**Project ID :**

25-26J-471

1. Topic (12 words max)

AI-Powered Cardiac Diagnosis Support System for Local Hospitals

1. Research group the project belongs to

**SST - Software Systems & Technologies**

1. Specialization of the project belongs to

**Software Engineering (SE)**

1. If a continuation of a previous project:

|  |  |
| --- | --- |
| Project ID | N/A |
| Year | N/A |

1. Brief description of the research problem including references (200 – 500 words max) – references not included in word count.

Heart diseases are the leading cause of death worldwide, accounting for nearly 32% of all global deaths, as reported by the World Health Organization (2021) [4]. Despite medical advances, **the lack of timely and accurate diagnosis of cardiac conditions remains a pressing challenge,** especially in the healthcare systems with limited resources such as those in Sri Lanka. In rural and semi-urban areas, the availability of experienced cardiologists is limited, and diagnosis often relies heavily on **subjective interpretation** of electrocardiograms (ECGs), heart ultrasounds, and other clinical findings by general practitioners. This introduces a high risk of **Diagnostic errors or delays,** which can be fatal in acute heart events such as myocardial infarctions.

Moreover, with the growing number of patients and limited diagnostic infrastructure, doctors are increasingly burdened with time constraints, leading to **diagnostic fatigue**. The **complexity of ECG patterns** and the subtle nature of early-stage cardiac abnormalities further complicate early detection, which often requires specialized expertise. In recent years, Artificial Intelligence (AI), particularly deep learning models, has shown great potential in automating and enhancing cardiac diagnosis. Studies have demonstrated that AI algorithms can analyze ECG waveforms and echocardiograms with performance **comparable to expert cardiologists** [1], [2].

However, existing AI tools often function as black boxes—providing diagnostic outputs without transparent reasoning, raising **concerns about explainability, accountability, and clinical trust**. Additionally, most commercial models are trained on datasets from Western populations, which **limits their generalizability and diagnostic accuracy in South Asian contexts** due to demographic and physiological differences [3].

This project aims to develop an AI-assisted heart diagnosis system **specifically tailored to the Sri Lankan healthcare environment**. It will integrate multiple inputs such as ECG data, patient history, and clinical symptoms to not only generate diagnostic suggestions but also **offer interpretable insights** into the model's reasoning. This transparency is crucial to enhance physician trust, reduce diagnostic errors, and support junior and non-specialist doctors in resource-constrained settings. The final objective is to develop a **lightweight, secure, and offline-compatible** tool that can be deployed in hospitals or clinics without requiring continuous internet connectivity or high-performance computing infrastructure.

By equipping medical professionals with **reliable and explainable AI-powered decision support**, this project contributes to scalable, equitable, and efficient cardiac healthcare delivery in underserved regions.

[1] Y. Hannun *et al*., “Cardiologist-level arrhythmia detection and classification in ambulatory electrocardiograms using a deep neural network,” *Nature Medicine*, vol. 25, no. 1, pp. 65–69, Jan. 2019. [Online]. Available: <https://doi.org/10.1038/s41591-018-0268-3>

[2] Z. I. Attia *et al*., “An artificial intelligence-enabled ECG algorithm for the identification of patients with atrial fibrillation during sinus rhythm: a retrospective analysis of outcome prediction,” *The Lancet*, vol. 394, no. 10201, pp. 861–867, Sep. 2019. [Online]. Available: <https://doi.org/10.1016/S0140-6736(19)31721-0>

[3] P. Rajpurkar *et al*., “Cardiologist-level arrhythmia detection with convolutional neural networks,” *arXiv preprint* arXiv:1707.01836, Jul. 2017. [Online]. Available: <https://arxiv.org/abs/1707.01836>

[4] World Health Organization, “Cardiovascular diseases (CVDs) fact sheet,” *World Health Organization*, Jun. 2021. [Online]. Available: <https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds)>

1. Brief description of the nature of the solution including a conceptual diagram (250 words max)

**Nature of the Solution:**

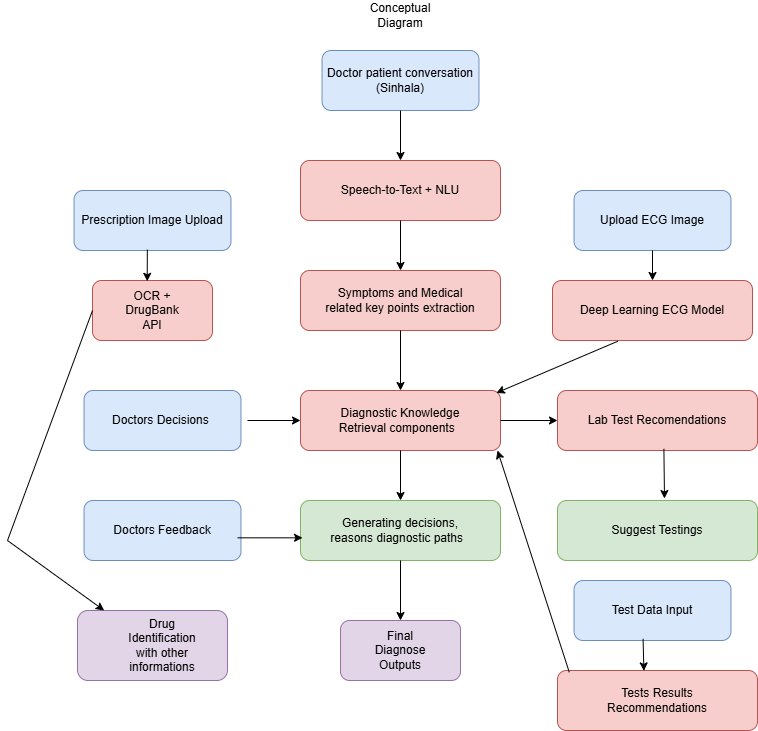
The proposed solution is an **AI-powered, multi-component cardiac diagnostic support system** designed for deployment in **local hospitals and primary care settings in Sri Lanka**, especially targeting **low-resource environments**.

This system integrates **AI-based decision support**, **natural language processing**, **medical knowledge retrieval**, **image processing**, and **predictive analytics** to assist doctors in making faster, evidence-based, and safer cardiac diagnoses.

**Key Functional Components:**

1. **Conversational AI for Symptom Extraction (Sinhala Language Support)**  
   Real-time transcription and symptom recognition from doctor-patient conversations in Sinhala, reducing manual data entry.
2. **Intelligent Prescription Handling with Drug Safety Checks**  
   OCR-based prescription reading with DrugBank API integration for identifying drug information, side effects, and dangerous interactions.
3. **AI-Driven Evidence-Based Diagnostic Advisor**  
   Uses Retrieval-Augmented Generation (RAG) and medical knowledge bases (PubMed, UpToDate, Sri Lankan guidelines) to suggest possible cardiac diagnoses with reference-backed reasoning.
4. **ECG Image Analysis and Heart Condition Classification**  
   Deep learning-based ECG image recognition with real-time quality checks, abnormality detection, and doctor feedback mechanisms for continuous improvement.
5. **Intelligent Laboratory Test Recommender**  
   Suggests essential cardiac lab tests based on patient symptoms and vitals. Analyzes lab history, detects anomalies, and prevents unnecessary testing.
6. **Doctor Feedback and Continuous Learning Loop**  
   Allows physicians to validate, override, or provide feedback on AI outputs. This data will be used for continuous system refinement and localization.

This integrated system **bridges a critical healthcare gap in Sri Lanka** by offering **AI-powered, explainable, and localized cardiac diagnostic support**, empowering general doctors in both urban and rural clinical settings. Additionally, System can be used by the medical interns to improve their knowledge.



1. Brief description of specialized domain expertise, knowledge, and data requirements (300 words)

The development of our **AI-Assisted Cardiac Diagnosis System** requires multidisciplinary knowledge spanning **cardiology, AI Agents (AI/ML), signal processing, software engineering, and user-centric design for low-resource environments**. The system integrates both **desktop** and **mobile** platforms, with the mobile app specifically tailored for **rural areas** where healthcare access, network reliability, and digital literacy are limited.

**Domain Expertise Required:**

* **Cardiology Knowledge**: Understanding of common heart conditions (arrhythmias, ischemic heart disease, cardiomyopathy, CHF), ECG interpretation, and treatment protocols.
* **Clinical Workflow Understanding**: Insights into how doctors assess, diagnose, and use ECGs and symptom histories, enabling AI to act as a supportive tool—not a disruptive one.
* **Rural Healthcare Practice**: Knowledge of healthcare delivery models in underserved areas to adapt workflows to field health workers and non-specialist users.

**Technical Knowledge Required:**

* **ECG Signal Processing**: Familiarity with ECG waveform components (P, QRS, T), noise reduction, segmentation, and feature extraction from bio signals.
* **Machine Learning/Deep Learning**: Expertise in CNNs for ECG classification, transformers for sequence modeling, and **Explainable AI** (e.g., SHAP, LIME) to ensure transparency and trust in diagnoses.
* **Handwriting OCR for Prescriptions**: Implementation of OCR to interpret **handwritten, often unreadable prescriptions**, especially critical for patients with low IT literacy.
* **Cross-Platform Development**:
  + **Backend**: Node.js or Spring Boot
  + **Frontend**: ReactJS (desktop), React Native (mobile)
  + **Offline Mode**: Ensuring app usability in areas with low or no internet.

**Data Requirements:**

* **ECG Datasets**: MIT-BIH, PTB Diagnostic ECG, Chapman ECG datasets for model refining.
* **Patient Histories**: Age, symptoms, blood pressure, medication, etc., for comprehensive case handling.
* **Expert Annotations**: Cardiologist-verified data for supervised learning and validation.
* **Mobile UX Testing Data**: Feedback from rural users to refine navigation, local language support, voice guidance, and offline diagnosis logic.

Strict adherence to data privacy (HIPAA/GDPR) ensures ethical data handling across all systems.

1. i. Objectives and Novelty

|  |  |  |  |
| --- | --- | --- | --- |
| Main Objective AI Powered Cardiac diagnose support system for local hospitals | | | |
| Member Name with Registration No | Sub Objective | Tasks | Novelty |
| Gunathilaka HAHV  IT22219916 | 1.Develop a conversational AI module to extract symptoms from doctor–patient conversation in Sinhala  2. Implement intelligent prescription handling with DrugBank API | * Extract drug names from scanned handwritten prescriptions using OCR * Connect to DrugBank API to fetch drug descriptions, usage, and side effects, allergy detection, alerts for duplicate or dangerous drug combinations * Speech-to-text (STT) pipeline to transcribe real-time conversations * Apply Natural Language Understanding (NLU) to detect and extract medical symptoms from free-form speech | Mobile-compatible system combining Sinhala-language conversational AI and real-time prescription intelligence. It listens to doctor–patient conversations to extract clinically relevant symptoms in Sinhala, decodes handwritten prescriptions and validating drug safety using the DrugBank API. This component minimizes manual input, supports low-literacy, low-connectivity environments, and brings advanced diagnostic and medication safety tools directly to rural clinical workflows—bridging a critical gap in Sri Lanka’s primary healthcare. |
| Sandanayake SDID - IT22898548 | Develop an AI Agent for Evidence-Based cardiac diagnosis using medical knowledge bases | * **Dynamic Multi-Source Knowledge Integration**: Design an AI agentic system that dynamically queries and synthesizes medical knowledge from authoritative sources such as **PubMed, UpToDate, medical school-recommended textbooks, and Sri Lankan clinical guidelines**, ensuring localized and evidence-based decision support. * **Retrieval-Augmented Generation (RAG) + Natural Language Understanding (NLU)**: Implement RAG in combination with NLU to perform **symptom-based differential diagnosis**, where the system retrieves relevant medical literature and clinical guidelines to reason through likely conditions based on patient symptoms, history, and context. * **Transparent, Evidence-Based Diagnostic Suggestions**: The AI provides **citation-supported diagnostic outputs**, each accompanied by references to the source material used, ensuring transparency, accountability, and clinical trust. * **Expertise-Aware Output Control**: The system dynamically **adjusts the depth and complexity of diagnostic explanations** based on the user's role and expertise (e.g., general physician, intern, or cardiologist), enabling more personalized and understandable support. * **Visual Diagnostic Reasoning Path**: Each diagnosis includes a **step-by-step, visually navigable reasoning trail**, mapping symptoms to retrieved evidence and clinical logic used, making the system’s thought process interpretable and easier to audit. * **Physician Feedback Loop for Continuous Learning**: A built-in feedback mechanism enables clinicians to validate, correct, or enrich diagnostic suggestions. This input is used for **continuous system refinement and adaptation to local clinical realities**. * **Low-Resource Optimization and Offline Caching**: The system is optimized for deployment in low-resource environments. It includes an **offline-lite mode** with locally cached essential data and diagnostic modules, allowing reliable operation without constant internet access. | Introduces a retrieval-driven Al diagnostic advisor that leverages  authoritative literature and local guidelines, minimizing hallucinations by providing transparent, source-backed, explainable outputs tailored for  rural healthcare contexts |
| Wimalasena HMKP-  IT22005908 | ECG Image Recognition and Heart Condition Classification with Real-Time Clinical Feedback Integration | * Enable patients or healthcare professionals to upload ECG images through a guided interface (web or mobile) * Preprocess ECG images to validate quality (detect mis uploads, distortions, or false inputs) * Notify users in real-time about image validity and readiness for diagnosis * Perform deep learning-based analysis to identify abnormalities and classify potential heart conditions from the ECG image * Generate confidence-aware predictions to indicate certainty levels for each diagnosis * Allow doctors to validate, override, or comment on predictions, and provide a reasoned explanation for each result * Adapt model using transfer learning to better suit Sri Lankan patient data and conditions * If multiple ECGs are available, visualize time-based progression of heart conditions through a diagnostic timeline * Continuously improve the prediction model using doctor feedback and diagnostic outcomes | * Confidence-Aware Clinical Decision Support: Integration of confidence scores with every prediction to inform doctors about uncertain diagnoses, improving clinical trust. * Smart Input Validation: Real-time ECG image verification ensures accurate input and prevents misdiagnosis due to poor-quality uploads. * Doctor-in-the-Loop System: Enables clinical professionals to override, validate, or provide feedback to AI decisions, enhancing trust and transparency. * Local Demographic Adaptation: Uses transfer learning on Sri Lankan ECG datasets to personalize and improve diagnostic accuracy. * Real-Time Diagnostic Timeline View: Offers visual tracking of heart condition progression over time when multiple ECGs are uploaded, aiding early detection. * Self-service + Professional Mode Interface: A guided interface supports both patients and medical staff to upload ECGs easily and safely. |
|  |  |  |  |
| De Ranasinghe I M R K  IT22088246 | Develop an intelligent laboratory test recommender that suggests essential cardiac tests based on patient symptoms, reducing unnecessary investigations. | * Build a rule-based and AI-augmented lab recommendation engine that uses patient symptoms, vitals, and cardiac risk profiles to suggest necessary tests. * Integrate lab **history management**: store, visualize, and interpret lab reports (e.g., Troponin, CRP, BNP, Lipids) across time. * Implement **anomaly detection** and **trend analysis** to flag sudden or suspicious changes in biomarkers (e.g., spike in Troponin). * Design a **temporal pattern recognition** system to assess patient health trajectory and **predict future test needs** (e.g., early signs of chronic condition). * Provide **recommendations for avoiding redundant/unnecessary tests** based on recent reports and value thresholds. * Generate **follow-up appointment alerts** and **next test plans** using predictive logic (e.g., "Suggest retesting CRP in 2 weeks if inflammation persists"). * Use **color-coded visualizations** (red/yellow/green) for risk communication with junior doctors. * Include **an explanation layer** for each suggestion and recommendation. * Support offline functionality and feedback logging for clinical validation | First Sri Lankan cardiac lab recommendation and prediction system that combines **real-time test recommendation**, **historical lab report analysis**, **anomaly detection**, and **future risk prediction** with intelligent appointment planning and test avoidance logic — empowering junior doctors to deliver proactive, cost-effective, and evidence-based cardiac care in low-resource settings. |

ii. Individual component description of how it is complied with the specialization.

|  |  |
| --- | --- |
| **Member Name with Registration No** | **Description** |
| **Wimalasena HMKP – IT22005908** | This component applies core concepts from software engineering, image processing, and deep learning. The member’s specialization in **AI and system deployment** is reflected in building a real-time ECG classifier with web-based integration. It requires proficiency in CNNs, signal-to-image conversion, and scalable deployment using frameworks like TensorFlow or PyTorch. |
| **Sandanayake SDID – IT22898548** | This component demonstrates expertise in **AI Agent systems**, **natural language understanding**, and **retrieval-augmented reasoning**. The focus on using structured medical databases aligns with advanced **AI system design**, **language models**, and **health informatics**, contributing to explainable, reliable decision-making in cardiac diagnostics. |
| **De Ranasinghe IMRK – IT22088246** | This module aligns with **intelligent systems and rule-based AI** specializations. It applies **decision logic**, UI/UX engineering, and **clinical data visualization**. By integrating structured rule systems and UI design, this member’s work supports clinical judgment through contextual lab test recommendations in a real-time environment. |
| **Gunathilaka HAHV – IT22219916** | This component reflects deep integration of **AI for natural language processing (NLP)** and **health data interpretation**. The speech-to-text pipeline and OCR-to-DrugBank bridge **speech recognition**, **NLU**, and **external API integration**, matching the specialization in conversational AI, drug intelligence, and clinical safety systems in mobile-first applications. |

1. Supervisor details

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Title | First Name | Last Name | Signature |
| Supervisor |  |  |  |  |
| Co-Supervisor |  |  |  |  |
| External Supervisor |  |  |  |  |
| Summary of external supervisor’s (if any) experience and expertise | | | | |

**This part is to be filled by the Topic Screening Staff members.**

1. Does the chosen research topic possess a comprehensive scope suitable for a final-year project?

|  |  |  |  |
| --- | --- | --- | --- |
| Yes |  | No |  |

1. Does the proposed topic exhibit novelty?

|  |  |  |  |
| --- | --- | --- | --- |
| Yes |  | No |  |

1. Do you believe they have the capability to successfully execute the proposed project?

|  |  |  |  |
| --- | --- | --- | --- |
| Yes |  | No |  |

1. Do the proposed sub-objectives reflect the students' areas of specialization?

|  |  |  |  |
| --- | --- | --- | --- |
| Yes |  | No |  |

1. Supervisor's Evaluation and Recommendation for the Research topic:

ptable: Mark/Select as necessary

|  |  |
| --- | --- |
| Topic Assessment Accepted |  |
| Topic Assessment Accepted with minor changes\* |  |
| Topic Assessment to be Resubmitted with major changes\* |  |
| Topic Assessment Rejected. Topic must be changed |  |

\* Detailed comments given below

Comments

|  |  |
| --- | --- |
| **Staff Member’s Name** | **Signature** |
|  |  |
|  |  |

\***Important**:

1. According to the comments given by the evaluator, make the necessary modifications and get the approval by the **Evaluator**.
2. If the project topic is rejected, identify a new topic, and request the RP Team for a new topic assessment.