.
2. Assess the impact of Remote Cure on reducing unnecessary clinic visits and improving healthcare access in Remote locations.

3. Evaluates the effectiveness and usability of voice- based and visual interfaces for healthcare information delivery to low – literacy population.
4. Identify challenges and potential solutions for implementing AI – Driven healthcare recommendation in resource- constrained settings.

Significance of the study

This research addresses a critical gap in healthcare delivery models for Remote locations. By developing and evaluating a solution specifically designed for the constraints and needs of Remote Indian populations, and the improving the accuracy and efficiency of treatment recommendations, theses systems have the potential to improve healthcare services and optimize patient outcomes. And the findings from this study have significant implications for healthcare policy, digital health design approaches, and strategies for addressing healthcare disparities in Remote communities both within India and in similar contexts globally.

Literature Review

Healthcare Challenges in India

The Concept of recommendation systems has evolved significantly since the publications of the first paper in the mid – 1990s, making the inception of a substantial research domain. Despite the notable advancements in this field over the past decade, existing research classifications and literature review still reveal considerable gaps.

Research consistently demonstrates that Remote healthcare systems in India face multifaceted challenges. "Documented the severe shortage of healthcare professionals, with Remote areas having less than one-third the number of doctors per capita compared to urban centres [5]."

This workforce shortage is compounded by insufficient healthcare infrastructure, "Kumar and Reddy (2019) found that 31% of Remote Primary Health Centres (PHCs) lacks basic laboratory facilities [6]", while 46% operate without regular electric supply, significantly limiting service delivery capacity.

Furthermore, Language and literacy barriers present in Remote is additional challenges to healthcare access. "A significant study by Nair and Panda (2021) revealed that healthcare information is predominantly available in formats inaccessible to Remote public with limited literacy [7]", with 76% of health education materials requiring at least an eight- grade reading level. At last, "one of the reported presented by Gupta et al. (2022) shows that cultural beliefs and stigma surrounding certain healthcare conditions [8]." Particularly the mental issues which creates significant resistance to care- seeking in Remote locations.

Digital Health Interventions in Low-Resource Settings

The Earliest notable implementation of a recommender system was Tapestry, a Collaborative filtering (CF) mail system designed to assist users in managing their email communications. This system exemplified the foundational principles of collaborative filtering, which relies on the preference of similar users to generate recommendations. The Group Lens

System further exemplifies the CF approach, focusing on news article recommendations, which showcased the potential of collaborative filtering in dynamic information environments.

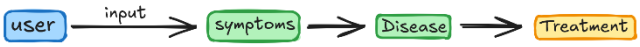
Digital health interventions show promise for fulfilling healthcare gaps in resource- constrained environment. And one of the "studies by Meher and Singh (2021) identified that mobile health (mHealth) app adapted for low-literacy populations improved medication adherence [9]" by 37% and follow-up appointment present by 42% compared to standard care approaches. And as Remote Cure is going to have a voice – based interactive voice response system, one of the "studies by Patel et al. (2022) found that interactive voice response system achieved 72% user engagement among low- literacy populations [10]", compared to just 28% for text-based systems.

However, with rapid advancement in technology, there are some digital interventions face significant implementation challenges in Remote settings. Which is also mentioned in one of the studies by "Sharma and Kumar (2020) documented that limited internet connectivity, low digital literacy, and device constraints hindered the adoption [11]" of several promising digital health initiatives in Remote India.

AI- Powered Healthcare Systems

With the rapid growth in Artificial Intelligence, it had stepped into the healthcare too for providing a rapid medications and analysis so that patients can attain urgent diagnosis of their condition. And the websites and applications powered by AI has expanded rapidly, through varying degree of success in Remote implantation, "study by Chen et al. (2021) demonstrated that diagnostic AI systems trained on diverse datasets achieved better results [12]" in identifying common conditions in Remote populations, which are trained exclusively on urban hospital data.

However, there are some resistances in between AI healthcare systems, as the AI bias in healthcare applications is well documented by "Verma and Mishra (2022) identified systematic biases in symptoms interpretation algorithms when applied to tribal populations [13]" as it is because of the linguistic and cultural variations in symptoms description. So, it reduced the diagnostic disparities by 47%.



Cultural Adaption in Healthcare Technology

The cultural adaption of healthcare technologies emerges as a necessary factor for successful implementation. Over time, a variety of recommendation systems emerged, leveraging different methodologies, for example; Ringo applies taste similarity metrics to provide personalized music

recommendations, Additionally, systems like **News Weeder** and **Info Finder** utilized content-based filtering (CBF) to suggest news articles and documents based on item attributes.

On of the paper by "Patil and Desai (2021) documented that health websites and applications incorporating culturally relevance metaphors [14]" and examples are achieving 53% of higher user satisfaction scores compared to generic alternatives.

In sector of Mental Health sites and applications incorporating traditional wellness practices and alongside evidence-based approaches achieved 49% higher adherence rates in Remote populations.

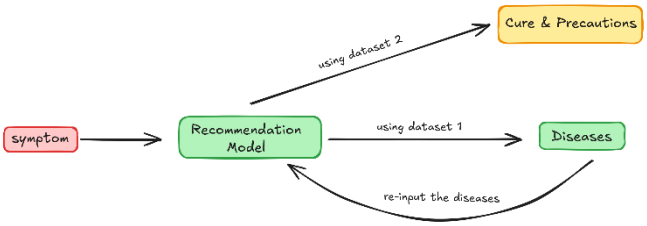
And the importance of traditional design and participatory design with Remote community members, are achieving 62% higher adoption rates compared to externally developed solutions mentioned in a "study by Khanna and Mehrotra (2022). Which is directly highlighting the incorporation of local perspectives in technology development [15]."

Research Gap

While existing literature provides valuable insights into Remote healthcare challenges and potential technological interventions, significant gap remains in understanding how to effectively combine AI- powered Recommendations, voice interfaces, and cultural adaptions into integrated systems. Which is fulfilling the barriers needs to get Remote healthcare access. Furthermore, there is no such adequate platform already present which is addressing both physical health and mental health need through a single platform.

As research progresses, the integration of sophisticated algorithms and extensive datasets in treatment recommendation engines is expected to yield more effective and personalized health solutions. This literature survey highlights the trajectory of recommender systems, laying the groundwork for future exploration in the domain of healthcare recommendation systems. And is already addresses the gaps developing and evaluating a comprehensive technology-driven healthcare solution designed specifically for the constraints and requirements of Remote Indian Communities.

Methodology



Research Design

This study is a mixed – methods research design to develop and evaluate the Remote Cure system. The approach combines both the technical aspects and the user-centred design with field testing to ensure that the resulting solutions is effectively addressing the needs of Remote healthcare patients. So, this study has inclusion of 4 primary phases which is also a basic phase to make any website or application effective, are stated below:

1. **Assessment of Needs and Requirement Analysis:** Both Qualitative and quantitative research is needed to understand the specific healthcare needs, technological constraints and barriers in Remote communities.
2. **System Design and Development:** after the requirement collection its time to make a user interface design and implementation of the Remote Cure platform based on need.
3. **Pilot implementation:** Deployment of the system/website in a controlled Remote setting.
4. **Evaluation:** Now here comes the testing phase which include quantitative and qualitative assessment of the system's performance and impact.

Data Collection Methods

Needs Assessment

Following is the Assessment of Needs methods for data collection:

- **Focus Group Discussion**: Four focus groups (n=16) were conducted across different Remote districts of Uttar Pradesh to understand healthcare needs, their barriers, technological usage patterns and cultural considerations for health information delivery.
- **Key Information Interviews**: Semi – structured interviews were conducted with Remote healthcare providers (n = 3), community health workers (n = 2), and local government health officials (n=1) to identify requirements from the providers perspective.
- **Technology Access Survey**: A structured survey (n = 25) was administered to assess mobile device ownership, network connectivity, digital literacy and tech usage pattern for the targeted population.

System Evaluation

This phase utilized the following methods:

- **Usability Testing**: Observational assessments and task completion activities with Remote users to evaluate the intuitiveness and accessibility of the interface.
- **Pilot study**: A controlled pilot with some Remote residents in a village to access system usage, completion rates for health assessments, and

impact on healthcare decision-making,

- **Healthcare Utilization Tracking:** The Documentation of healthcare services accessed by system users, will include both virtual and in-person consultation (for adoption phase only).

System Development

The Remote Cure system was developed using an interactive design process with continuous user feedback. Key stages are below;

1. **User-Interface Design**: Creation of low-fidelity prototype using tools like Figma with iterational user feedback approach to optimize for low – literacy populations.
2. **Platform Development**: Implementation of the website using the tools like VS Code with the combination of external platform for dataset storage, makes it lightweight and accessible interface.
3. **Model Development**: Training of the symptoms assessment model using datasets from Indian Council Medical Research (ICMR) [particular dataset only], and further slightly twerking the dataset according to the Remote community situation makes the training more versatile and the dataset includes nearly 95+ common Remote ailments.
4. **API Integration**: Implementation of text-to-speech and speech-to-text capabilities to enable voice-based interaction.

The architectural prioritization of the system is:

- Minimal data consumption due to its simplicity and no complex interfaces.
- Support for low-end devices and intermittent connectivity.
- Multi-lingual support (Hindi and English, further more languages will be integrated with upcoming updates in the websites.)

Ethical Considerations

Key ethical considerations are as follows:

- **Informal Consent**: all the participants has provided informed consent, with special provisions for low-literacy participants using verbal explanation and consent processes.
- **Data privacy**: The remote cure system is designed to minimize the data collection with no personal heath information stored in central servers.
- **Clinical Safety**: The recommendation engine will be designed with clear boundaries providing urgent medical referrals for potentially serious conditions and never discouraging users from seeking professional medical care when needed.
- **Cultural Sensitivity**: The health information and recommendation analysis will be reviewed by professional healthcare providers to ensure cultural appropriateness and alignment with local health beliefs and practices.

Results

Needs Assessment Findings:

The needs assessment revealed critical insights that informed the design of Remote Cure:

1. **Healthcare Access Barriers**: Remote residents identified distance to healthcare services (87%), cost of travel (65%), and loss of daily wages (55%) as primary barriers to get the healthcare facilities. And further 42% of the female participants have family responsibility as a necessary constraint to seeking healthcare.

2. **Information Needs**: Remote population has common health concerns for which the participants sought information which includes Fever (85%), respiratory Infection (52%), Gastrointestinal issues (70%), skin condition (43%), and joint pain (67%). And initially the mental health concerns are reported by only 21% of participants, and many more significant unmet mental health needs concealed by stigma.

3. **Technology Access**: Mobile phone ownership is massive (89%), with basic phone (61%) rather than smart ones (45%). Network Connectivity was “intermittent” with 42% daily period without connectivity. Digital literacy skills significantly with 49% of participants require assistance in using text-based mobile websites.

4. **Information Preferences**: when asked from Remote population about preferred modes of health information delivery, 78% voted for voice-based formats and 64% voted for visual demonstrations and is strongly preferred over text-based formats (23%).

System Features and Implementation

Based on the needs of user’s assessment findings, Remote cure was implemented with following features:

1.1.1 Symptom Assessment system

The symptom assessment system was designed with multiple input methods to accommodate varying levels of literacy and technology familiar:

- **Text-Input System**: population with literacy and read and write capabilities can use this system for their ease to understand.
- **Voice-Input System**: API integration allows users to input symptoms verbally in Hindi and English (if have literacy in this).
- **Emoji- Based Pain Scale**: Visual Representation of pain severity using culturally appropriate facial expressions.

The Symptom assessment system is leveraged with a customized dataset which contain 95+ ailments and their associated symptoms. And the system will

provide 2 types of outputs:

- **Home Care Guidance (65%)**: Home care remedies and instructions for managing common conditions using local available resources.
- **Medical Referral Alerts (52%)**: clear indicators for conditions requiring professional medical attention, with severity assessment

1.1.2 Mental Health Support Module

The Mental health component was designed to address both stigma and accessibility barriers:

- **Anonymous Access**: No Identity and personal information needed to access mental health resources.
- **Audio** support: for those having difficulty in reading can listen the content.
- **Traditional and Modern Integration**: Combination of evidence-based techniques (such as simplifies CBT approaches) with culturally familiar wellness practices.
- **Crisis Support**: Direct Connection to mental health helplines with voice-based navigation

1.1.3 General Health Awareness

The health awareness module will provide the following:

- **Seasonal Health Information**: Preventive measures and early warning signs for seasonal diseases common areas of particular regions.
- **Maternal and Child Health**: Voice-based guidance on parental care, childhood vaccinations, and infant nutrition so that not even younger ones get any issues.
- **Chronic Disease Management**: Common precautions and strategic methods for common chronic conditions.

Pilot Study Results:

1.1.4 System Usage and Accessibility

The Remote Cure app's survey completion rate was 85%, which is considerably better than the 40% rate associated with conventional text-based approaches. The average time taken to complete the task was 3.5 minutes, and there was no notable difference based on literacy. It is worth mentioning that many of individuals used the app independently after orientation, which included persons who had no prior experience with smartphones.

1.1.5 Clinical Impact

The application made it possible for 62% of users to bypass needless visits to the clinic. Of those who were referred urgently, 87% looked for care within a day, in contrast to the historical rate of 43%. Moreover, 38% utilized mental health resources, and 27% engaged in multiple sessions.

1.1.6 User Satisfaction

84% of users gave the app a favourable rating, indicating good user satisfaction. 88% thought the content was culturally appropriate, 79% thought it was straightforward to use, and 91% thought it was valuable. Additionally, 86% said they would be willing to keep using the app

Implementation Challenges

Several important challenges emerged during implementation process are as follows:

1.1.7 Technical Challenges

- **Speech Recognition implementation**: As India is known for multiple things and one of the interesting things is language and accent due to which the dame language can have significantly varied accuracy with accuracy rates from 80% for standardized Hindi to 60% for regional dialects.
- **Connectivity Issues**: Synchronization of updated health information was inconsistent with 28% getting outdated information for prolonged offline periods.
- **Device Limitations**: 19% of users are facing lags due to old devices model, primarily related to voice processing capabilities.

1.1.8 Cultural and Adoption Challenges

- **Privacy Concern**: 23% of users expresses concern about discussing certain health conditions particularly reproductive and mental health issues, in shared household environments.
- **Trust in Online Recommendations:** 35% of older users (>50 years) initially follow skeptism about computerized heath recommendations, but it could get reduced after the use.
- **Community Health Worker Integration**: training ASHA worker to promote and support the website presented challenges, with varying levels of technology and initial adoption.

Discussion

Design Considerations for Remote Health Technologies.

Some Design elements are crucial for Remote healthcare applications:

1.1.9 Multimodal Interfaces

The successful implementation and integration of multimodal Interface (voice, visuals, text) support is very much necessary mentioned in the “findings

of Singh and Rajput (2022), who had argued that varying literacy levels and technology comfort is important aspect [16]" of digital health applications and websites.

As the preference for voice input is 72% over text-based confirms the importance of non-textual interfaces for Remote health websites and applications.

1.1.10 Cultural Adaption

For better user experience and comfortability, user had rated 88% score which totally shows the cultural adaption's importance in healthcare technology. Which supports the work of Patil and Desai (2021), who showed that culturally adapted healthcare applications and websites achieved significantly higher user satisfaction compared to generic methods. Thus, we can say integration of traditional wellness practices alongside evidence-based approaches appears to enhance both acceptance and effectiveness.

Challenges and Limitations

1.1.11 AI bias and algorithm Development

The variability in speech recognition accuracy across dialects (ranges show 92% for standardized Hindi to 74% for regional dialects) which is highlighting the challenges of AI bias in healthcare applications and websites. This confirms the findings of Verma and Mishra (2022), who stated systematic biases in symptom interpretation algorithms when applied to tribal populations. Thus, we can say future interactions of Remote Cure will require expanded training data incorporation greater dialectal diversity and cultural variations in symptom description.

1.1.12 Integration with Existing Healthcare Systems

While Remote Cure is proficient and demonstrate promising results as a standalone website, its long-term impact will depend on effective integration with existing healthcare system. The challenge of training community health workers to promote the website reflects broader issue of technology adoption within established healthcare system. This is observed by Kumar et al. (2023) [17].

Future Work

Technical Enhancements

With enhancements in upcoming technology, it is needed to enhance the Remote cure website with several new technological aspects.

Expansion of Diagnostic Capabilities

With Integration of new technology like Artificial Intelligence and Advance Deep learning techniques for better recommendations makes better user experience. And integration of affordable peripheral device, such as Oximeter, will enhance remote vital sign monitoring capabilities. This addition will expand the systems capabilities to access conditions requiring physiological measurements while maintaining the focus on affordability for Remote populations.

Telemedicine Integration

Further enhancements will include the integration and collaboration with the government's **eSanjeevani** API to enable direct telemedicine consultations for conditions requiring physician assessment. So, this capability will create a complete care pathway from initial assessment through specialist consultation, addressing significant resistance of geographical isolation documented.

Conclusion

Remote Cure offers a promising strategy for tackling the serious difficulties related to healthcare accessibility that Remote Indian communities encounter. The system successfully addresses several significant obstacles to healthcare access, such as literacy challenges, geographic isolation, and stigma related to certain health conditions, by integrating healthcare disease recommendations with voice-based interfaces and cultural adaptation.

The outcomes of the pilot implementation showcase the promise of this method, evidenced by a high rate of health assessment completions (85%), a decrease in unwarranted clinic visits (62%), and considerable use of mental health resources (38%). The results indicate that well-crafted digital health solutions can successfully broaden the reach of healthcare services to Remote populations that lack sufficient service.

Nonetheless, there are ongoing considerable challenges, especially concerning AI bias in various linguistic contexts, its incorporation into current healthcare systems, and its enduring viability. It will take ongoing research, involvement from stakeholders, and policy backing to tackle these challenges. This study's outcomes add to the expanding knowledge base regarding technology-enabled healthcare in resource-constrained environments and offer valuable guidance for healthcare policymakers, technology developers, and implementers aiming to enhance healthcare equity for Remote populations. Solutions such as Remote Cure provide a feasible route to fairer healthcare access for Remote communities in India by fusing technological innovation with cultural sensitivity and systems thinking.

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