## 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.

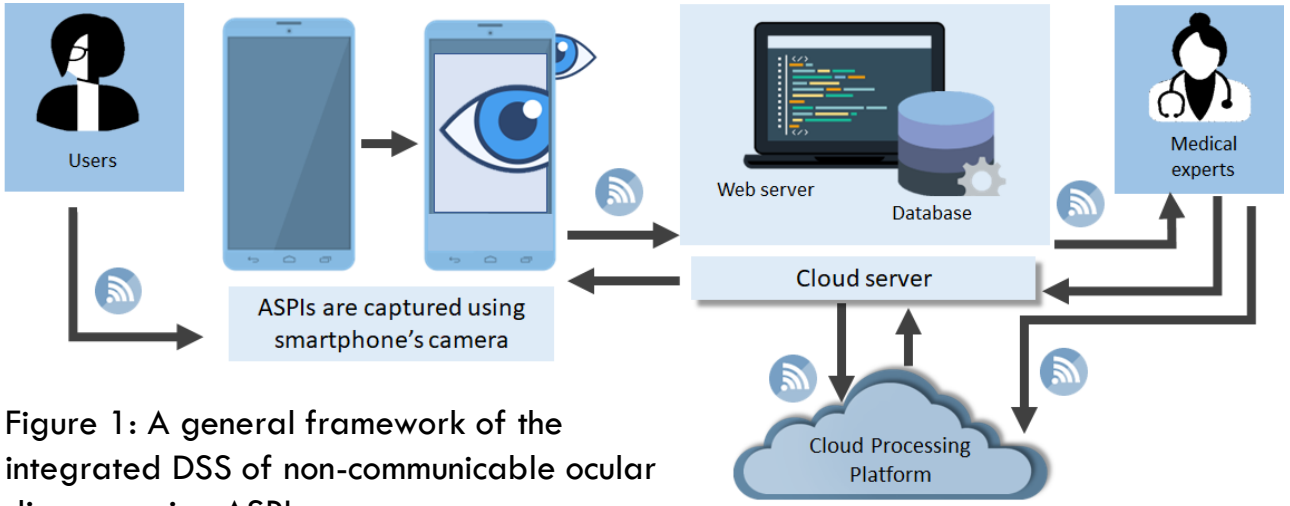



Figure 1: A general framework of the integrated DSS of non-communicable ocular diseases using ASPIs.

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: Dr. Marizuana Mat Daud

Project Members :

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<br>Activity 2: Design of the integrated structure of cloud information database | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Activity 3: Data and information collection<br>Activity 4: Data association of corneal state in the related NCODs | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | |
| Activity 5: Deep learning NN implementation for corneal state pattern classification and prediction<br>Activity 6: Benchmarking of other machine learning algorithms<br>Activity 7: Integration of output of Activity 2 and 8 to develop the DSS cloud-based DSS | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | |
| Activity 8: System testing and validation<br>Activity 9: Impact analysis and project finalisation | | | | | | | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | |
| Research Milestone | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

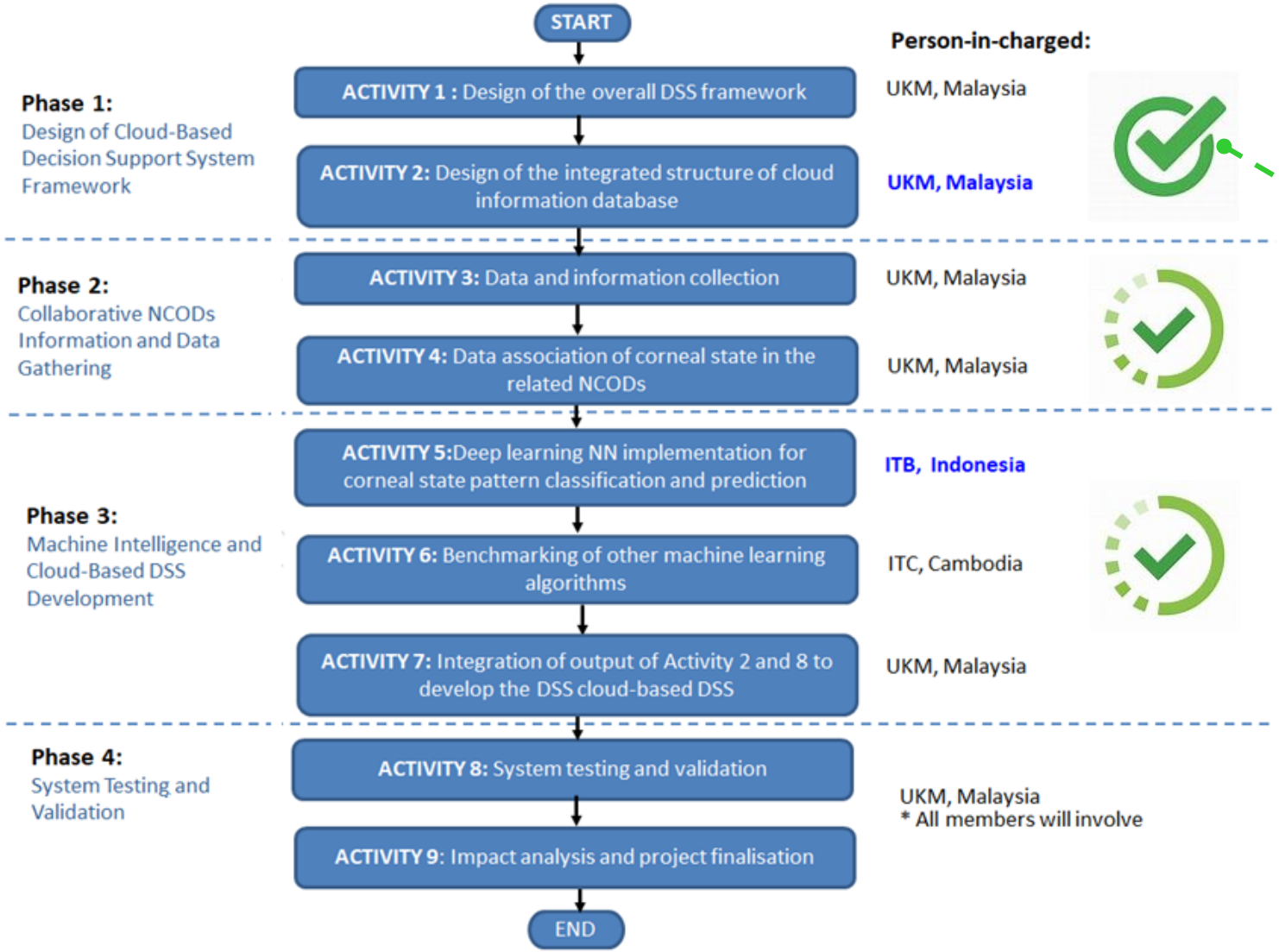
| **ACTIVITIES** | **DATE** |
|---|---|
| Completion of designing cloud DSS framework | 31 August 2023 |
| Completion of gathering collaborative NCODs information and data | **31 Dec 2024** |
| Completion of developing machine intelligence and cloud-based DSS | **30 June 2025** |
| Completion of system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

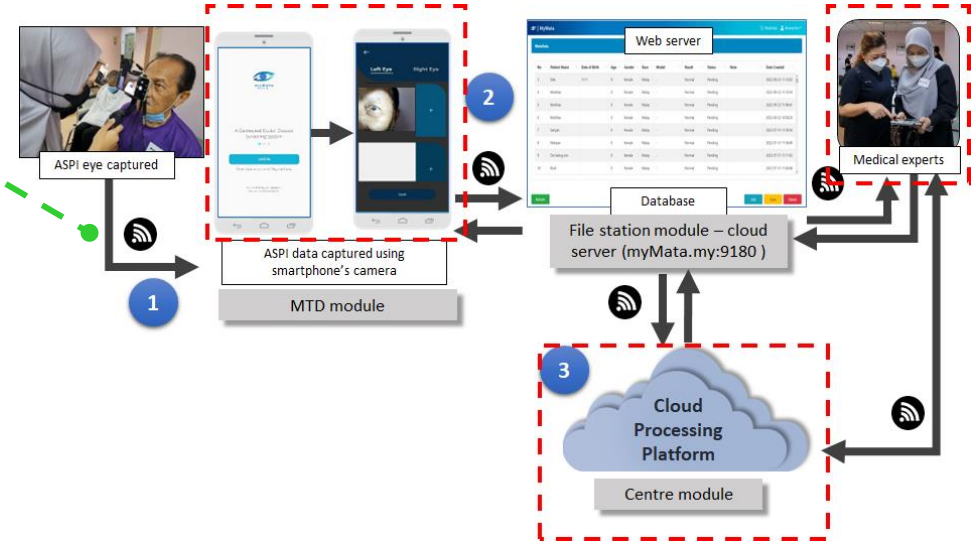
## Revised Project Budget:

*Purchasing completed on 15 Feb 2024 & 20 Feb 2024*

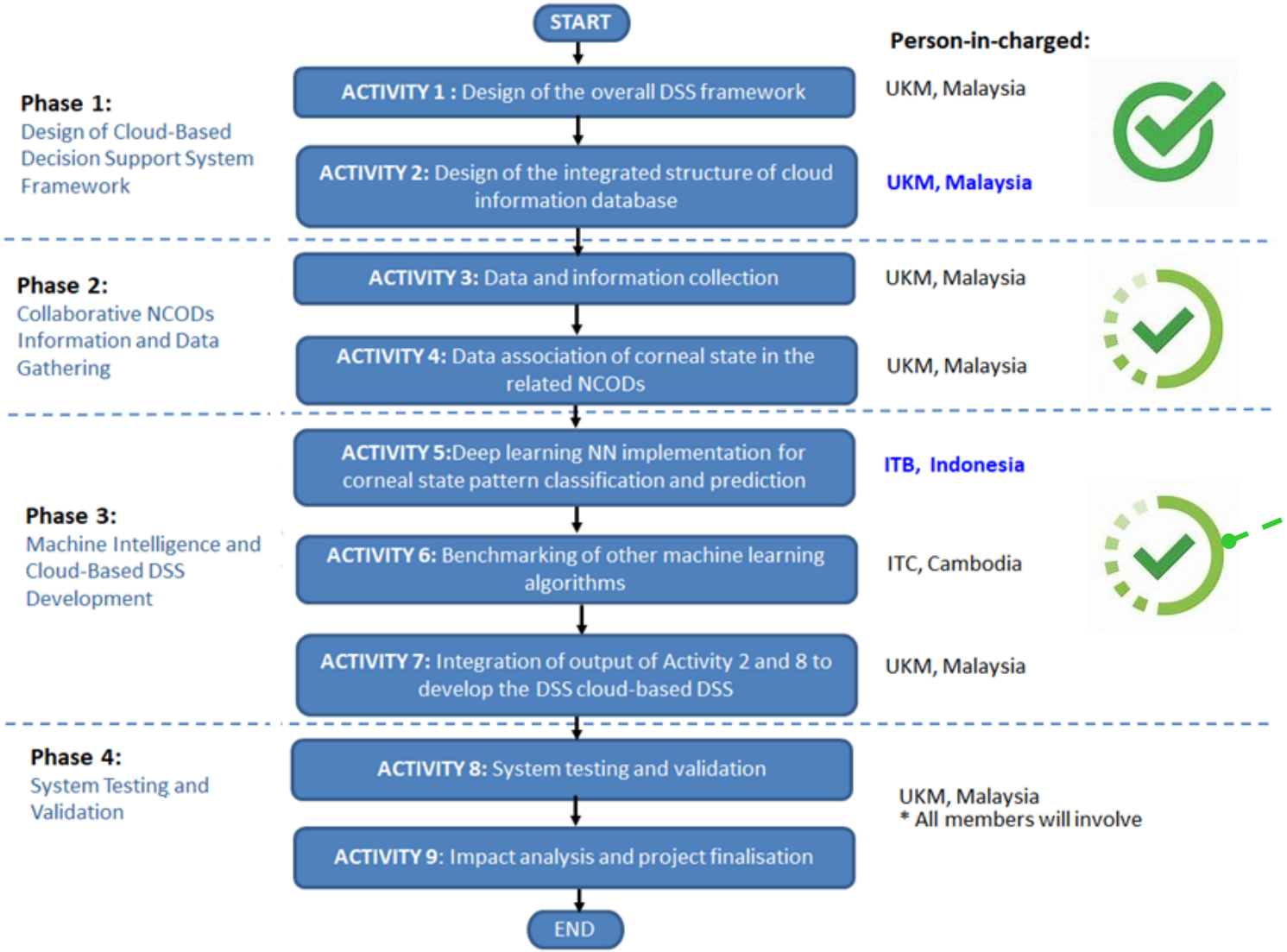
| ITEM | BUDGET (USD) | SPENT (USD) |
|---|---|---|
| **1. Equipment/ Software** | | |
| XOJO Pro Edition | 1598 | **~USD 1584** |
| Rental of Dedicated Server for Web Service Hosting with new domain | 750 | **~USD 719** |
| High performance laptop for mobile tests | 2000 | **~ USD 1930** |
| **Note:** Currency rate: 20 Feb 2024 -- 4.7988 MYR<br>**Total:** | 4348 | **~USD 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** | |
| **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** | |
| **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 | |
| **Total:** | **7250** | |
| **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 | |
| **Total:** | **3920** | |
| **3. Dissemination** | | |
| 1.One article sent to an open access journal: USD 2,700<br>2. One conference proceeding ( Flight, Accommodation, Ground transport, APC) | 2700<br>1713 | |
| **Total:** | **4013** | |
| **GRAND TOTAL (USD):** | **22,016** | |
| **(JPY):** | **2,907,432.96** | |

# Project Activities:



# Project Activities:





# Project Activities:

**Phase 2:** Collaborative NCODs information and data gathering

| 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*** | *relationship between corneal surface irregularities, tear film stability, and inflammation* |

**Phase 3:** Machine intelligence and cloud-based DSS development

**Preliminary experimental work:**

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

# Automated PTERYGIUM Detection using ASPIs

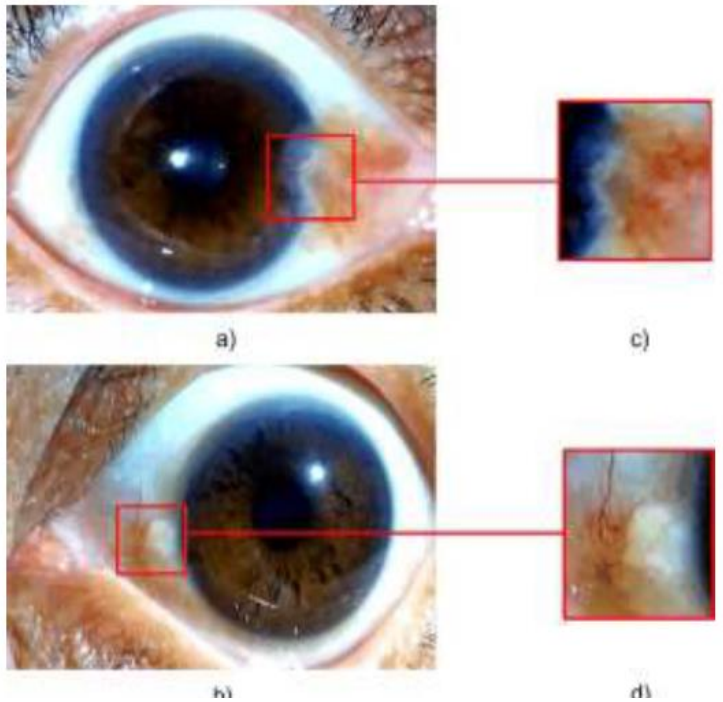



**FIGURE 1.** ASPI of (a) pterygium, (b) pinguecula and appearance of © pterygium tissue, (d) pinguecula tissue.

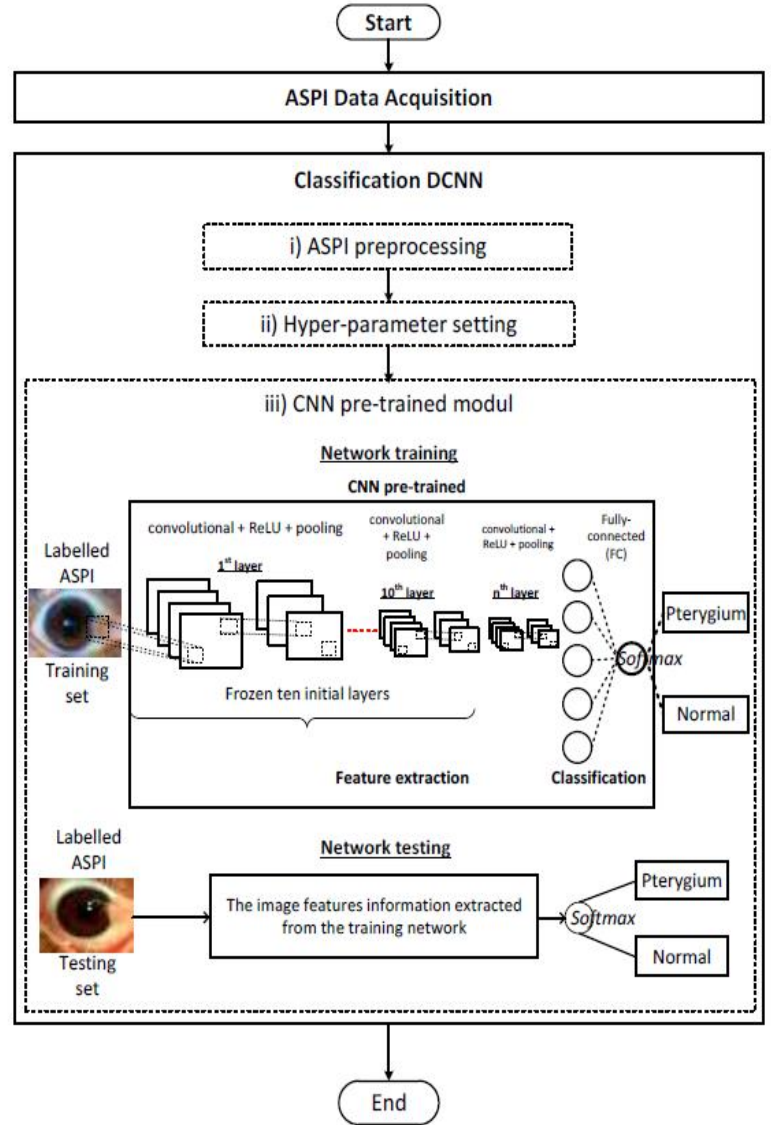



**FIGURE 2.** Proposed block diagram of pterygium detection using a digital image processing and deep learning approaches.

[1]N Syahira M Zamani, W Mimi Diyana W Zaki, Aqilah Baseri Huddin, Aini Hussain, Haliza Abdul Mutalib, Aziah Ali. (2020). Automated Pterygium Detection Using Deep Neural Network. - *IEEE Access.* 1659-1672.

# Automated Nuclear CATARACT Detection using ASPIs

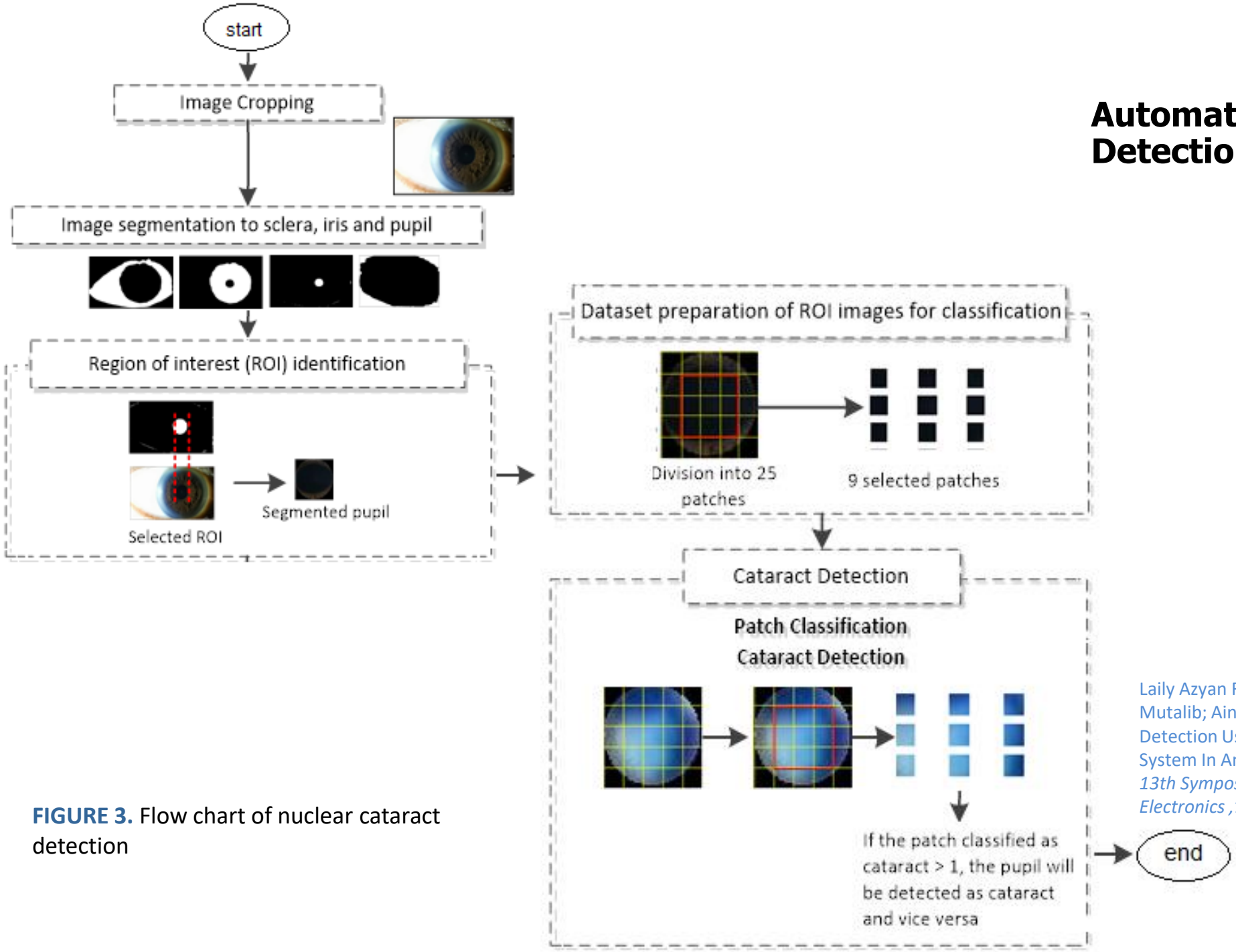



**FIGURE 3.** Flow chart of nuclear cataract detection

Laily Azyan Ramlan; Wan Mimi Diyana Wan Zaki; Haliza Abdul Mutalib; Aini Hussain; Aouache Mustapha. (2023). Cataract Detection Using Pupil Patch Classification And Ruled-based System In Anterior Segment Photographed Images. - *IEEE 13th Symposium on Computer Applications & Industrial Electronics* ,124-129.

# R&D results:

| Disease type | Number of data | |
|---|---|---|
| | Normal | Disease |
| **Pterygium** | 152 | 152 |
| **Cataract** | 50 | 50 |

a) Normal

b) Non communicable ocular diseases that can be captured using smartphone cameras ; pterygium (left) and cataract (right)

| Network | Batch Size | Epochs | Learning Rate | Optimizer | Accuracy | Precision | AUC |
|---|---|---|---|---|---|---|---|
| ResNet50 | 10 | 20 | 0.0001 | SGDM | 95.72% | 97.93% | 98.73% |
| | 32 | | | | 93.75% | 97.16% | 98.24% |
| | 64 | | | | 91.12% | 98.45% | 97.50% |
| VGG16wbn | 10 | | | | 97.04% | 97.99% | 99.19% |
| | 32 | | | | 93.09% | 95.17% | 98.87% |
| | 64 | | | | 90.46% | 95.56% | 98.29% |
| NasNetMobile | 10 | | | | 93.75% | 96.50% | 96.79% |
| | 32 | | | | 91.45% | 94.37% | 96.18% |
| | 64 | | | | 87.50% | 94.53% | 95.23% |
| MobileNetV2 | 10 | | | | **97.70%** | **99.32%** | **99.34%** |
| | 32 | | | | 94.08% | 94.67% | 98.57% |
| | 64 | | | | 90.46% | 93.01% | 97.39% |
| Xception | 10 | | | | 94.41% | 97.20% | 98.82% |
| | 32 | | | | 92.11% | 97.06% | 97.15% |
| | 64 | | | | 86.84% | 95.90% | 95.38% |

**FIGURE 4.** Results of the pterygium detection using existing developed model and the current deep learning models

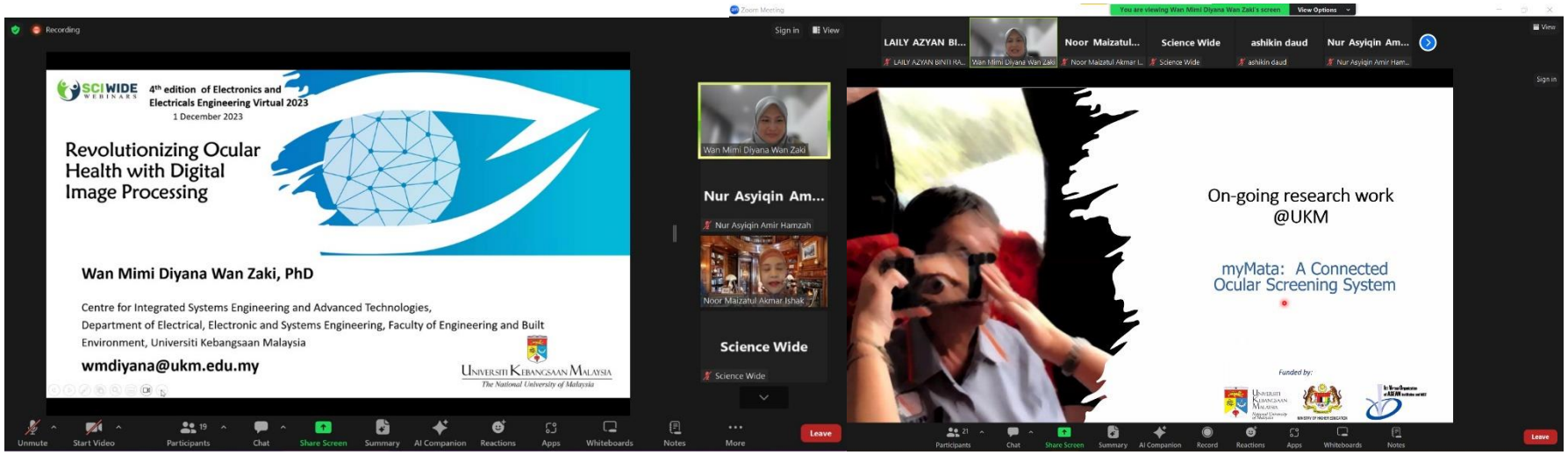
| Network | Batch Size | Epochs | Learning Rate | Optimizer | Accuracy | Precision | AUC |
|---|---|---|---|---|---|---|---|
| ResNet50 | 5 | 20 | 0.00001 | Adam | 98.11% | 97.79% | 99.65% |
| | 10 | | | | **98.22%** | 97.59% | **99.86%** |
| VGG16wbn | 5 | | | | 93.78% | 93.97% | 96.26% |
| | 10 | | | | 91.67% | **97.95%** | 95.90% |
| NasNetMobile | 5 | | | | 87.67% | 85.09% | 90.34% |
| | 10 | | | | 94.78% | 96.54% | 98.79% |
| MobileNetV2 | 5 | | | | 93.56% | 90.66% | 98.96% |
| | 10 | | | | 95.44% | 95.14% | 99.19% |
| Xception | 5 | | | | 90.22% | 87.87% | 96.56% |
| | 10 | | | | 95.11% | 95.52% | 99.02% |

**FIGURE 5.** Results of the cataract detection using existing developed model and the current deep learning models

# Scientific Contribution:

Presentations at International Conferences:

| No: | Paper title: | Author names | Affiliation | Conference name: | The date of the conference | The venue of the conference |
|---|---|---|---|---|---|---|
| 1. | Keynotes : Revolutionizing Ocular Health with Digital Image Processing | Wan Mimi Diyana Wan Zaki | Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, UKM Bangi, Malaysia | SCI Wide Webminar - 4th Edition of Electronics and Electricals Engineering Virtual 2023 | 1 December 2023 | Virtual |



# Scientific Contribution:

## Published Journal Papers:

| No: | Paper title: | Author names | Affiliation | Journal name: | The publisher of the Journal | The volume number and Pages |
|---|---|---|---|---|---|---|
| | | | | | | |

## Accepted for Publication Journal Papers:

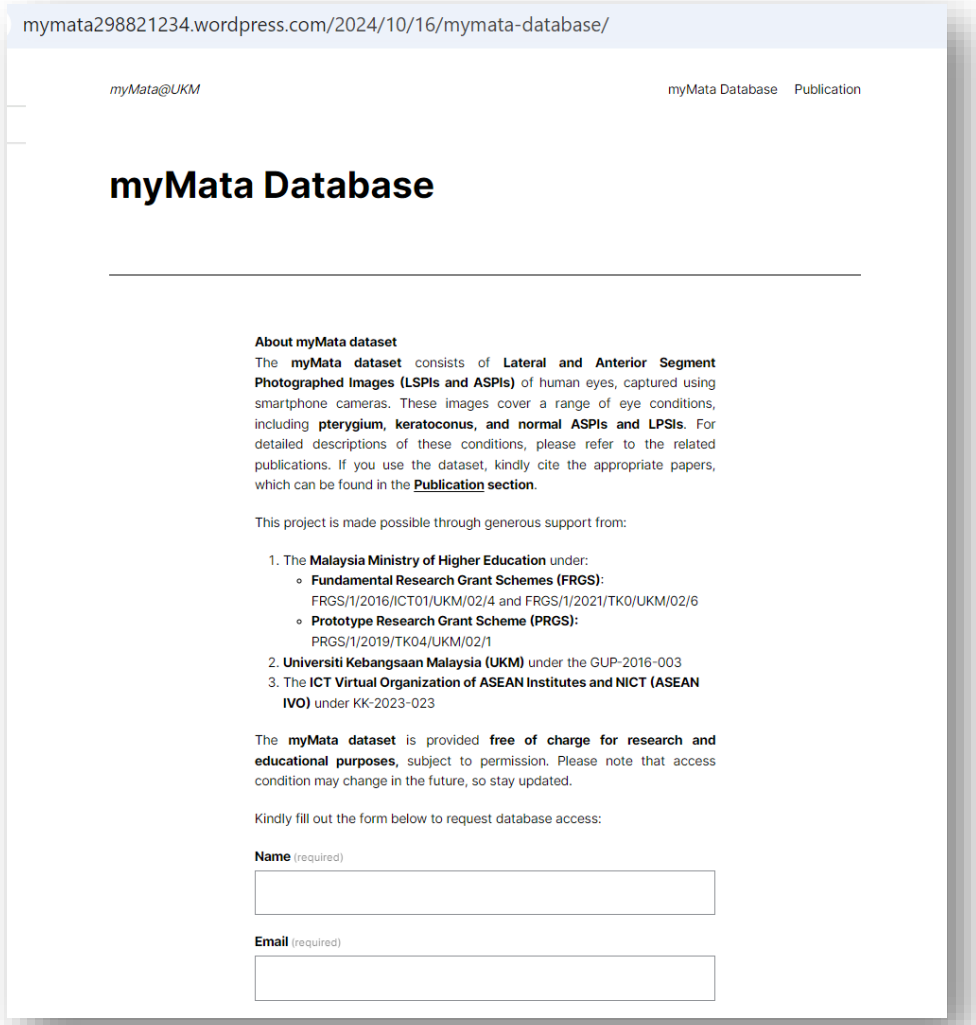
| No: | Paper title: | Author names | Affiliation | Journal name: | The publisher of the Journal | The volume number and Pages |
|---|---|---|---|---|---|---|
| 1 | The Impact of Mobile Application for Ocular Disease Screening in Community Outreach Program | Laily Azyan Ramlan, Wan Mimi Diyana Wan Zaki* Haliza Abdul Mutalib, Marizuana Mat Daud, Aouache Mustapha | Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, UKM Bangi, Malaysia* | Jurnal Kejuruteraan | UKMPress | Vol. 37 (2): March: 2025 |

# Societal Impact report

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.

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



# Conclusion & Future Work:

- ✓ Phase 1 has been successfully completed, and the output from **Activity 2** will be integrated with that of **Activity 8** during **Phase 3**.
- ✓ Experimental results using archived datasets indicate strong performance. With optimized hyperparameters, the **MobileNetV2** model achieved **97.7% detection accuracy** and an **AUC of 99.34%** for pterygium detection, while the **ResNet50** model achieved **98.22% accuracy** and an **AUC of 99.86%** for cataract detection.
- ✓ Developing reliable and robust machine learning models, however, requires large datasets. Extending the project timeline would enable further data collection and allow for additional testing in real-time applications.
- ✓ Integrating the outputs from Activity 2 and Activity 8 will likely be challenging, as it requires careful optimization to achieve optimal system performance.