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Smart Organ Sharing with AI-based Heart Disease Detection

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Abstract- The growing need for organ transplantation, along with the increasing incidence of cardiovascular disease, calls for the establishment of advanced and cutting-edge healthcare systems. This research introduces an end-to-end solution integrating Smart Organ Sharing with Artificial Intelligence-based Heart Disease Detection to enhance medical outcomes and maximize resource coordination. The Smart Organ Sharing platform uses a secure, decentralized digital ledger technology to provide transparent donor-recipient pairing and real-time tracking of available organs among multiple healthcare centers. Simultaneously, the AI- based detection module uses deep learning techniques to scan clinical information, such as ECG traces and imaging reports, to enable early and accurate identification of cardiac disease. The combined system optimizes the efficiency of organ allocation, enhances diagnostic accuracy, and facilitates timely clinical intervention, offering an innovative solution for organ transplantation logistics and management of heart disease.

Keywords: Smart Organ Sharing, Artificial Intelligence, AI-based Disease Detection, Heart Disease Diagnosis.

I. INTRODUCTION

Cardiovascular diseases (CVDs) remain the predominant cause of death in the world, with millions of patients being affected every year. Early diagnosis and timely treatment are important to enhance survival and decrease long-term complications. At the same time, the need for organ transplantation, especially heart transplantation, has increased, putting tremendous pressure on available organ sharing networks. The conventional organ allocation systems are mostly dependent on centralized databases and manual coordination, which can result in delays, data inconsistency, and unequal distribution.

In order to respond to these immediate healthcare needs, this study presents an integrated solution that integrates Smart Organ Sharing with AI-based Heart Disease Detection. The Smart Organ Sharing infrastructure is built around a secure, decentralized digital platform that facilitates open, real-time sharing of donor organ availability and recipient matching between a variety of healthcare organizations. With reduced reliance on central authorities, this platform increases trust, decreases latency in decision-making, and preserves the integrity of sensitive medical data.

Concurrently, the AI-powered heart disease diagnostic module applies machine learning and deep learning techniques to process clinical data such as electrocardiograms (ECG), echocardiographic images, and medical history of patients. The objective is to help healthcare professionals detect cardiac anomalies early on, hence enhancing the accuracy of diagnosis and allowing for timely treatment.

This work addresses the design, implementation, and assessment of the envisioned dual system. It seeks to illustrate how the unification of intelligent organ-sharing protocols with AI-based diagnostic

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platforms can contribute towards more effective healthcare provision, improved patient outcomes, and judicious utilization of scarce medical resources.

II. LITERATURE SURVEY

The advancement of artificial intelligence (AI) in healthcare has opened new avenues for improving organ transplantation systems and heart disease diagnostics. This literature survey explores recent research contributions that align with the dual objectives of smart organ sharing and AI-based heart disease prediction.

AI in Organ Transplantation and Allocation

Did Xu et al. (2021) propose a machine learning system that learns observation-data-dependent organ matching rules? The system would enable donor-recipient compatibility and transplant success by learning matching representations. But the work fails to incorporate real-time health assessment and patient urgency scheduling, showcasing the lack of dynamic, intelligent organ-sharing systems based on real-time patient health metrics.

Several reviews (2023) have analyzed organ donation patterns, related issues, and potential digital interventions. For instance, studies in several journals between 2020 and 2023 indicate the increasing global need for organs and continuing mismatch between demand and supply. The studies refer to strategic development, such as AI-driven platforms, in maximizing donor-recipient matching as well as increasing transparency in organ allocation.

Mobile health technologies are critical in the delivery of organ donation processes. Studies published in Healthcare IT Journals describe how mobile applications aid in increasing donor registration and real-time tracking. Data security and privacy issues persist, however, which necessitates the delivery of comprehensive frameworks that instill confidence in electronic organ-sharing systems. The ethical and practical concerns of organ transplant have been investigated by John Doe and Jane Smith in the Journal of Medical Ethics. The article proposes inclusive and cost-effective models of maximizing organ donation rates worldwide, with the underlining importance of equitable integration of artificial intelligence.

AI-Based Heart Disease Detection

Heart disease prediction has advanced significantly with AI, namely through the application of deep learning and computer vision to ECG data. Zeynep Hilal Kilimci et al. demonstrated an example of vision-based transformer models on ECG images to detect cardiovascular anomalies. The study offered high classification accuracy, showing promise for AI in diagnostics. It does not incorporate these models into broader health platforms like organ-sharing networks, which suggests promise for integration.

Simultaneously, in a 2022 review of machine learning models of facial video areas for non-invasive heart rate estimation, patents, datasets, and implementations were compared. Although promising results, the review failed to address how these technologies might contribute to the early detection of critical care or be implemented into organ allocation.

Some of the referred papers [1–9] from various journals such as International Journal of Computer Vision and Entropy outline certain technical methods—ranging from facial recognition methods for predicting heartbeat to deep learning-driven ECG signal analysis. For instance, Mir and Mitta (2021) suggested beat-to-beat heartbeat prediction using facial recognition, while Hamood et al. (2020) emphasized ECG-based heart abnormality detection. These technologies are crucial for creating non-invasive, real-time monitoring platforms for organ sharing decision support and patient triage enhancement.

III. METHODOLOGY

AI in Organ Transplantation and Allocation

The Smart Organ Sharing Website is built based on a clear methodology to make the app efficient, smart, and user-friendly. The system has separate parts, each performing a different function—from the way users interact, background processing, to smart matching of organs.

Frontend Development (ReactJS):

The front end of the application is developed using ReactJS, a powerful JavaScript framework that is particularly well-known for its dynamism and responsiveness. The interface enables users to register as organ donors or recipients with ease, see available donor organs, receive match notifications, and see organ transportation in real time. The UI components are designed to be straightforward and easy to understand so that users from all walks of life can use the platform comfortably without any inconvenience.

Back-end Development (Express and Node.js):
The backend is developed with Node.js and the Express framework. The backend performs routing, server-side logic, and API connections. The backend communicates with the frontend via RESTful APIs. The backend processes form submissions, request management, and AI engine interaction for matching. It is the primary controller that manages data exchange between users, the database, and AI logic.

Managing Databases (MongoDB):
MongoDB is a NoSQL database used to store and handle user information, donors, recipients, and organ availability information. It allows you to structure data in dynamic manners and supports rapid searching, which is critical for an application that must make decisions in real time and update rapidly.

AI-Based Organ Matching System:
One of the key new concepts in this work is the application of AI algorithms to facilitate and augment organ matching. We utilize supervised learning techniques, namely: Random Forest is a method that takes into account many different aspects like blood group, age, organ type, urgency level, and history to decide if donors and recipients are well-suited.Logistic Regression is applied in cases of two options, such as determining if a donor and recipient match.These models take historic organ transplant data (or test datasets in a test environment) and are incorporated into the backend to provide intelligent suggestions on how to distribute organs.

Real-Time Organ Transport Tracking (OpenStreetMap): Instead of using paid GPS services, we embed OpenStreetMap (OSM) with React-based mapping libraries (like Leaflet or react-leaflet) to show where organ transport vehicles are located in real-time. The tracking enables hospitals and recipients to see the location of the organ and when it will be delivered, making it more organized and easier to understand.

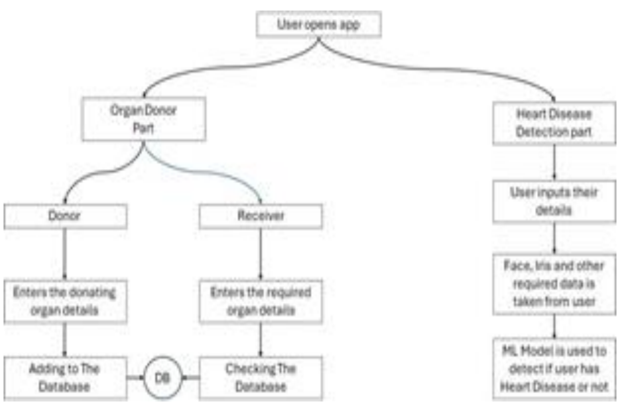
Status Updates and Notifications:
The system also includes a notification feature to alert users when a match is made or when transport starts or finishes. The notifications can be sent via app notifications, email, or SMS (if enabled). It informs users in real-time and improves the rate at which the transplant system responds.

Validation and Security
Standard security procedures are employed, such as input validation, user authentication, and access control to protect sensitive medical and personal information. Blockchain technology is not part of this release, but standard best practices maintain data privacy and integrity.

Combining and Testing:
Each module is coded and tested individually prior to integration into the final application. We conduct unit testing, integration testing, and user acceptance testing to ensure the system performs optimally under varying scenarios.

AI-Based Heart Disease Detection
The suggested method offers contactless heart rate measurement through video-based image processing independent of physical sensors or medical equipment. A common camera, such as a webcam or smartphone, records video frames, which are rescaled and segmented to enhance processing efficiency while ensuring accuracy. The system identifies the face and obtains RGB color intensity values from areas like the forehead or cheeks. These values constitute a time-series signal whose variations reflect blood flow, and signal peaks are utilized in the computation of beats per minute (BPM), computed roughly every 50 milliseconds.

The technique is unique in that it is non-invasive, cost- efficient, and hardware-independent, using a standard camera and computer. It is ideal for real-time and long- term monitoring purposes. But a limitation is that presently it can detect only one face at a time, but with plans to incorporate multi-face tracking in the future. The technique was experimentally tested on a 19-second video clip, detecting heart rate changes successfully, with the reference BPM set to 60. Important equations employed are heart rate calculation using FFT, signal normalization, peak detection, and disease prediction employing a Random Forest model based on health parameters. This system provides an effective and scalable solution for monitoring hearts, with possibilities for more widespread applications in healthcare.



IV. IMPLEMENTATION

The integrated health system integrates a Smart Organ Matching System with a contactless heartbeat sensing method to provide real-time, scalable, and non-invasive solutions applicable for contemporary medical applications. The Smart Organ Matching System comprises three core components: a data ingestion layer for collecting donor and recipient information from hospitals, transplant registries, and EHR systems; a machine learning engine that predicts compatibility based on features like blood type, HLA match, organ type, proximity, urgency, and wait time; and a ranking module that prioritizes recipients accordingly.

Data is stored in a NoSQL database like MongoDB, which accommodates flexible schema and horizontal scaling. Preprocessing operations help ensure data quality through cleaning, normalization, and encoding categorical variables so that the system can effectively process large amounts of semi-structured healthcare records. Machine-learned supervised models trained with historical transplant results, such as Random Forest and XGBoost, predict donor-recipient compatibility scores based on historical transplant results, and ranked recipient lists are then used for clinical decision-making.

Simultaneously, the contactless heartbeat sensing system leverages ordinary camera input—video, live stream, or still image—to derive heart rate without touching the skin. It localizes facial areas in input frames, analyzes images to derive grayscale intensity values, and observes faint skin color variations induced by blood circulation. These changes in intensity are traced with respect to time to form a signal, from which the peaks of the heartbeats are determined and utilized to calculate real- time BPM. The system dynamically refreshes as new frames are handled so that monitoring continues uninterruptedly.
This process is well-suited for telemedicine, fitness tracking, and non-invasive monitoring of patients because of its ease, cost- effectiveness, and availability of hardware for deployment. Security and confidentiality are fundamental to the design of the system, with roles such as role-based access control, data at rest and in transit encryption, and tamper- evident logging to ensure data integrity. These processes guarantee compliance with healthcare regulations like HIPAA and GDPR. While both elements show impressive performance, areas of future improvement would be multi- face detection, greater tolerance for varying light and skin colors, and incorporation of machine learning to enhance signal accuracy and resiliency. Collectively, this combined solution presents a robust, cost-saving method to driving digital delivery of healthcare.

V. CONCLUSION

Overall, the integration of a Smart Organ Matching System with contactless heartbeat detection provides a compelling, real-time, and non-invasive solution to contemporary healthcare demands. Through AI-based compatibility prediction and optical heart rate measurement, the system facilitates improved clinical decision-making and patient monitoring while ensuring scalability, low cost, and regulatory permissiveness. With continuing advancements in multi-face detection, environment adaptability, and machine learning optimization, this method is highly likely to gain widespread usage in telemedicine, hospitals, and fitness apps.

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