

Using Technology to Support Healthcare Access in the Northern Regions of Brazil – A Telemedicine-based Approach

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Abstract. Background: Access to primary healthcare services remains uneven in Brazil, particularly in the North region, where geographic distance, low medical density, and logistical constraints limit access to basic healthcare for remote communities. **Aims:** This paper presents a research and development project that aims to support communication between healthcare professionals and residents of remote communities in the North of Brazil through the use of telemedicine resources. **Method:** We conducted field visits and technical assessments in North communities to identify infrastructural, connectivity, and logistical constraints. Based on this analysis, we define aspects such as healthcare workflows, usage scenarios, and a telemedicine solution architecture, including a portable booth and a supporting digital platform. **Results:** We specified modules for vital signs collection, real-time video-based consultations, automatic transcription of medical consultations, and summary generation to support medical anamnesis. It also includes mechanisms for data security and privacy, as well as support for speech recognition and translation in indigenous languages. **Conclusion:** The current state of the project establishes a technical baseline that enables the implementation and evaluation of remote examinations and telemedicine consultations in real-world settings.

1. Introduction

Equitable access to public health services remains a significant challenge in countries characterized by territorial and social inequalities, such as Brazil [Oliveira and Pereira 2024]. In this sense, social inequality regarding access to basic health programs stands out as a problem faced by communities located in the northern region of the country [Garnelo et al. 2018]. Factors that intensify this issue include the low physician density present in the northern region [Scheffer and et al. 2023] and the logistics involved in allocating physicians to hard-to-reach areas [Oliveira et al. 2023]. These challenges intensify social vulnerability in inland areas of the northern region, making it necessary to develop solutions that regulate access to medical resources for people living in such areas.

To overcome these challenges, it is possible to adopt telemedicine-based solutions, allowing access to basic healthcare. Telemedicine refers to the use of Digital Information and Communication Technology (DICT) to deliver healthcare services remotely

[Lisboa et al. 2023]. In this sense, we aim to integrate telemedicine resources to provide access to healthcare professionals in remote communities of the northern region. In this project, our goal is to support communication between these practitioners and community members, utilizing technology to address a relevant problem they face.

Regarding the advances achieved in the context of the project, key characteristics include the definition of the application context, the proposed solution, and the validation of the adopted approach, which represent initial findings. Throughout the execution of the project, we identified constraints related to infrastructure, connectivity, and logistics in communities located in the northern regions of Brazil, with an emphasis on riverside and Indigenous communities. These constraints guided the decisions made throughout the project, defining the telemedicine resources and architectural strategies necessary for conceiving the solution. In this way, we established the requirements, usage scenarios, and telemedicine care flows appropriate to the application context.

The proposed solution will be implemented through a mobile booth, designed for easy transportation to remote communities. This autonomous cabin aims to enable the provision of telemedicine consultations in locations with limited access to healthcare services, offering support for interaction between patients and healthcare professionals. Another benefit includes the reduction of the need for frequent travel to urban centers. Regarding technological resources, we defined modules for collecting patients' vital signs, mechanisms for automatic transcription of consultations, the generation of summaries to support the preparation of medical anamneses, the specification of data security and privacy mechanisms, and support for the automatic translation of Indigenous dialects.

2. Goals

Our primary goal is to **facilitate communication between community members and healthcare practitioners** through Digital Information and Communication Technologies, enabling autonomous healthcare delivery through a telemedicine system. In this context, we aim to install a portable healthcare cabin that can be deployed and operated in any location. This approach enables consultations between community members with the cabin installed and healthcare professionals, aiming to reduce the waiting time for care, prevent unnecessary patient displacement, and expedite the treatment of existing diseases.

To achieve it, we defined specific goals that will support the development project:

- Enable the provision of telemedicine services with real-time clinical data collection in compliance with the Brazilian General Data Protection Law, allowing the conduction of remote consultations and examinations;
- Provide a telemedicine care booth suitable for conducting consultations in different localities;
- Support the clinical process during telemedicine consultations through artificial intelligence resources, including native Indigenous language speech recognition, automatic transcription of consultations, and the generation of summaries as support for anamnesis elaboration;
- Expand the functionalities of a clinical care support platform integrated with telemedicine, including single-lead electrocardiogram analysis, patient data protection and traceability, the production of statistical reports based on population

- data to support decision-making, the issuance of clinical guidance to patients during remote care, and the integration of these functionalities into a web platform;
- Establish an integrated architecture and an optimized care workflow for telemedicine;

3. Adopted Technologies

- **DICT-based telemedicine** for data collection and the execution of examinations in real time.
- **Real-time videocommunication platform** for conducting synchronous video calls during telemedicine consultations.
- **Natural Language Processing** for the automatic transcription of consultations and the generation of summaries to support anamnesis.
- **Automatic speech recognition for native Indigenous languages** to provide support for communication between healthcare professionals and members of Indigenous communities.
- **Web-based telemedicine platform**, including the creation of an interface to mediate interactions between the patient and telemedicine resources.
- **Relational database** for storing system configurations and general records.
- **Container-based provisioning infrastructure using Docker**, responsible for provisioning the system execution environment.
- **Blockchain technology for data security and traceability** to protect patient data, ensuring compliance with the General Data Protection Law.
- **Portable and autonomous telemedicine booth**, a booth prototype with its own energy, communication, cooling, and acoustic systems.

4. Beneficiaries

As direct beneficiaries of this project, members of communities located in remote areas of the country's northern region stand out, including riverside and Indigenous populations part of the *Huni Kuin*. As highlighted earlier, these groups face difficulties characterized by limited access to basic healthcare.

5. Results

As the main results achieved, we highlight the incremental evolution of the system with an emphasis on telemedicine resources. In this sense, we implemented functionalities related to profile and consultation management, interview transcription, automatic translation, and data security, as we describe in the following.

The generation of reports and automatic transcriptions of consultations uses artificial intelligence resources. For this purpose, we adopted *Whisper*¹, which is responsible for capturing the audio from a video and sending it to OpenAI for transcription. In this sense, through simulations, we were able to generate reports that describe the current state of patients, enabling them to support the physician responsible for conducting a consultation in performing the anamnesis and defining the patient's medical evolution. In addition, we also achieved advances in the automatic translation of the *hãtxa kuĩ* language, which

¹<https://openai.com/pt-BR/index/whisper/>

is the language used by the *Huni Kuin* community. To this end, it was necessary to create a dataset composed of different words from this language, which was integrated into the telemedicine service, enabling the automatic translation of the language during the transcription process of a consultation.

Regarding data security, we have adopted blockchain-based technologies to ensure the privacy of data processed during telemedicine consultations. In this sense, its adoption was motivated by the need to ensure that sensitive data is preserved after finishing a consultation. Regarding its use, through the development of a proof of concept, we identified that its application helped maintain the integrity of the data being processed. In this way, we ensured the protection of data in transit during a telemedicine consultation, in accordance with the regulations defined in the General Data Protection Law.

These functionalities allowed the development of a telemedicine solution that supports the delivery of remote consultations, with a focus on communication between healthcare professionals and patients. As future perspectives, we intend to integrate the system with different booth functionalities through specific modules. Additionally, the booths will be relocated to inland areas of the northern region of Brazil to conduct simulations of consultations in real-world settings. This application demonstrates how the use of technological resources can support the resolution of a concrete problem, expanding access to healthcare for inland communities in Brazil.

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References

- Garnelo, L., Lima, J. G., Rocha, E. S. C., and Herkrath, F. J. (2018). Access and coverage of primary health care for rural and urban populations in the northern region of Brazil. *Saúde em Debate*, 42:81–99.
- Lisboa, K. O., Hajjar, A. C., Sarmiento, I. P., Sarmiento, R. P., and Gonçalves, S. H. R. (2023). A história da telemedicina no Brasil: desafios e vantagens. *Saúde e Sociedade*, 32:e210170pt.
- Oliveira, L., Fraccolli, L., and Araújo, S. (2023). Acesso à saúde: desafios, perspectivas, soluções e oportunidades na atenção primária à saúde. *Pedro & João Editores*.
- Oliveira, T. d. S. and Pereira, A. M. M. (2024). Expressions of inequalities in access to health services in Latin America: a scoping review. *Ciência & Saúde Coletiva*, 29:e04932024.
- Scheffer, M. and et al. (2023). Demografia médica no Brasil 2023. Technical Report Informe Técnico nº 01, Faculdade de Medicina da Universidade de São Paulo (FMUSP) and Associação Médica Brasileira (AMB), São Paulo, Brasil. Atualizado com dados do Censo Demográfico 2022 do IBGE.