Leveraging AI for Medical Services

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Abstract:

The recent developments in AI have opened up many opportunities in automating a plethora of tasks that can be time consuming or require specialists who can be hard to come by. The opportunities of using AI in the medical field are plenty, but in the context of our country they can be used to not only improve health care outcomes in villages and towns across the country.

The medical facilities available to the people living out of major metro areas can be scarce. Even in towns, one cannot guarantee access to good health care providers. This forces people to travel long distances to see a good healthcare provider. The field of telemedicine aimed to alleviate these problems and have been successful to some extent, but using this AI we can not only make the process more accessible and efficient but also incorporate the recent improvements in medical transcriptions to allow patients to maintain their own medical records, giving them the flexibility to see other doctors.

1. **Problem Statement**

   The medical facilities in India especially in rural areas and small towns are scarce. This forces people to travel long distances for receiving medical care. Around 30% of people living in rural areas have to travel more than 30 km to receive basic health care. Nearly 44% of older population in rural areas had to seek treatment in urban areas, while 91.6% of ailing elderly received treatment in the same city of their residence.
   The ratio of urban to rural doctors is nearly 4:1 in India. Even in urban areas people tend to go to different doctors for a variety of reasons. In such a case carrying all the medical files from different doctors might become a hassle. To overcome such problems we can use AI and the widespread use of smartphones.

   Various tasks like Automatic Speech Recognition, Named Entity recognition, and other natural language processing tasks have vastly improved due to the rise in efficiency of different Large Language Models. We can leverage this improvement to improve the healthcare outcomes for Indians across various demographics and geographical locations.

2. **Market/Customer Need Assessment**

   This can result in a multitude of problems. People need to match with the schedules for the doctor and in the event the doctor has to cancel the appointment, the patient has already traveled a long distance. The ailment the patient is suffering from might be serious, but can go undiagnosed for a long time due to lack of available resources and the remoteness of the patient.

Even in urban areas, people do visit different doctors depending on their convenience or t the doctor's availability. In such a case it becomes important that the doctor be aware of any pre-existing conditions and previous medications for further treatment. Medical files are important in such scenarios, but we can use technology to eliminate the need for physical files.

Thus, most of the basic healthcare can be administered by the medical providers in a very efficient manner.

In this report I would like to propose solutions to said problems using state of the art LLM models like OpenAI's Whisper model and Named Entity Recognition model.

3. Target Specification and Characterisation

The target of this project is simple:

A. We have to make healthcare more accessible to people living in remote areas.
B. Patients should have a well documented electronic record of their diagnoses and treatments available to them on demand.

These targets can be achieved in the following way:

A. Using LLM models for transcription of input audio. This includes notes by the patient or the doctor or a conversation between them.
B. Giving the patient the ability to list out the problems faced in audio and then transcribing it and translating it into another language if required for the doctor.
C. Having the option for the patient to listen to doctor's notes and instructions in their mother tongue.
D. Converting the conversation between doctor and patient into structured medical health care records for both the doctor as well as the patient.
E. Allow patients to share their medical history to a trusted doctor for better health care service.
F. Using Named Entity Recognition to highlight the terms according to medical relevance for improved efficiency.
G. For regular check ups and basic readings like Blood Pressure,clinics or health care centers of rural areas can be used and observations and notes can be sent to doctors.

4. External Searches

To ensure that the application fulfills the targets, we reviewed existing methodologies used to fulfill the individual components of our proposed model: Transcription models, Translation Models, Medical Named Entity Recognition Models.

4.1 Transcription Models:

The evolution of transcription models has seen remarkable progress within the medical field, spurred by advancements in artificial intelligence and machine learning. Transcription, a critical process in healthcare, involves converting spoken medical information into accurate written text, impacting areas such as clinical documentation, medical reports, and healthcare communication.

The most recent developments in this field with respect to transfer learning and attention mechanisms have enabled accurate text representations for multilingual audio with different speakers across various age groups, accents, genders, ethnicities.

4.2 Translation Models:

Similar to transcription models, translation models have undergone transformational strides, driven by advancements in artificial intelligence and machine learning. Translation, the task of converting text or speech from one language to another, has witnessed notable progress in recent years. The development of these models from simple rule based systems to neural network based models and then attention based systems to the present system which uses zero shot or few shot training, has been transformative to say the least.

4.3 Large Language Models;

The recent developments of large language models spurred by OpenAI's ChatGPT have been phenomenal. LLMs have enabled various NLP tasks to be completed using the same model, this will help us to perform the aforementioned tasks of translation and transcription. For example, the whisper model developed by OpenAI trained on 6,80,000 hours of multilingual and multitask supervised data. The Whisper architecture is a simple end-to-end approach, implemented as an encoder-decoder Transformer. Input audio is split into 30-second chunks, converted into a log-Mel spectrogram, and then passed into an encoder. A decoder is trained to predict the corresponding text caption, intermixed with special tokens that direct the single model to perform tasks such as language identification, phrase-level timestamps, multilingual speech transcription, and to-English speech translation.

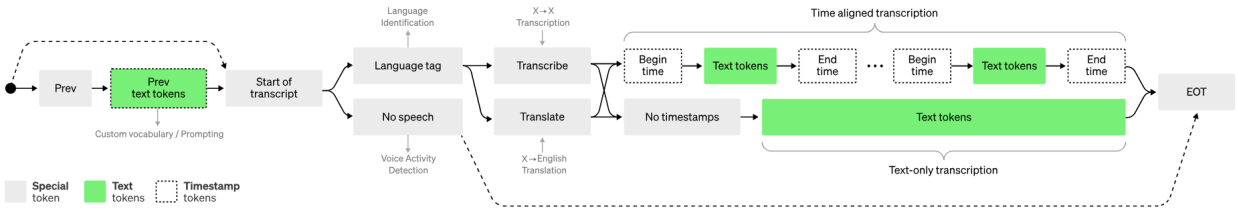

Fig 4.3.1: Architecture of the Whisper Model

4.4 Named Entity Recognition:

Medical records are important resources in which patients' diagnosis and treatment activities in hospitals are documented. In recent years, many medical institutions have done significant work in archiving electronic medical records. Handwritten medical records are gradually being replaced by digital ones. Many researchers strive for extracting medical knowledge from digital data, using medical knowledge to help medical professionals understand potential causes of various symptoms, and building medical decision support systems.

Medical named entity recognition (NER) is an important technique that has recently received attention in medical communities in extracting named entities from medical texts, such as diseases, drugs, surgery reports, anatomical parts, and examination documents. There was a paper published by Wen et al in 2021[3] which used different techniques like In domain training and pseudo labeling to extract entities from unstructured medical health records in Chinese language.

Another model BioBERT which is a fine tuned version of the BERT model was introduced as well. This model was trained on biomedical corpora and is used for data mining on medical texts.

5. Benchmarking Alternate products

There are many transcription services used by doctors. In India, stats are not available but the first name that pops up on searching for transcription services is Augnito AI.

Augnito AI is a UK based company which offers multilingual medical transcription services. It takes an audio input from doctors or nurses and stores it in electronic health record form. Its services require specific instructions to change entry columns.They claim that their Ambient service can automatically fill out the medical form based on conversation between doctor and a patient.

The company offers only transcription services for medical professionals to store data which is compatible with major medical databases.

6. Applicable Regulations

The applicable regulations are:

1. Adherence to data protection regulations such as GDPR (General Data Protection Regulation) or HIPAA (Health Insurance Portability and Accountability Act) to ensure the privacy and security of patient data.
2. Obtain informed consent from patients before using AI technologies in their diagnosis, treatment, or care. Patients should be aware of how their data is used and the potential impact of AI on their healthcare.
3. Develop AI systems that are transparent and provide clear explanations for their decisions. Users, including healthcare professionals, should understand how the AI arrives at its conclusions.
4. Comply with regulatory frameworks specific to medical devices and AI in healthcare, such as those established by the FDA, MoFHW, and other relevant health authorities.
5. Design AI systems that can seamlessly integrate with existing healthcare information systems, promoting interoperability and ease of use within the broader healthcare ecosystem.
6. Establish clear lines of accountability for the use of AI in medicine. Determine who is responsible in the event of errors or adverse outcomes and clarify liability issues.
7. Implement systems for ongoing monitoring and auditing of AI applications to identify and rectify any issues that may arise during their use in clinical settings.

7. Applicable Constraints

The varying constraints of this project are:

1. There are datasets available for NER in indic languages, but specific datasets for the medical domain are lacking.
2. Development of our models to be compatible withElectronic Health Records (EHR) which are compatible with existing medical databases.
3. Data confidentiality must be maintained during the training process.
4. Necessary steps need to be taken to ensure privacy of patient data.
5. Establishing rules for a patient to share his/her data to ensure they don’t accidentally compromise their own data.
6. Ensuring data transparency for the users.
7. Persuading doctors and hospitals to form some sort of cooperation agreements with clinics in semi urban and rural areas.

8. Business Opportunity

In India, it is expected that expenditure of AI in the health market will grow from $14.6 billion to $102.7 billion in 2028. Hospitals all across India are investing in AI to improve diagnoses, treatment and patient care. Using this app, hospitals will have an unique opportunity to expand their services to semi urban and rural areas by tying up with smaller clinics and hospitals for providing their patients with basic services depending on severity of symptoms. Basic tests and readings can be taken in these clinics and then depending on results further treatment can be suggested by doctors in urban areas.
Thus AI can be used for re-imagining telemedicine and health care dispensation in India.

9. Concept Generation

The concept at the very base of this application is the ability for a patient to speak in their own language the problems they face, the application to transcribe that audio, translate the text if required and send the text file to the doctor highlighting the entities in the text.
Similarly the doctor would send some instructions in text which can be translated in the native language and then convert it into audio.

Depending on the severity of symptoms the doctor can either suggest for immediate checkup in a major hospital or refer any routine checkups or small treatments to a local health center or clinic, closest to the patient.

Throughout this process the doctor and the patient will each have a copy of the medical health records of the patient. Even if the user is living in an area with access to good healthcare, this app can simplify appointments with doctors and increase the efficiency of the entire process.

10. Product Details and Technical Specifications:

Based on the concept, we can generate the following flowchart:

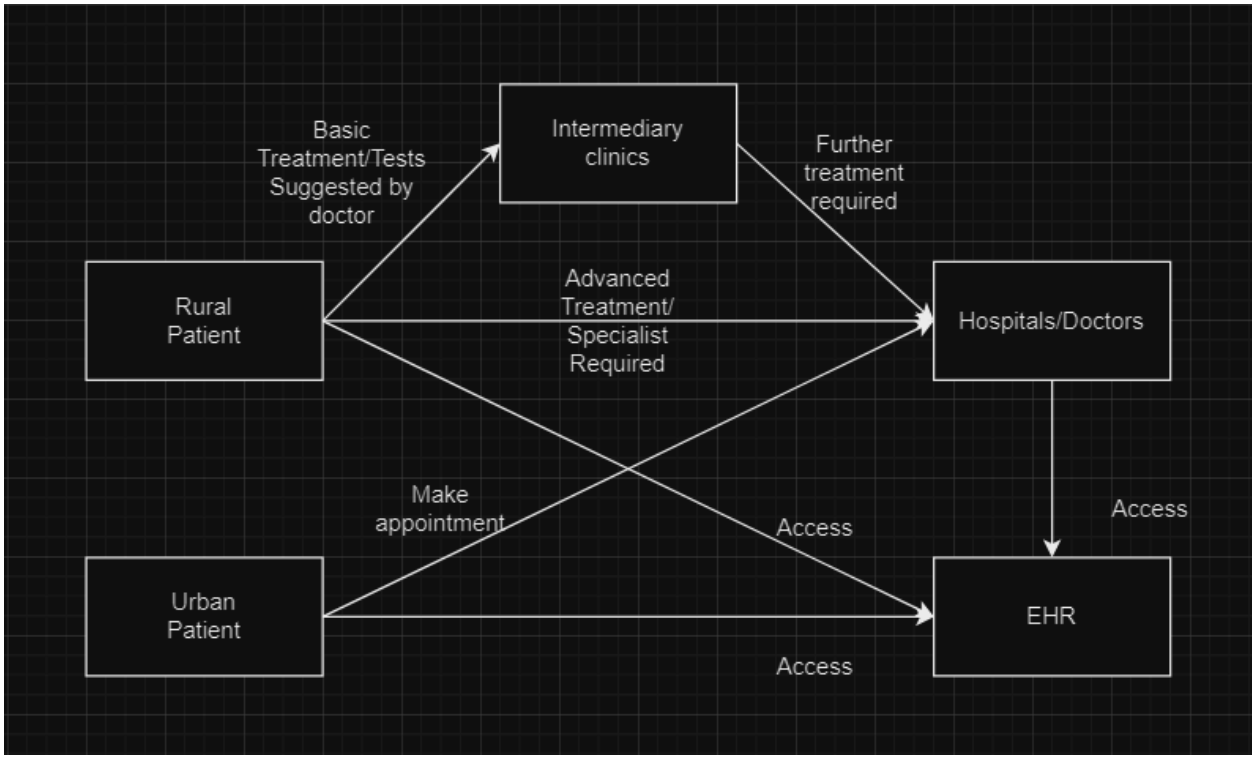

Fig 10.1: Proposed Treatment Flowchart

After reading the report generated by our app, the doctor can suggest three things based on symptoms: change medication, ask for basic reports through intermediary clinics or ask the patient to seek required treatment immediately. After receiving the basic reports through the same process, wherein the medical professional sends a report to the doctor through the app, the doctor can convey the next steps directly to the patient or the hospital.

For the patient in urban settings there is no use for the intermediary clinics. At any time the patient can access their health records securely updated by doctors.

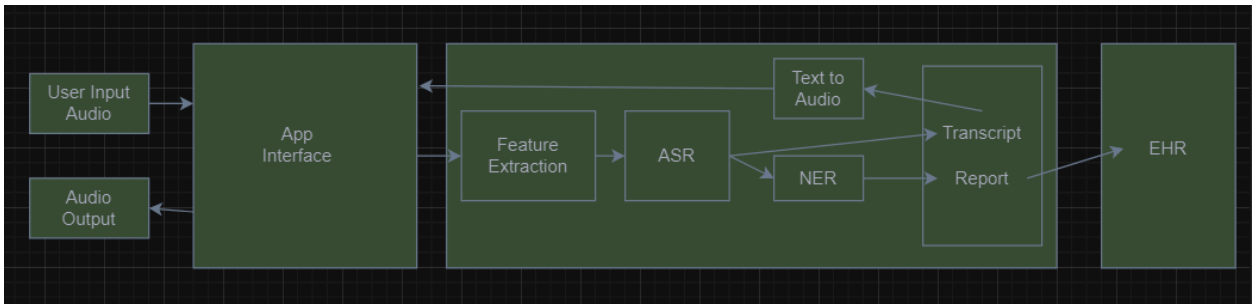

Fig 10.2: Flow Diagram of proposed solution.

After a speech input is given it undergoes feature extraction after which they are put through the Automatic Speech Recognition (ASR) Model and Named Entity Recognition (NER) model to generate transcript and report. Report is then added to the EHR according to the prescribed format. The transcript can then be either read or put through a Text to Speech model to get the audio version.

The entire app needs to be made using technologies like Swift, Kotlin and will require DevOPs team to not only host the application but to keep the app updated through CI/CD techniques.

The team will require:

- App Developers
- DevOPs Engineer
- UI/UX Designer
- NLP and Deep Learning Engineers
- Data Scientists
- Domain Specialists (Medical Field)
- Linguists
- Data security Experts

11. Conclusion

AI has revolutionized various aspects of human life and it is here to stay. It is being adopted widely in the medical field and its use will only increase over time. In India, the medical services are disproportionately available to the urban city centers. This creates a huge gap which can be bridged using modern technologies. Investment in medical services for rural India is lacking and doctors are not available in these areas. Thus we can use AI and Cloud to alleviate this lack of investment and doctors to reduce the treatment time for rural patients. It can also be used to help patients reduce their dependence on the file system for maintaining their medical records, which will greatly improve the quality of treatment they receive as all their medical history will be easily available to the doctors.

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