Background :

Most people **in rural and semi-urban areas** afflicted with ocular diseases were diagnosed late due to **a lack of ophthalmologists** and **costly immobile equipment**. Digital ocular screening exists yet available in some places, especially in urban areas. Mobile applications are the current niche in healthcare, even for screening or analysing non-communicable ocular diseases (NCODs). Many industries are actively adopting **mobile phone technology**, and this does not make the healthcare industry left behind. This technology is a promising platform that can offer **cost-effective solutions** as the combination of smartphones and cloud computing facilitates **a scalable solution**. To make the best of the situation, the Internet of Things (IoT) has shown potency, representing an ideal solution to the limited medical attention received by people in developing countries. The IoT allows health practitioners and clinicians to **conduct patient monitoring and diagnosis remotely and regularly.** An integrated decision support system (DSS) using a collaborative cloud and machine intelligence approach may advance the prediction of NCODs, which inadvertently gives health practitioners and clinicians an efficient and prompt system that allows them **a second opinion** on a diagnosis.

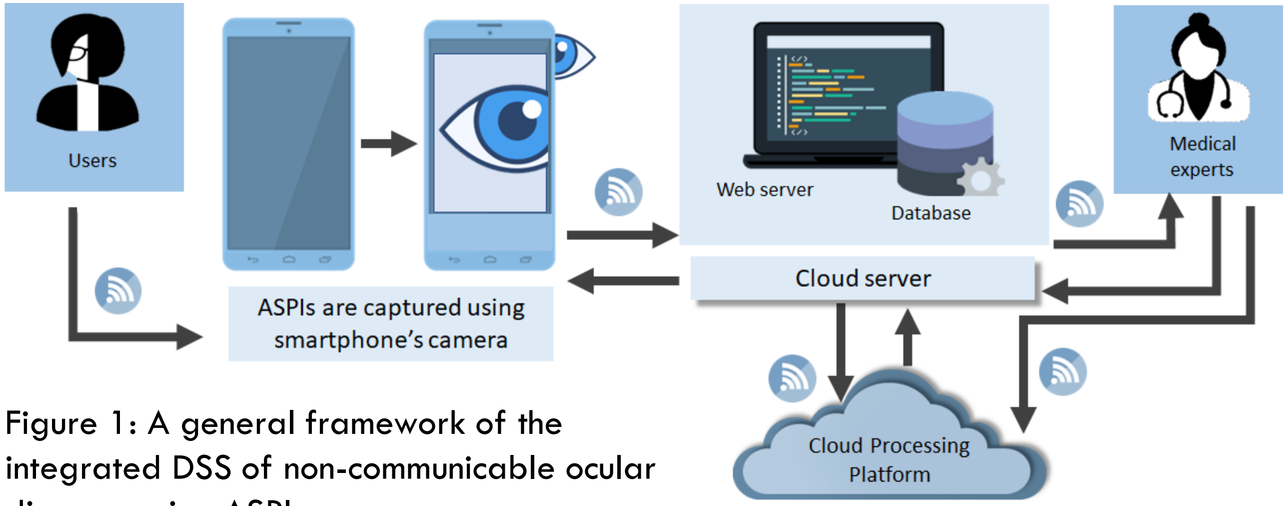


Figure 1: A general framework of the integrated DSS of non-communicable ocular diseases using ASPIs.

Project Title: **Integrated Decision Support System for Non-Communicable Ocular Diseases using Machine Intelligence**

Targets:

To develop an integrated cloud-based DSS for NCODs to detect anterior segment ocular diseases using machine intelligence, cloud technology and an integrated system approach.

1. *Development of the Decision Support System to screen anterior segment-related NCODs using ASPIs captured using smartphone cameras.*
2. *Development of machine intelligence models with the best classifier that provides the highest classification and prediction accuracies to detect identified anterior segment NCOD*
3. *Societal, health and well-being impact analysis with the underprivileged old folks and rural communities*

Speaker: AP Dr Wan Mimi Diyana Wan Zaki

Project Members :

Project Title: **Integrated Decision Support System for Non-Communicable Ocular Diseases using Machine Intelligence**

Project Duration : 1 June 2023- 31 Nov 2025 (18 + 12 months)

RESEARCH ACTIVITY	2023							2024												2025										
	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N
INTEGRATED DECISION SUPPORT SYSTEM FOR NON-COMMUNICABLE OCULAR DISEASES USING MACHINE INTELLIGENCE																														
Activity 1: Design of the overall DSS framework Activity 2: Design of the integrated structure of cloud information database																														
Activity 3: Data and information collection Activity 4: Data association of corneal state in the related NCODs																														
Activity 5: Deep learning NN implementation for corneal state pattern classification and prediction Activity 6: Benchmarking of other machine learning algorithms Activity 7: Integration of output of Activity 2 and 8 to develop the DSS cloud-based DSS																														
Activity 8: System testing and validation Activity 9: Impact analysis and project finalisation																														

10- 13 June: system testing and impact study @ Semporna, Sabah

29- 31 July: on-site system validation @ O-Raing Ov, Phnom Penh

Research Milestone

ACTIVITIES	**DATE**
Completion of designing cloud DSS framework	31 August 2023
Completion of gathering collaborative NCODs information and data	**31 Dec 2024**
Completion of developing machine intelligence and cloud-based DSS	**30 June 2025**
Completion of system testing and validation	**30 Nov 2025**

Project Title: **Integrated Decision Support System for Non-Communicable Ocular Diseases using Machine Intelligence**

Revised Project Budget:

Purchasing completed on 15 Feb 2024 & 20 Feb 2024

1. *LOI signing with HBB*
2. *System validation and testing @on-site*

1. *Economy roundtrip flight and accommodation for 2 project members*
2. *Seminar room*

1. *APC for 1-WoS-SCIE Q1 journal*
2. *APC for an international conf proceeding*

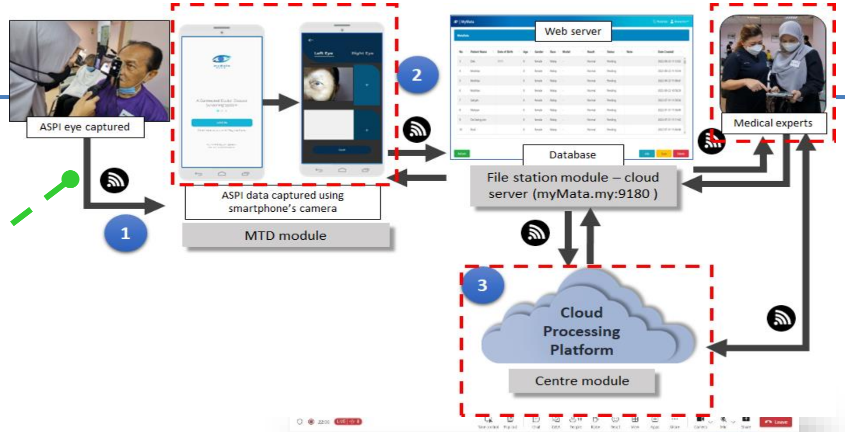
ITEM	BUDGET (USD)	SPENT (USD)
1. Equipment/ Software		
XOJO Pro Edition	1598	1584
Rental of Dedicated Server for Web Service Hosting with new domain	750	719
High performance laptop for mobile tests	2000	1930
Note: *Currency rate: 20 Feb 2024 -- 4.7988 MYR =* ***1USD*** **Total:**	4348	**4233**
2a. Travel: Data collection and information gathering in Malaysia (Sept 2023 – April 2025)		
Data collection in Malaysia x 3 trips (Accommodation, transport)	800/trip x2	
Total:	**1600**	0
2b. Travel: On-site visit and meeting/MoU signing with HBB , Cambodia (2 researchers) - (Feb 2025)		
Economy roundtrip flight, accommodation, ground transport for 2 days	500/trip x 2	
Total:	**1000**	0
2c. Travel: System testing and validation, and 1-day workshop in Cambodia (1 researcher from Indonesia & 4 researchers from Malaysia) - (May 2025)		
Economy roundtrip flight, accommodation, ground transport for 3 days	7250	**1090**
Total:	**7250**	**1090**
2d. Travel: Final meeting in Malaysia (1 researcher from Indonesia & 1 researcher from Cambodia) - (Sept –Oct 2025)		
Economy roundtrip flight, accommodation, ground transport for 3 days	2480	
Seminar room	1440	
Note: Currency rate: 29 Oct 2025 -- 4.223 MYR = 1USD	**3920**	**958.6**
3. Dissemination		
1.One article sent to an open access journal: USD 2,700 2. One conference proceeding (Flight, Accommodation, Ground transport, APC)	2700 1713	2626.5 507.4
Total:	**4013**	**3133.9**
GRAND TOTAL (USD):	**22,016**	**9,415.50**
Note: Currency rate: 29 Oct 2025 ~~1 USD= JPY 152.87 **(JPY):**	**2,907,432.96**	**1,439,347**

Project Activities:

START

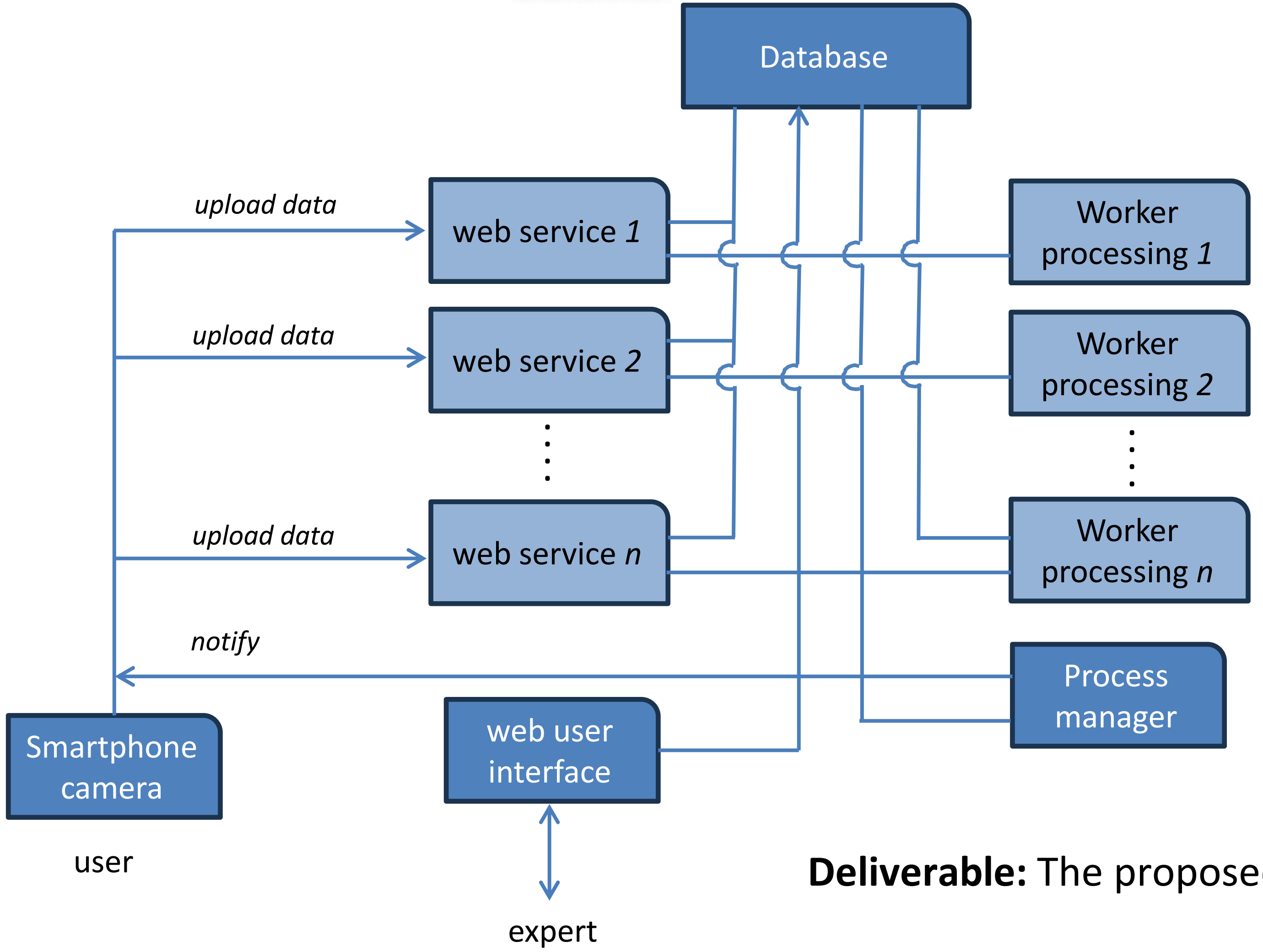
Phase	Activity	Person-in-charged:
Phase 1: Design of Cloud-Based Decision Support System Framework	**ACTIVITY 1 :** Design of the overall DSS framework	UKM, Malaysia
	ACTIVITY 2: Design of the integrated structure of cloud information database	**UKM, Malaysia**
Phase 2: Collaborative NCODs Information and Data Gathering	**ACTIVITY 3:** Data and information collection	UKM, Malaysia
	ACTIVITY 4: Data association of corneal state in the related NCODs	UKM, Malaysia
Phase 3: Machine Intelligence and Cloud-Based DSS Development	**ACTIVITY 5:** Deep learning NN implementation for corneal state pattern classification and prediction	**ITB, Indonesia**
	ACTIVITY 6: Benchmarking of other machine learning algorithms	ITC, Cambodia
	ACTIVITY 7: Integration of output of Activity 2 and 5 to develop the DSS cloud-based DSS	UKM, Malaysia
Phase 4: System Testing and Validation	**ACTIVITY 8:** System testing and validation	UKM, Malaysia * All members will involve
	ACTIVITY 9: Impact analysis and project finalisation	

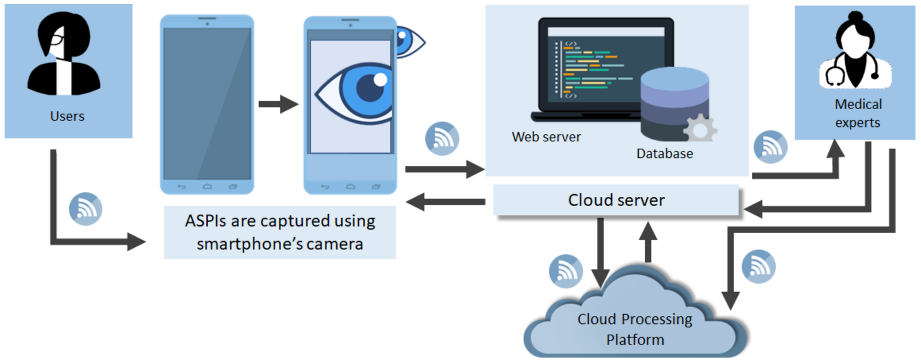
END



Project Activities:

Phase 1: Objective 1





Deliverable: The proposed cloud DSS framework

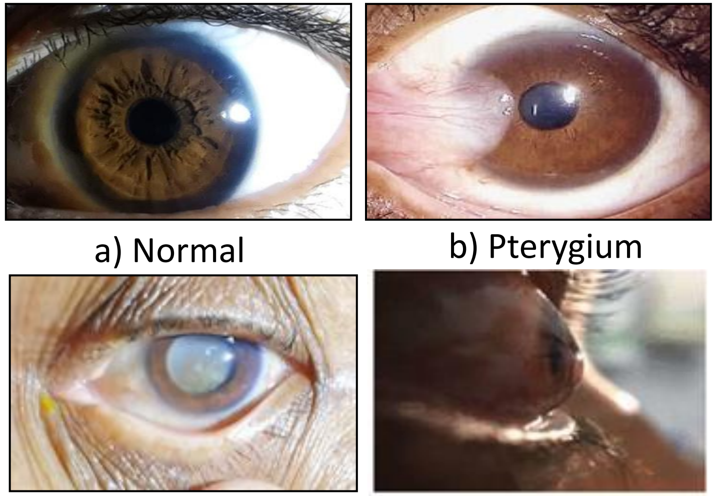
Project Activities:

Phase 2: Collaborative NCODs information and data gathering

Objective 2

Disease Type	Data association of corneal state in the related NCODs
Pterygium	*caused by fibrovascular tissue encroachment onto the corneal region. The tissue may cause vision blurring if it grows into the pupil region*
Cataract	*lens clouding and poses a significant risk of vision loss or blindness*
Keratoconus*	*corneal steepening and thinning and results in a corneal bulge due to the non-inflammatory corneal disorder*
Dry Eye Disease (DED)*	*relationship between corneal surface irregularities, tear film stability, and inflammation*

** under optimization stage*



a) Normal b) Pterygium c) cataract d) keratoconus

b) – d) Non communicable ocular diseases that can be captured using smartphone cameras

Phase 3: Machine intelligence and cloud-based DSS development

Proposed experimental frameworks for pterygium, cataract, keratoconus and DED:

- ✓ Implement the novel algorithms and models previously developed using digital image processing and deep learning techniques.
- ✓ Benchmarking with the current machine learning models

Project Activities:

System testing and Impact Study @ Semporna, Sabah (10-13 June 2025)

Impact study through questionnaires

- **Study design:** mixed-method approach using a structured questionnaire to access pre- and post- program
- **Total participants approached**: 149
  Completed responses: 68% (n=98)
  Location: Pulau Kulapuan and Pulau Salakan, Semporna Sabah (rural and island communities)
  Demographics: 65% female, 35% male (40-71 years old)
- **Data collection tools:**
  Questionnaire with 43 items
  Structured around awareness, perception, technology use and well-being.



- A total of 113 participants underwent screening using the myMata system, resulting in the collection of 226 eye images.
- Among these, 35 images showed pterygium, while 17 were identified as cataract cases.

Phase 4: Objective 3

R&D results:

PTERYGIUM and CATARACT Detection:

Figure1. Pterygium image

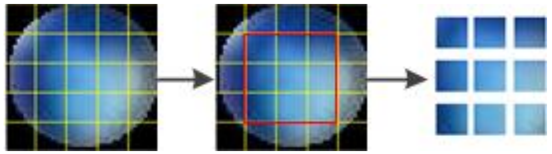


Figure 2. Cataract patch image

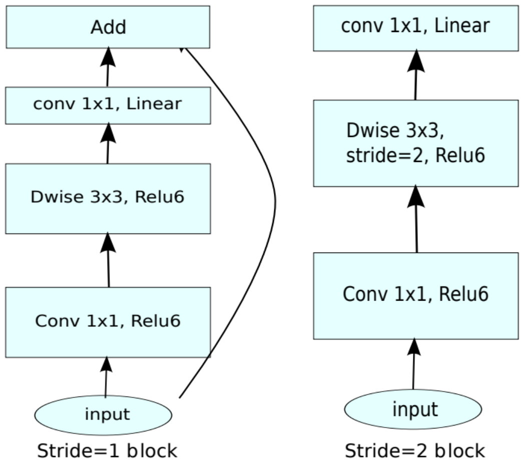


Figure 3. MobileNetV2
Source: Sandler et. al

Table 2. Performance for pterygium classification

Network	Batch Size	Optimizer	Accuracy (%)	Sensitivity (%)	AUC (%)	Elapsed time (min)
ResNet 50	10	Adam	96.71	96.05	97.79	8.72
	32		97.70	96.71	99.16	2.58
	64		97.04	96.05	98.84	4.80
	10	SGDM	95.72	93.42	98.73	4.98
	32		93.75	90.13	98.24	2.40
	64		91.12	83.55	97.50	4.08
VGG16	10	Adam	97.70	97.37	99.18	5.50
	32		97.04	95.39	99.23	3.23
	64		97.37	97.37	99.23	3.40
	10	SGDM	97.04	96.05	99.19	5.37
	32		93.09	90.79	98.87	2.42
	64		90.46	84.87	98.29	2.73
Mobile NetV2	10	Adam	97.37	96.05	99.41	3.53
	32	**Adam**	**97.37**	**96.71**	**99.18**	**2.13**
	64		96.71	94.74	99.16	2.30
	10	SGDM	97.70	96.05	99.34	3.93
	32		94.08	93.42	98.57	2.17
	64		90.46	87.50	97.39	2.23

Table 1. Performance for cataract patch classification

Network	Batch Size	Optimizer	Accuracy (%)	Sensitivity (%)	AUC (%)	Elapsed time (min)
ResNet 50	5	Adam	98.11	98.44	99.65	65
	10		98.22	98.89	99.86	22
	5	SGDM	96.56	96.44	98.79	83
	10		96.78	95.33	99.05	30
VGG16	5	Adam	93.78	93.56	96.26	27
	10		91.67	85.11	95.90	15
	5	SGDM	89.11	98.22	98.11	55
	10		91.33	98.00	98.11	35
Mobile NetV2	5	**Adam**	93.56	97.11	98.96	25
	10		**95.44**	**95.78**	**99.19**	**7**
	5	SGDM	92.44	92.00	97.62	50
	10		92.11	91.56	97.74	20

[2]Wan Mimi Diyana Wan Zaki, Laily Azyan Ramlan, Nurul Syahira Mohamad Zamani, Marizuana Mat Daud, Haliza Abdul Mutalib, *Smartphone-Based Detection of Cataract and Pterygium Using MobileNet: A Unified Approach for Anterior Segment Photographed Images,* 5th International Conference on Image Processing and Vision Engineering, 7- 8 April 2025, Porto, Portugal.

R&D results:

KERATOCONUS Detection:

Figure1. KC data collection

Table 2. Result Summary (Optimizer: SGD)

Optimizer: SGD							
α	**TA (%)**	**VA (%)**	**TL**	**VL**	**Test (%)**	**Precision (%)**	**Recall (%)**
0.01	95.57	95.60	0.1237	0.2321	75.5	75.5	90.6
0.001	86.45	92.31	0.3107	0.2301	73.4	73.4	88.1
0.005	96.67	95.60	0.0986	0.2088	76.7	76.7	92.0

Table 3. Result Summary (Optimizer: Adam)

Optimizer: Adam							
α	**TA (%)**	**VA (%)**	**TL**	**VL**	**Test (%)**	**Precision (%)**	**Recall (%)**
0.01	67.73	63.74	0.6202	0.6026	65.4	65.4	78.5
0.001	96.55	98.90	0.0790	0.0782	74.1	74.1	88.9
0.005	67.00	65.93	0.6187	0.5823	50	50	60.0

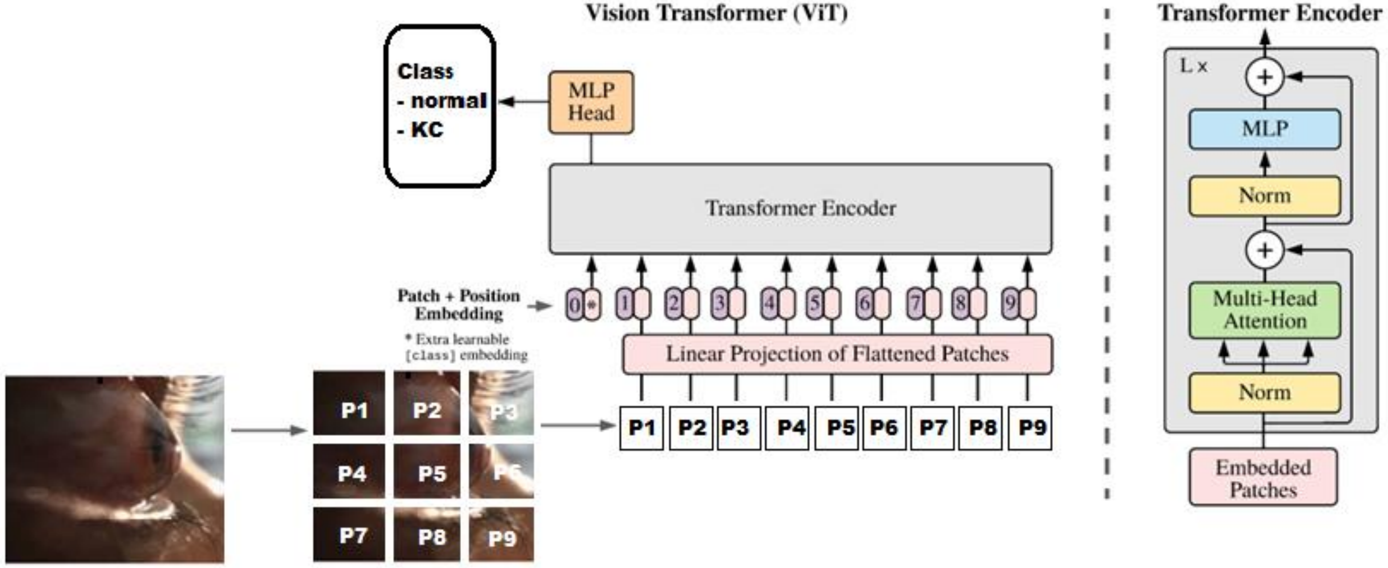


Figure 2. KC data collection

[3]Marizuana Mat Daud, Wan Mimi Diyana Wan Zaki, Fazlina Mohd Ali, Haliza Abdul Mutalib, Edge-Deployed Vision Transformer Model for Automated Keratoconus Classification in Corneal Imaging, 3rd International Conference on Innovative Computing and Cutting-edge Technologies , 22 – 25 September 2025, Istanbul, Turkiye.

R&D results:

DRY EYE DISEASE Detection:

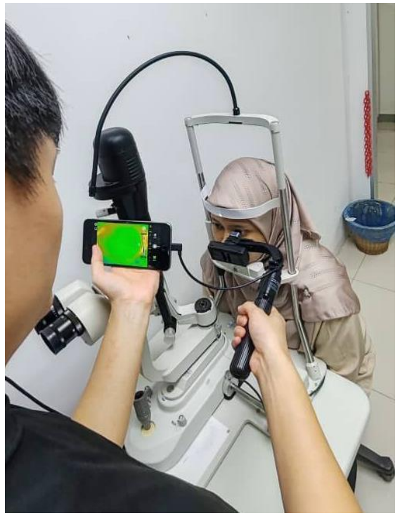


Figure 1. Digital Infrared Thermography Images data captured using InfiRay P2 Pro that was mounted on a selfie stick using a slit lamp chin rest.

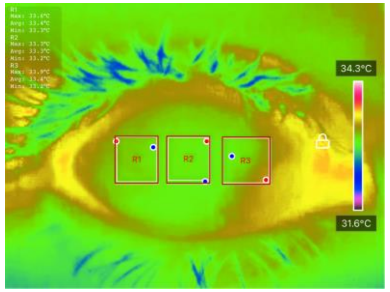


Figure 2. An example of how average OST was extracted for each ROI.

Table 1. SVM assessment using the three top features.

Kernel	Assessment (%)	Top-3 Features	Top-5 Features	Top-10 Features	Average
Linear	Acc	86.49	90.54	89.19	88.74
	Sen	93.75	94.12	92.31	93.39
	Spe	73.08	82.61	81.82	79.17
	Err	13.51	9.46	10.81	11.26
Quadratic	Acc	90.54	89.19	91.89	90.54
	Sen	92.45	89.29	92.59	91.44
	Spe	85.71	88.89	90.00	88.20
	Err	9.46	10.81	8.11	9.46
Cubic	Acc	86.49	77.03	90.54	84.68
	Sen	90.38	85.71	92.45	89.52
	Spe	77.27	60.00	85.71	74.33
	Err	13.51	22.97	9.46	15.32
Fine Gaussian	Acc	87.84	87.84	77.03	84.23
	Sen	86.44	86.44	76.92	83.27
	Spe	93.33	93.33	77.78	88.15
	Err	12.16	12.16	22.97	15.77
Medium Gaussian	Acc	85.14	81.08	78.38	81.53
	Sen	83.61	79.69	77.27	80.19
	Spe	92.31	90.00	87.50	89.94
	Err (%)	14.86	18.92	21.62	18.47

[5]Laily Azyan Ramlan, Wan Mimi Diyana Wan Zaki, Marizuana Mat Daud, Haliza Abdul Mutalib, 2025, Non-Invasive Dry Eye Disease Detection Using Infrared Thermography Images: A Proof-of-Concept Study, Diagnostics , 15(16): 1-19.

Table 2. Summary of the best classifier method results k.

Distance Technique	Assessment (%)	k = 1	k = 3	k = 5	Average
Euclidean	Acc	85.14	91.89	89.19	88.74
	Sen	88.68	92.59	87.93	89.73
	Spe	76.19	90.00	93.75	86.65
	Err	14.86	8.11	10.81	11.26
Chebyshev	Acc	85.14	86.49	86.49	86.04
	Sen	88.68	86.21	85.00	86.63
	Spe	76.19	87.50	92.86	85.52
	Err	14.86	13.51	13.51	13.96
Mahalanobis	Acc	82.43	87.84	87.84	86.04
	Sen	86.79	87.72	87.72	87.41
	Spe	71.43	88.24	88.24	82.63
	Err	17.57	12.16	12.16	13.96

Table 3. Summary of the best classifier method results k.

Classifier Method	Parameter/Kernel Type	Features	Accuracy (%)
k-NN	Euclidean + (k = 3)	Top-3	91.89
SVM	Linear	Top-10	91.80

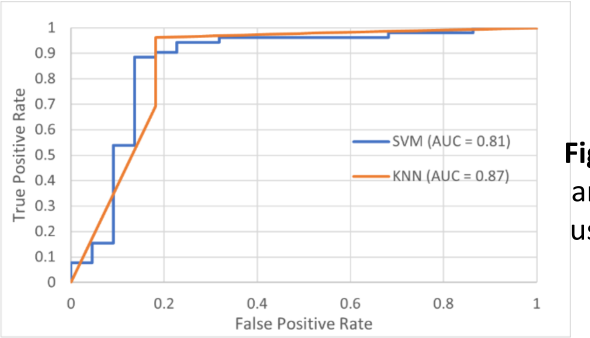


Figure 3. Linear SVM and Euclidean k-NN using top 3 features ROC results.

R&D results:

On-site system validation and Capacity building @ Phnom Penh, Cambodia (28-31 July 2025)

MyMata Screening in Phnom Penh, Cambodia

- Total number of subjects with images captured through the myMata app: 29 (58 images)
- For cataract, a total of 11 images were excluded from the analysis due to detection and cropping errors, and an additional 3 cortical cataract images were also removed from the dataset
- For pterygium, 5 images were excluded from the dataset due to cropping errors.

	Cataract Detection	Pterygium Detection
Accuracy	63.60%	50.90%
Sensitivity (Recall)	100.00%	32.30%
Specificity	11.10%	77.30%
Precision (PPV)	61.90%	66.70%
F1-Score	76.50%	43.50%

- Both models demonstrate potential but require further refinement.
- The cataract model's tendency to over-detect cataracts and the pterygium model's difficulty in identifying positive cases highlight the need for:
  - improved dataset balance
  - better handling of occlusions (e.g., fingers, eye positioning)
  - possibly enhanced image pre-processing to improve feature clarity

Scientific Contribution:

Presentations at International Conferences:

No	Paper title:	Author names	Affiliation	Conference name:	Date	Venue
1	Keynotes : Revolutionizing Ocular Health with Digital Image Processing	Wan Mimi Diyana Wan Zaki	UKM	4th Electronics and Electricals Engineering Virtual 2023	1 December 2023	Virtual
2	Smartphone-Based Detection of Cataract and Pterygium Using MobileNet: A Unified Approach for Anterior Segment Photographed Images	Wan Mimi Diyana Wan Zaki, Laily Azyan Ramlan, Nurul Syahira Mohamad Zamani, Marizuana Mat Daud, Haliza Abdul Mutalib	UKM	5th International Conference on Image Processing and Vision Engineering	7- 8 April 2025	Porto, Portugal
3	Edge-Deployed Vision Transformer Model for Automated Keratoconus Classification in Corneal Imaging	Marizuana Mat Daud, Wan Mimi Diyana Wan Zaki, Fazlina Mohd Ali, Haliza Abdul Mutalib	UKM	3rd International Conference on Innovative Computing and Cutting-edge Technologies	22 – 25 September 2025	Istanbul, Turkiye

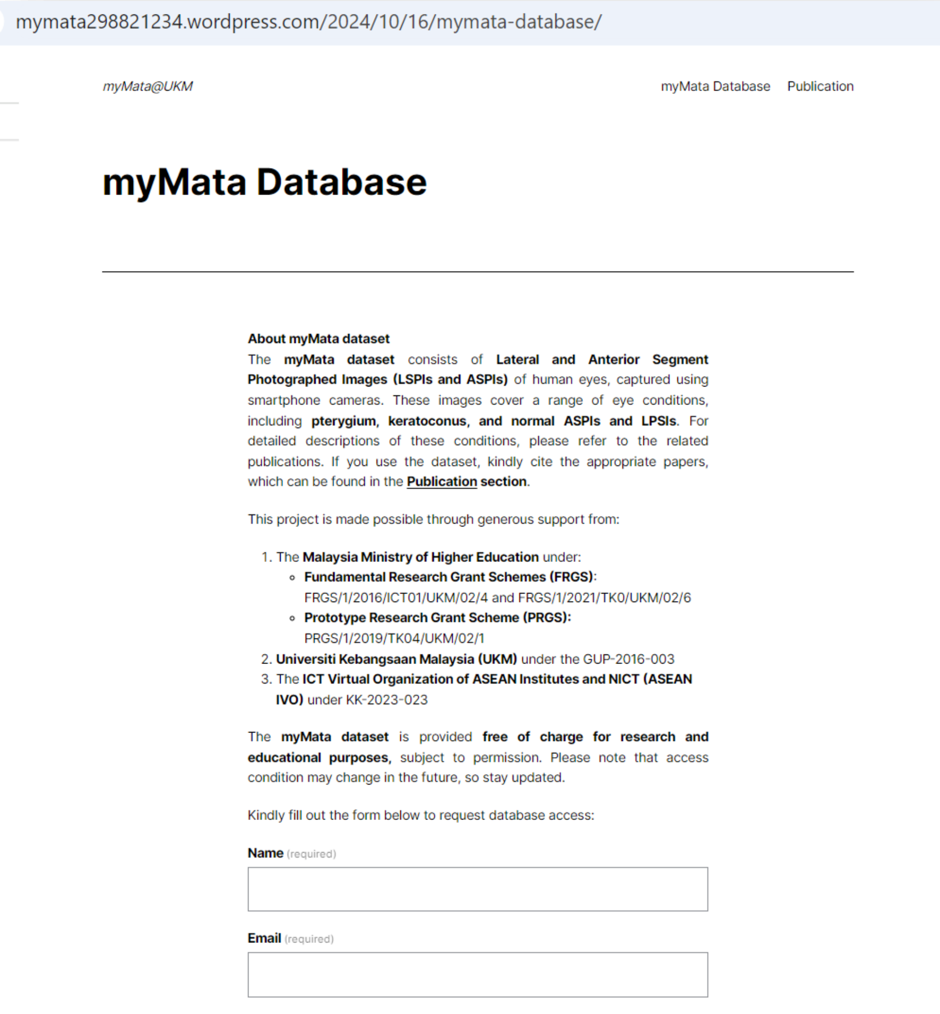
Published Journal Papers:

No:	Paper title:	Author names	Affiliation	Journal name:	The publisher of the Journal	The volume number and Pages
4.	The Impact of Mobile Application for Ocular Disease Screening in Community Outreach Program	Laily Azyan Ramlan, Wan Mimi Diyana Wan Zaki* Haliza Abdul Mutalib, Marizuana Mat Daud, Aouache Mustapha	UKM	Jurnal Kejuruteraan	UKMPress	Vol. 37 (2): March: 2025
5.	Non-Invasive Dry Eye Disease Detection Using Infrared Thermography Images: A Proof-of-Concept Study Diagnostics	Laily Azyan Ramlan, Wan Mimi Diyana Wan Zaki, Marizuana Mat Daud, Haliza Abdul Mutalib	UKM	Diagnostics	Multidisciplinary Digital Publishing Institute (MDPI)	15(16): 1-19

Societal Impact

Our project has released the myMata dataset for public use, leveraging data from previous collection programs to drive innovation in ophthalmic research and technology.

1. The dataset is currently being used to develop machine learning models aimed at accurately detecting anterior segment conditions
2. This open-access approach fosters collaboration and supports the development of AI-driven healthcare solutions with the potential to improve early diagnosis and patient outcomes.


mymata298821234.wordpress.com/2024/10/16/mymata-database/

myMata@UKM myMata Database Publication

myMata Database

About myMata dataset

The **myMata dataset** consists of **Lateral and Anterior Segment Photographed Images (LSPIs and ASPIs)** of human eyes, captured using smartphone cameras. These images cover a range of eye conditions, including **pterygium, keratoconus, and normal ASPIs and LPSIs**. For detailed descriptions of these conditions, please refer to the related publications. If you use the dataset, kindly cite the appropriate papers, which can be found in the **Publication section**.

This project is made possible through generous support from:

1. The **Malaysia Ministry of Higher Education** under:
   - **Fundamental Research Grant Schemes (FRGS):** FRGS/1/2016/ICT01/UKM/02/4 and FRGS/1/2021/TK0/UKM/02/6
   - **Prototype Research Grant Scheme (PRGS):** PRGS/1/2019/TK04/UKM/02/1
2. **Universiti Kebangsaan Malaysia (UKM)** under the GUP-2016-003
3. The **ICT Virtual Organization of ASEAN Institutes and NICT (ASEAN IVO)** under KK-2023-023

The **myMata dataset** is provided **free of charge for research and educational purposes**, subject to permission. Please note that access condition may change in the future, so stay updated.

Kindly fill out the form below to request database access:

Name (required)

Email (required)

For more details, visit: myMata Database:
https://mymata298821234.wordpress.com/2022/09/13/mymata-database/

Societal, health and well being impact analysis (Objective 3)

System testing and Impact Study @ Semporna, Sabah (10-13 June 2025)

Impact Area	Indicators	Outcomes
Community Inclusion	Engagement of elderly and rural groups in screening.	100+ villagers participated in eye screening and awareness activities.
Health Awareness	Knowledge of eye diseases and early detection.	Post-survey showed higher understanding of cataract/pterygium and importance of screening.
Behavioral Impact	Willingness for regular eye check-ups and follow-up.	Most respondents indicated intent to re-screen and share information with family.
Digital Literacy	Readiness to use the myMata app	Participants expressed interest in guided use; need for simplified instruction noted.
Well-Being Impact	Confidence and independence in daily activities.	Improved sense of control and reduced anxiety about eye problems

Report: https://www.youtube.com/watch?v=RKEiOjTpkls

On-site system validation and Capacity building @ Phnom Penh, Cambodia (28-31 July 2025)

Impact Area	Indicators	Outcomes
Healthcare Access	Eye screening availability in underserved rural areas..	Local volunteers conducted screenings using myMata; reduced travel burden for patients
Technology Empowerment	Practical training and knowledge transfer.	HBB volunteers trained in installation, data upload, and system troubleshooting.
Cross-Border Collaboration	Partnership between Malaysian and Cambodian teams.	Joint validation session held; **HBB CEO committed to adopting system for outreach.**
Sustainability and Local Ownership	Continued use of system beyond project period.	Pre-configured device provided to clinic; **plans to include myMata in HBB outreach.**
Health Equity & Inclusion	Affordable, mobile-based screening for low-income groups.	Free digital screening provided; enhanced access for underserved communities.

Report: https://youtu.be/CJdDidfS_dY

Future works and Conclusion

Future works:

1. **Scientific & Technological Work**
   - Integrate Explainable AI (XAI) within the DSS to enhance model transparency and clinician confidence. If extended, results will be published and presented internationally.
2. **System Development – Hybrid cloud-edge Architecture**
   - Develop a lightweight edge app for local image processing and disease detection to overcome rural connectivity issues observed in Semporna and Phnom Penh.
3. **Future Experimentation**
   - Continue joint studies with HBB to validate model performance using shared datasets for cataract and pterygium.
   - Establish benchmarking protocols and document best practices for regional AI-based eye screening adoption.

Conclusion:

- ✓ The project demonstrated the potential of a cloud-based DSS for early detection of ocular diseases.
  - XAI integration will enhance interpretability and clinician trust, supporting broader adoption.
- ✓ Through a hybrid cloud–edge design and collaboration with HBB Cambodia, the system aims for scalable, accessible, and policy-ready deployment across regional healthcare settings.
- ✓ If the project extension is allowed, it will enable deeper analysis, dissemination, and publication of the testing and validation results, thus maximizing the project's scientific and societal value.