Data Collection

Data Preprocessing

STM32 Software Expansion

STM32 Flashing

ECG Measurement Kit

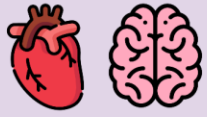
AD8232 ECG

- Power Voltage: DC 3.3V
- Output: Analog
- Interface (Connect RA, LA, RL): 3 PIN, 2.54 PIN or earphone jack
- Size: 36*31*18 mm
- Working Temperature: -40℃ to +85℃

Development

WellnessAI+

WellnessAI+ represents an intelligent wearable device equipped with ECG and advanced AI capabilities, enabling it to conduct instantaneous emotion recognition and delayed heart disease prediction using heart pulse data. This technology empowers users to monitor both their physical and emotional well-being, providing healthcare professionals with comprehensive diagnostic insights.



Created & Proposed by:
Koay Xian Cong

Open Source AI Model Development

Heart Disease Prediction Model

- Dataset: Pre-processed ECG Images
- Algorithm: Convolutional Neural Network (CNN), Long Term Short Memory (LSTM)

Real Time Emotion Recognition Model

- Dataset: AMIGOS, DREAMER, WESAD, DEAP
- Algorithm: Convolutional Neural Network (CNN)

kaggle colab

ANACONDA. jupyter

Model Optimizer and Hardware Accelerator

STM32 X-LINUX-AI

life.augmented

- Optimised for STM32MP1 series.
- OpenCV
- C++/Python deep learning model support.
- Supports multiple deep learning frameworks: TensorFlow Lite, ONNX.
- XNNPACK delegate activated.

X-LINUX-AI OpenSTLinux Expansion packages

yocto PROJECT

ONNX

Model Deployment - Wearable

Edge Computer

STM32MP157F DK

- STM32MP157 Arm®-based dual Cortex®-A7 32 bits + Cortex®-M4 32 bits MPU in TFBGA361 package
- USB Type-C™-DRP
- 4x USB Host Type-A
- 5V/3A USB Type-C™ power supply
- Debugger/Programmer
- 40-pin Raspberry Pi and Arduino shield capabilities
- On-board ST-LINK debugger
- 4" TFT 480x800 pixels with LED blacklight
- Wi-Fi 802.11b/g/n
- Bluetooth Low Energy 4.1

Wi Fi arm STM32

Cloud Computer

Web/Mobile App (Optional)

mac OS

- Model hosted on AWS, GCP, Azure, etc.
- Non real-time heart disease prediction.
- Data visualization on any devices.
- Data storage for medical monitoring.

aws Streamlit android

Research

Tools for Literature Review

ELSEVIER IOP Institute of Physics MENDELEY

NUsearch

Planning & Documentation

Tools for Project Management

draw.io

moodle

Moderator & Supervisor

Update

User

Medical Practitioner

Deployment

Methods and Approach

Methods	Tools and Approach	Justification	Limitation
Step 1: Setting up Software and Hardware	STM32MP157F-DK2 	• Powered by a dual-core ARM Cortex-A7 CPU with an ARM Cortex-M4 • STM32MP1 microprocessors are designed for low power consumption, making them well-suited for battery-powered or wearable devices. • The presence of an ARM Cortex-M4 microcontroller on the edge computer allows for real-time control and signal processing • Comes with a 4" TFT 480x800 pixels with LED backlight	• Compared to Raspberry Pi, STM32MP157F-DK2 has fewer readily available resources and support due to smaller communities. • STM32MP157D-DK2 is less common and requires sourcing from specific distributors.
	STM32 Cube programmer	• STM32 Cube Programmer is developed and maintained by the manufacturer, ensuring compatibility and reliability. • Integrates well with other STM32Cube tools and libraries, streamlining the development process.	• STM32 Cube Programmer can be resource-intensive, particularly when working with large projects.
Step 2: Integrating ECG kit onto edge computer.	AD8232 ECG 	• Precise in collecting vital heart activity.	• May not be as comfortable for wearables.
Step 3: Open-Source AI Model Development	Python	• It has various libraries available for data manipulation, analysis, visualization, etc in AI model development.	• Advanced DL models may require substantial computational resources
	Anaconda	• Provides a convenient environment for managing Python packages and creating isolated development environments	• Model is saved locally in the PC.
	Git/GitHub	• Version control system that allows for efficient version tracking in AI model development	• Data security and privacy concern.
Step 4: Model Optimizer and Hardware Accelerator.	STM32 X-Linux-AI	• Expansion package that targets artificial intelligence for STM32MP1 series microprocessors	• limited model architectures available
Step 5: Deployment of AI models into edge computers and cloud computers.	Cloud platforms	• Offer access to powerful GPU instances, which significantly accelerate AI model inference and training. • Offers APIs to link the results to front-end web/mobile apps.	• AI models deployed in the cloud may experience network latency

Risk Management and Mitigations

Importance = Severity + Likelihood [Low = 1, Medium = 2, High = 3]. The higher the value, the more important the risk.

Events	Timeline (Week)	Risks	Mitigation	Impact	Pre, Post Mitigation Severity & Likelihood	**
Integrating ECG kit onto edge computer.	10 – 14	Incompatibility issue between edge computer and ECG measurement kit.	Perform compatibility testing and refer to hardware documentation.	Delay in project timeline.	Pre: Low Post: Low Likelihood: Low	3
		Short circuit due to incorrect power connections.	Adhering to the documentation and requirements.	Delay in project timeline if new microcontroller order is needed.	Pre: Medium Post: Low Likelihood: Low	4
Open-Source AI Model Development	14 – 28	Advanced deep learning models may require substantial computational resources, impacting performance on resource-constrained systems.	Optimize and simplify AI models, employ cloud-based resources when necessary, and manage hardware efficiently.	Delayed model training. Performance degradation.	Pre: Medium Post: Medium Likelihood: High	7
		An exclusive reliance on deep learning methods proved insufficient in identifying all crucial ECG signal features.	A hybrid strategy is applied to improve detection efficiency.	Inaccurate results. Misdiagnoses.	Pre: High Post: Medium Likelihood: High	8
		ECG signal analysis demands a substantial volume of data for accurate results.	Performing data augmentation to increase the size of the dataset available.	Inaccurate results. Misdiagnoses.	Pre: High Post: Medium Likelihood: High	8
Deployment of AI models into edge computer and cloud computer	27 – 31	The model takes too long to produce output.	Rigorously test AI model deployment on the edge computer to ensure real-time performance and functionality.	Model inaccuracies and reduced usability.	Pre: High Post: High Likelihood: High	9
		API and model compatibility issues.	Perform test cases with available AI models before training a new model.	Delay in project timeline.	Pre: High Post: Medium Likelihood: High	8
		Network latency when deployed in the cloud.	Optimize model size.	Delayed response time.	Pre: High Post: Medium Likelihood: High	8

Year 3 Final Year Project

Supervisor: Dr Hermawan Nugroho
Moderator: Prof T. Nandha Kumar
Project Code: HN-BEng-23-01

Student Name: Koay Xian Cong
Student ID: 20418760

Legends: Error Bars for Uncertainty: ↔ Moderator Meeting Week:
Submission Dateline: ✖ Project Milestone: ★

Tasks	Autumn Semester												Study Week		Exam	Sem Break			CNY Break	Spring Semester							HR Break					Study Week	
	Sept	Oct					Nov				Dec				Jan					Feb		Mar					Apr					May	
	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10	WEEK 11	WEEK 12	WEEK 13	WEEK 14	WEEK 15	WEEK 16	WEEK 17	WEEK 18	WEEK 19	WEEK 20	WEEK 21	WEEK 22	WEEK 23	WEEK 24	WEEK 25	WEEK 26	WEEK 27	WEEK 28	WEEK 29	WEEK 30	WEEK 31	WEEK 32	WEEK 33	WEEK 34	WEEK 35	WEEK 36	WEEK 37
Project Planning																																	
Hazard Identification, Risk Assessment, Risk Control Form (HIRARC) Form	↔																																
FYP Briefing and Discussion on Project Specification	↔	↔	↔																														
Hardware Inspection and Sensor Component Research		↔	↔																														
Software, Tools and Application Research		↔	↔																														
Finalising Project Objectives and Project Specification		↔	★	↔																													
Hardware and Software Research and Purchase Cost Estimation		↔	↔	→																													
Purchase Requisition			↔	→																													
Lab Space Booking			↔	→																													
Obtaining Ethical Approval			↔	→																													
Writing Project Outline and Planning Report			↔	→	→	→																											
Submission of Project Outline and Planning Report					↔	✖	→																										
Research and Literature Review																																	
Researching of Common Application of Edge Computing	↔	↔	↔																														
Literature Review of Emotion Recognition using ECG			↔	→	→	★	→																										
Literature Review of Common Heart Disease			↔	→	→	★	→																										
Literature Review of Heart Disease Detection using Machine Learning and Deep Learning			↔	→	→	★	→																										
Literature Review of Heart Disease Prediction Model			↔	→	→	★	→																										
Literature Review of STM32MP157F DK Edge Computing Device and Application			↔	→	→	★	→																										
Literature Review of Software Tools, Model and Architecture for Edge Computing			↔	→	→	★	→																										
Design Solution/Application																																	
Research and Learning the Function of STM32MP157F DK Edge Computer			↔	→	↔	→																											
Installing Virtual Machine to Set Up STM32 Software to Flash OS into the Edge Computer					↔	→	→																										
Installing STM32 Cube Programmer in Ubuntu OS					↔	→	→																										
Coding Program to Test Functions of Edge Computer					↔	→	→																										
Integrating Heart Monitoring Sensor onto the Edge Computer					↔	→	↔	★	→																								
Coding Program to Test Sensors and Perform Experiments to Ensure Accurate Measurements of Sensors							↔	→	↔	★	→																						
Designing Wearables of that can be Integrated with Heart Disease Detection and Prediction Solution (Optional)								↔	→	→	→	→																					
Development of AI Model																																	
Setting Up Environment to Deploy Heart Disease Detection and Prediction Model										↔	→																						
Coding Program to Develop Emotion Recognition Model										↔	→	→							★	→													
Coding Program to Develop Heart Disease Prediction Model										↔	→	→							★	→													
Coding Program to Connect Sensor with AI Model												↔									★	→											
Coding Program to Display Prediction Output on the LCD Display (Optional)																					↔	→	↔	→									
Developing User Interface to Monitor Heart Disease and Data Collected from Sensor (Optional)																					↔	→	↔	→	↔	→							
Debugging Code to Solve Bugs Found, Improvement of Code/Model																					↔	→	↔	→	↔	→							
Deployment of Model and Sensor into Edge and Cloud Computer																																	
Combining both Software and Hardware Developed into Wearables (Optional)																							↔	→	↔	→							
Deploying Heart Disease Prediction Model Developed onto Cloud Computer																						↔	→	→	→	★	→						
Deploying Emotion Recognition Model Developed onto Edge Computer																						↔	→	→	→	★	→						
Performing Testing on Real Live User																								↔	→	→	→						
Obtaining User Experience, Feedback and Model Prediction Result																								↔	→	→	★	→					
Performance Improvement and Solving Bugs																								↔	→	→	→	→					
Thesis, Documents and Presentation																																	
Writing Sections of Draft Thesis																								↔	→	→	→	→					
Draft Typed Thesis Submission																										↔	✖	→					
Writing Sections of Final Thesis																										↔	→	→		↔	→	→	
Final Thesis, Logbook, Code and Miscellaneous Submission																														↔	→	✖	→
Preparation of Presentation																														↔	→	→	
Presentation																																✖	→
Return of Project Items																																	→