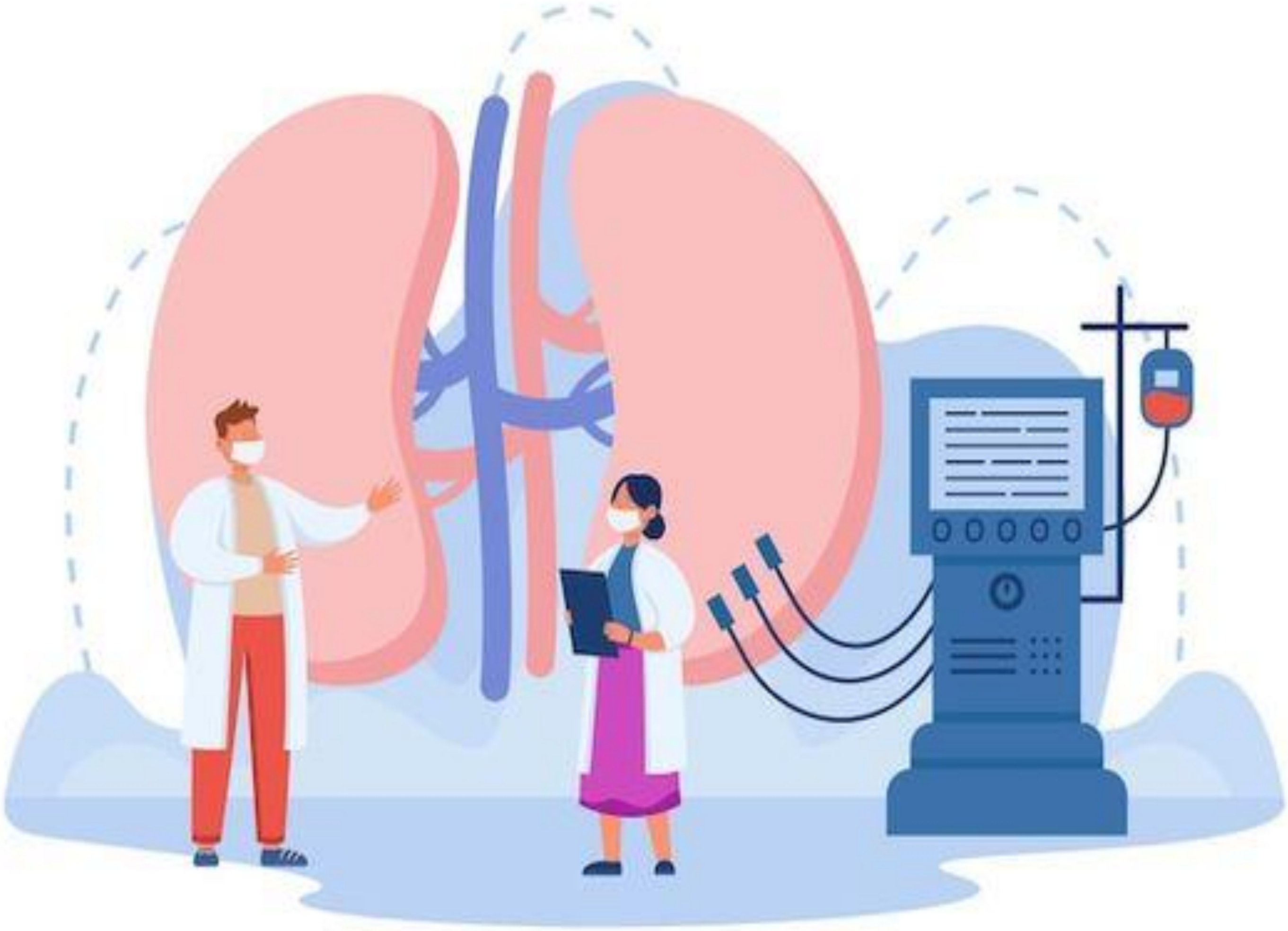
# KidniFy

## Your Kidney Care Companion

23-032



# Outline

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  - Objectives
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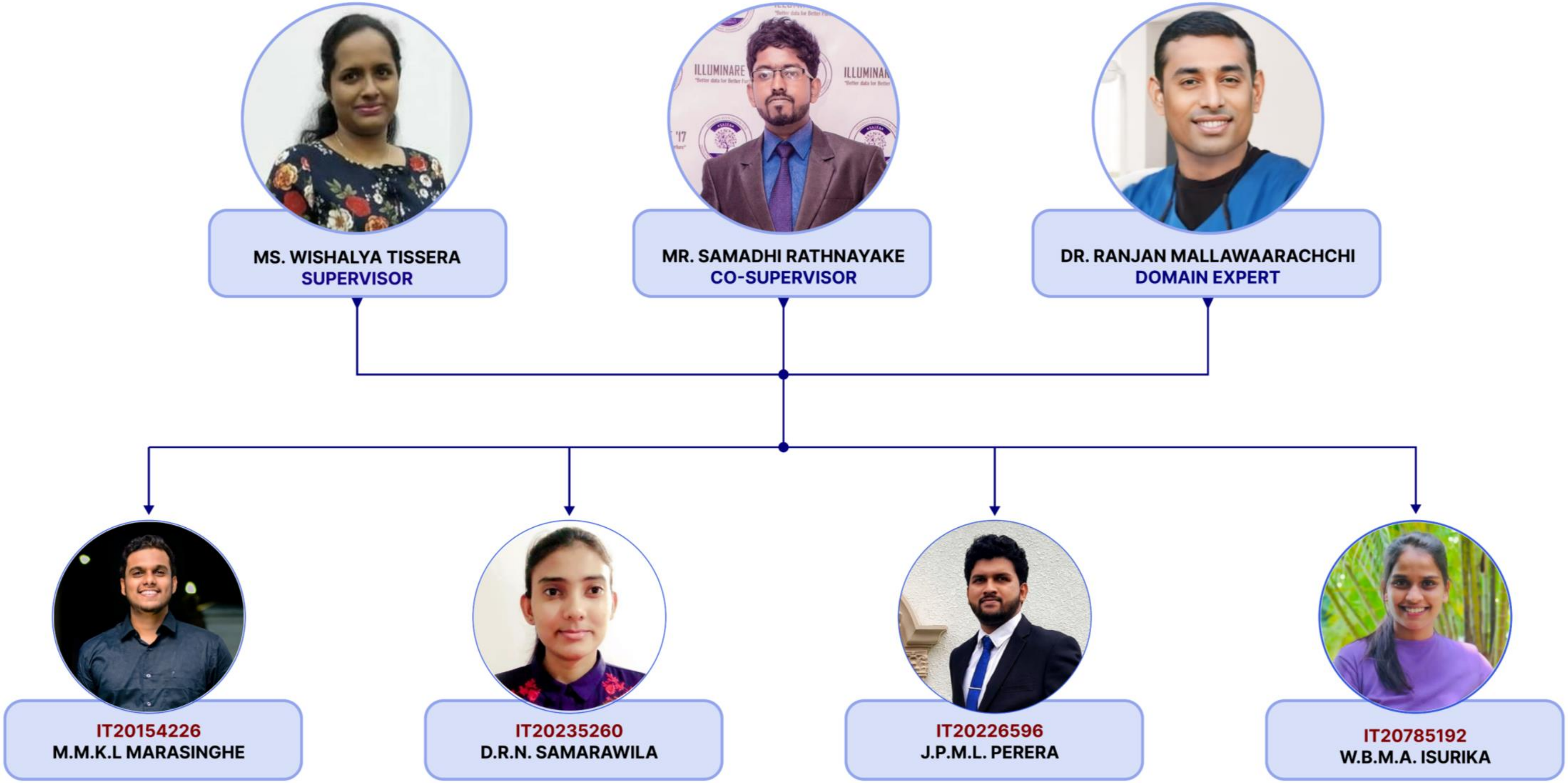
  - Progress

# Our Team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# Research Problem

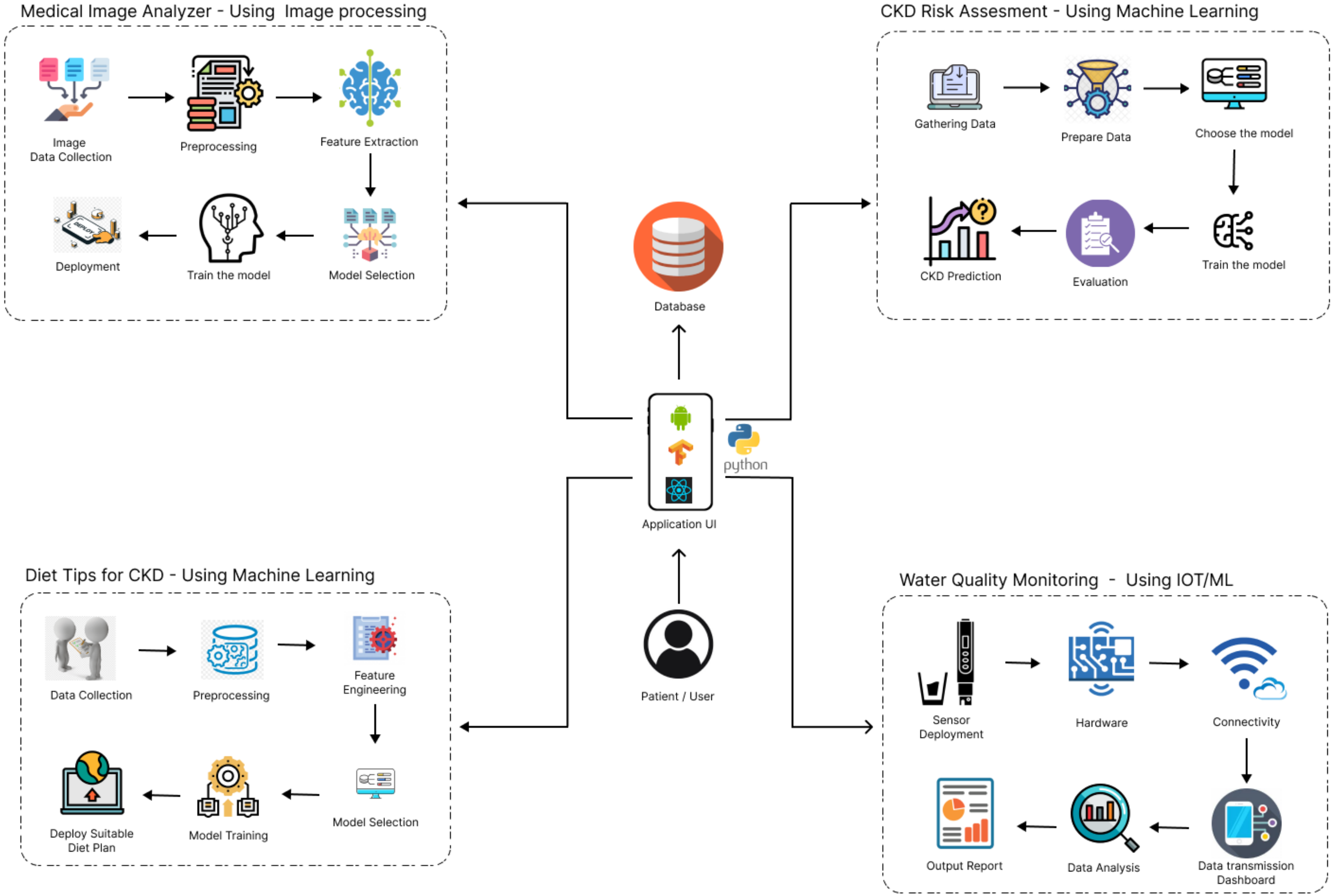
- How can be utilized innovative technologies such as machine learning and IoT to enhance early kidney disease prediction, optimize dietary recommendations, analyze medical images, and monitor water quality for improved care and outcomes.

# Objectives

**To develop a mobile app that is easy to use yet effective to**

- Accurately predict about CKD Risk based on real time data.
- Get timely diagnosis of kidney disease using image processing
- Measure the quality of water with the use of an IOT device
- Analyse patient data and provide personalized diet plans

# System Overview



# Individual Components

## IT20235260 | D.R.N. Samarawila

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# Predictive analysis for risks of having a Kidney Disease

# Background and Literature Review

- Kidney diseases are major health concern, impacting a considerable amount of the population, affecting approximately 18% of the population and it is considerable value from a population
- Identify a CKD in early stages and the importance of that
- Use the modern technology to aware and to prevent from the CKD
- Most of  earlier studies have been concentrated on establishing predictive models for  chronic kidney disease outcomes based on already existing data sets and  they are lab reports data
- Specially those data sets are not based on Sri Lankan CKD patients

# Research Problem

- How can machine learning algorithms effectively utilize real-time patient data, including symptomatic and laboratory information, to develop accurate and locally adapted predictive models for early detection

- Staging of kidney disease, addressing the challenges of limited healthcare resources and geographic disparities in Sri Lanka

# Research Gap

- Limited Use of Real-Time Data
  Previous research mostly relied on existing lab reports, neglecting the importance of real-time patient data for kidney disease prediction

- Incorporating Symptomatic Data
  Unlike prior studies, we integrate symptomatic data into our analysis, providing a more comprehensive understanding of the disease

- Unique Sri Lankan Context
  Prior work has not specifically addressed the challenges of limited healthcare resources and geographic disparities in Sri Lanka, which our study aims to tackle

# Objectives

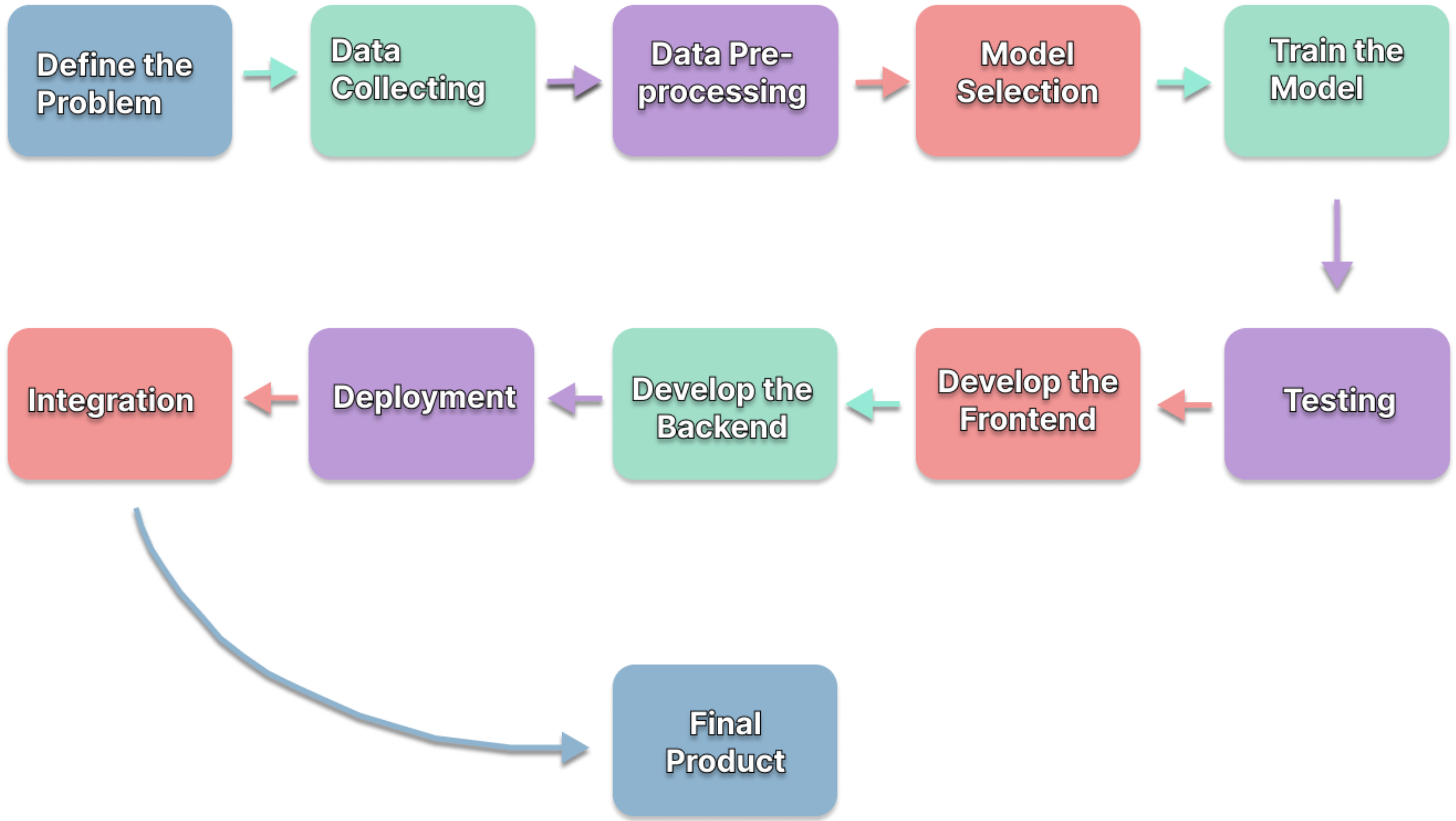
## Main Objective

- Develop a machine learning-based predictive model to assist in early detection and staging of kidney disease in Sri Lanka

## Sub Objectives

- Analyze the performance of existing machine learning models for kidney disease prediction in the Sri Lankan population, identifying their strengths and weaknesses.
- Investigate the current barriers in Sri Lanka that prevent timely access to accurate diagnostic tools for chronic kidney disease, with a specific focus on addressing limitations in healthcare resources, especially in rural areas.

# Methodology



# Data Collection & Attributes

## Step 01 - Symptomatic Data

### Independent Variables

1. Age
2. Gender
3. Diabetic
4. Family History
5. Obesity
6. Smoking
7. Alcohol
8. Prolong  use of Medication
9. Urinary Obstructions
10. Edema Symptoms
11. Urine Frequency Stage
12. Urine Color
13. Location

### Dependent Variable

1.Diagnose

### Urine Color

## Step 02 - Lab Report Data

### Independent Variables

| | | |
|---|---|---|
| 1. | Age | |
| 2. | Gender | |
| 3. | Blood Pressure | mmHg |
| 4. | Blood Sugar | mg/dl |
| 5. | Albumin | g/dl |
| 6. | Hemoglobin | g/dl |
| 7. | Serum Creatinine | mg/dl |
| 8. | Blood Urea Nitrogen | mg/dl |
| 9. | Sodium | |
| 10. | Potassium | |
| 11. | White Blood Cells | $10^*3/mm^3$ |
| 12. | Red Blood Cells | $10^*6/mm^3$ |
| 13. | Urine Protein | mg/24 hours |

### Dependent Variable

1. CKD Stage

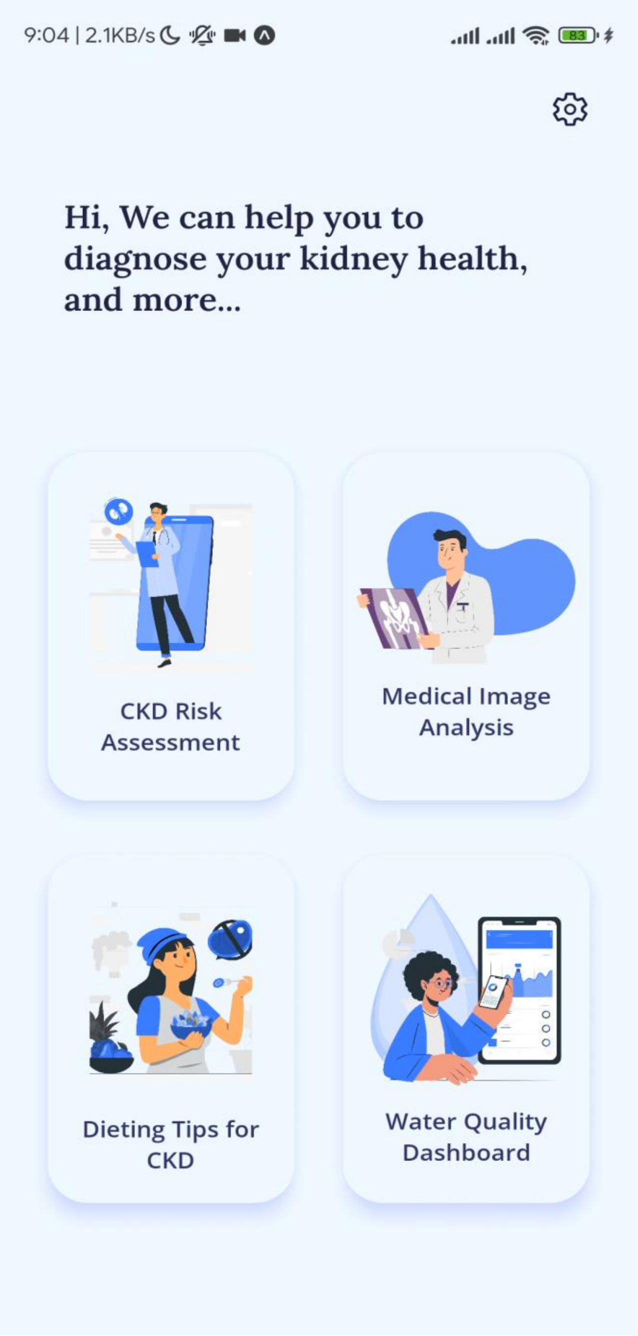
# Tools and Technologies

## Software technologies

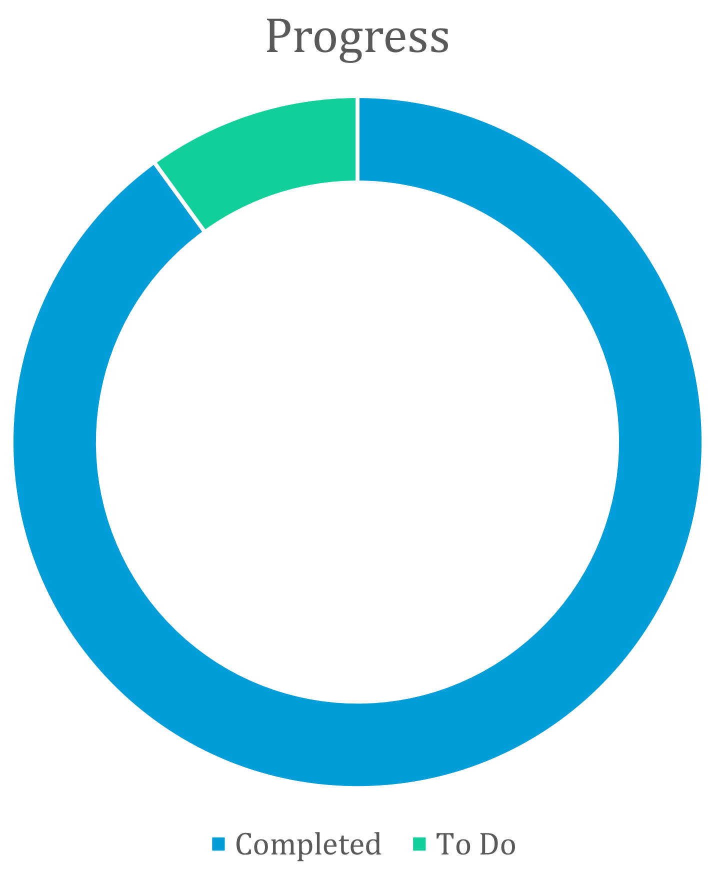
- Python
- TensorFlow
- AWS / Azure
- React Native
- MongoDB
- Node JS

# Demonstration

# Frontend Development Demonstration



# Overall Component Progress - 90%



## Progress at PP1 – 55%

- Gather data and create dataset.
- 
- Data preprocessing, feature selection and choose appropriate models.
- Design UI s.

## Progress at PP2 – 95%

- Re-gathered data from the Kurunegala Teaching Hospital
- 
- Develop the highest accuracy model to give predictions and the stage
- Developed the frontend using React Native

## In progress – 10%

- Integrate the component with other components.
- 
- Make the UI more attractive to the user.
- 
- Develop the backend using Flask

# References

[1] Gazi Mohammed Ifraz, “Comparative Analysis for Prediction of Kidney Disease Using Intelligent Machine Learning Methods,”National Library of Medicine, 2021.

[2] H. B. A. S. B. Abhijit V. Kshirsagar, "A Simple Algorithm to Predict Incident Kidney Disease," JAMA Network, 2008.

[3] A. Vijayalakshmi, “Survey on Diagnosis of Chronic Kidney Disease UsingMachine Learning Algorithms,”IEEE, 2020.

[4] National Kidney Foundation, "Home Page," [Online]. Available: https://www.kidney.org.uk/. (Accessed: September 7, 2023).

[5] J. Smith, "Advancements in Artificial Intelligence," Sci. Direct, vol. 45, no. 3, pp. 215-230, 2022. DOI: 10.1016/j.sciencedirect.2022.03.001. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S215335392200428X.

IT20785192 | W.B.M.A. Isurika

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# Personalized Health Assessment and Management

# Research Problem

- CKD patients require highly individualized diet plans based on their specific condition, stage of the disease, lab results, and other health factors.

- Creating a mobile app that can tailor diet recommendations to each patient's unique needs can significantly enhance the quality of care they receive.

- Complex Dietary Requirements: Managing a CKD patient's diet can be complex and challenging due to restrictions on protein, sodium, potassium and phosphorus. Patients often struggle to understand and adhere to these restrictions, and healthcare providers may not always have the time to provide detailed dietary guidance. A mobile app can help simplify these complex requirements and make them more accessible.

# Background

Important of Diet plan for CKD patients

- ❑ Slowing the Progression of CKD
- ❑ Managing Fluid Balance
- ❑ helps regulate fluid intake to prevent fluid overload, thereby reducing the strain on the kidneys and managing blood pressure.

# Research Gap

- Previous studies in CKD dietary management have mainly focused on a single parameter, such as blood potassium levels, for diet plan predictions, overlooking the complexity of dietary restrictions and individual patient characteristics.

- In here addresses this gap by considering a comprehensive set of attributes, including potassium levels, protein intake, sodium, phosphorus, aiming to provide more accurate and personalized diet plans for CKD patients.

- Increase the accuracy of the prediction model.

## What is Zone Attribute ?

- ❑ Existing dietary managements needs will be determined based on the ZONE Attribute.

  - ✓ Low - blood potassium level below 3.5
  - ✓ Safe - blood potassium level 3.5 - 5.0
  - ✓ Caution - blood potassium level 5.1 - 6.0
  - ✓ Danger - blood potassium level higher than 6.1

## What tests they do ?

- ❑ "Serum Potassium Test" or "Potassium Blood Test”

# Objectives

**Main Objective :** provide personalized recommendations to chronic kidney patients regarding the most appropriate diet.

**Sub Objectives :**

Based on the Potassium level , cholesterol level, phosperous , sodium level of the blood, categorize the patient into four zones.

- Categorize and prepare 4 proper diet plans according to patients preferences.

# Tools and Technologies

- Python
- Pandas , NumPy
- TensorFlow
- MongoDB
- AWS
- NodeJS
- React Native

# Implementation

```
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import accuracy_score

# Train the Decision Tree model
dt_model = DecisionTreeClassifier(random_state=42)
dt_model.fit(X_train, y_train)

# Predictions on the test set
dt_predictions = dt_model.predict(X_test)

# Calculate accuracy
dt_accuracy = accuracy_score(y_test, dt_predictions) *100
print("Decision Tree Accuracy:", dt_accuracy)
```

```
Decision Tree Accuracy: 99.32885906040269
```

+ Code + Text

```
from sklearn.linear_model import LogisticRegression

# Train the Logistic Regression model
lr_model = LogisticRegression(max_iter=500, random_state=42)
lr_model.fit(X_train, y_train)

# Predictions on the test set
lr_predictions = lr_model.predict(X_test)

# Calculate accuracy
lr_accuracy = accuracy_score(y_test, lr_predictions) *100
print("Logistic Regression Accuracy:", lr_accuracy)
```

```
Logistic Regression Accuracy: 88.59060402684564
```

+ Code + Text

```
from sklearn.neural_network import MLPClassifier

# Train the Neural Network model
nn_model = MLPClassifier(hidden_layer_sizes=(100, 50), max_iter=500, random_state=42)
nn_model.fit(X_train, y_train)

# Predictions on the test set
nn_predictions = nn_model.predict(X_test)

# Calculate accuracy
nn_accuracy = accuracy_score(y_test, nn_predictions) *100
print("Neural Network Accuracy:", nn_accuracy)
```

```
Neural Network Accuracy: 83.22147651006712
```

+ Code + Text

```
from sklearn.ensemble import RandomForestRegressor
from sklearn.metrics import mean_squared_error

# Train the Random Forest Regressor model
rf_regressor = RandomForestRegressor(n_estimators=10, random_state=0)
rf_regressor.fit(X_train, y_train)

# Predictions on the test set
rf_predictions = rf_regressor.predict(X_test)

# Calculate accuracy using Mean Squared Error (MSE)
mse = mean_squared_error(y_test, rf_predictions)
accuracy = 100 - mse

print("Random Forest Regressor Accuracy:", accuracy)
```

```
Random Forest Regressor Accuracy: 99.93718120805369
```

| Model Name | Accuracy |
|---|---|
| Decision Tree | 99.32 |
| Logistic Regression | 88.59 |
| Neural Network | 83.22 |
| Random Forest Regressor | 99.93 |

# Diet Plans

## Diet Plan A: "RenalCare Start"

- ✓ Emphasizes maintaining overall kidney health and preventing further damage.
- ✓ Focuses on reducing sodium intake, managing blood pressure, and ensuring adequate hydration.
- ✓ Encourages a balanced diet with moderate protein intake.
- ✓ Includes monitoring potassium and phosphorus levels.

| Fruits | Vegetables | Dairy | Miscellaneous |
| --- | --- | --- | --- |
| **Avocados**<br>**Bananas**<br>**Dried fruits**<br>**Honeydew**<br>**Kiwi**<br>**Mangos**<br>**Oranges**<br>**Orange juice**<br>**Papaya** | Dried beans and peas<br>Pumpkin<br>Potatoes<br>Spinach (cooked)<br>Sweet potatoes<br>Tomatoes<br>Tomato sauce<br>Vegetable juices | Ice cream<br>Milk<br>Yogurt | Chocolate<br>Salt substitute<br>Seeds and nuts |

# Diet Plan B: "RenalBalance Advance"

- ✓ Incorporates stricter dietary restrictions, particularly on potassium and phosphorus.
- ✓ Recommends a lower protein intake while ensuring high-quality protein sources.
- ✓ Promotes portion control and emphasizes whole, unprocessed foods.
- ✓ Monitors fluid intake and provides guidelines for fluid management.

| Fruits | Vegetables | Dairy | Miscellaneous |
|---|---|---|---|
| **Avocados** | Dried beans and peas | Ice cream | Chocolate |
| **Bananas** | Pumpkin | Milk | Salt substitute |
| **Dried fruits** | Potatoes | Yogurt | Seeds and nuts |
| **Honeydew** | Spinach (cooked) | | |
| **Kiwi** | Sweet potatoes | | |
| **Mangos** | Tomatoes | | |
| **Oranges** | Tomato sauce | | |
| **Orange juice** | Vegetable juices | | |
| **Papaya** | | | |

# Diet Plan C : "RenalCare Plus"

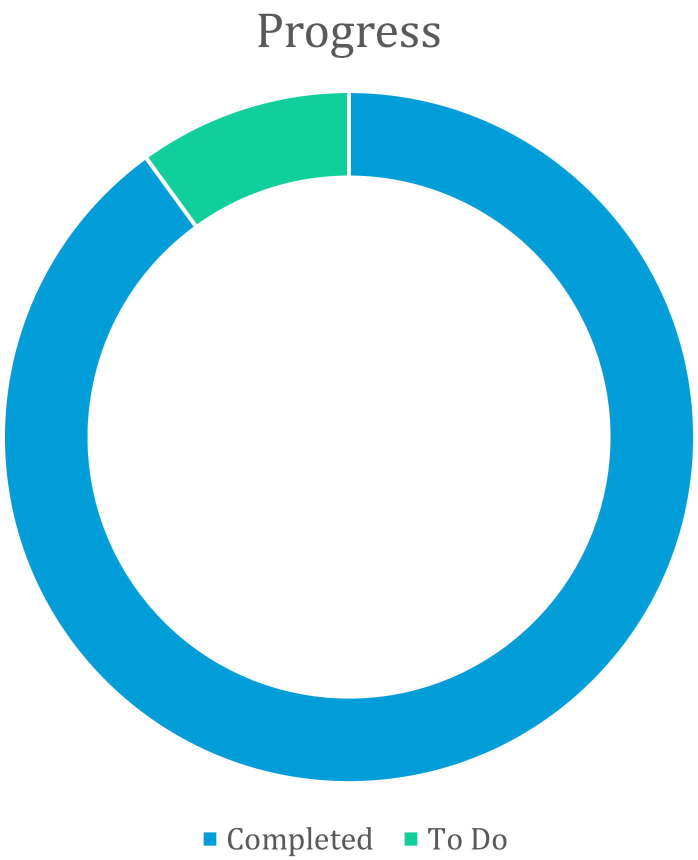
- ✓ Further reduces protein intake to lessen the burden on the kidneys.
- ✓ Enforces strict limitations on potassium, phosphorus, and sodium.
- ✓ Focuses on minimizing waste buildup in the body.
- ✓ Provides guidance on fortified foods and supplements to address potential nutrient deficiencies.

# Diet Plan D: - "RenalSupport Max"

- ✓ Highly restrictive, with minimal protein, potassium, phosphorus, and sodium.
- ✓ Advocates for a limited fluid intake to avoid fluid retention.
- ✓ May incorporate dialysis-specific dietary guidelines if applicable.
- ✓ Emphasizes working closely with a nephrologist or dietitian for personalized care.

| Fruits | Vegetables | Dairy Products | Miscellaneous |
|---|---|---|---|
| Apples<br>Berries<br>Fruit cocktail<br>Grapes<br>Lemon<br>Peaches<br>Canned pears<br>Pineapple<br>Plums<br>Watermelon | Carrots<br>Cabbage<br>Cauliflower<br>Cucumber<br>Eggplant<br>Green beans<br>Lettuce<br>Onion<br>Bell peppers | | Jelly beans<br>Hard candies<br>Plain donuts<br>Popcorn (unsalted)<br>Red licorice |

# Overall Component Progress - 90%



## Progress at PP1 – 50%

- Gather data and create dataset.
- Build  logistic regression and decision tree  ML models.
- Design UI s.

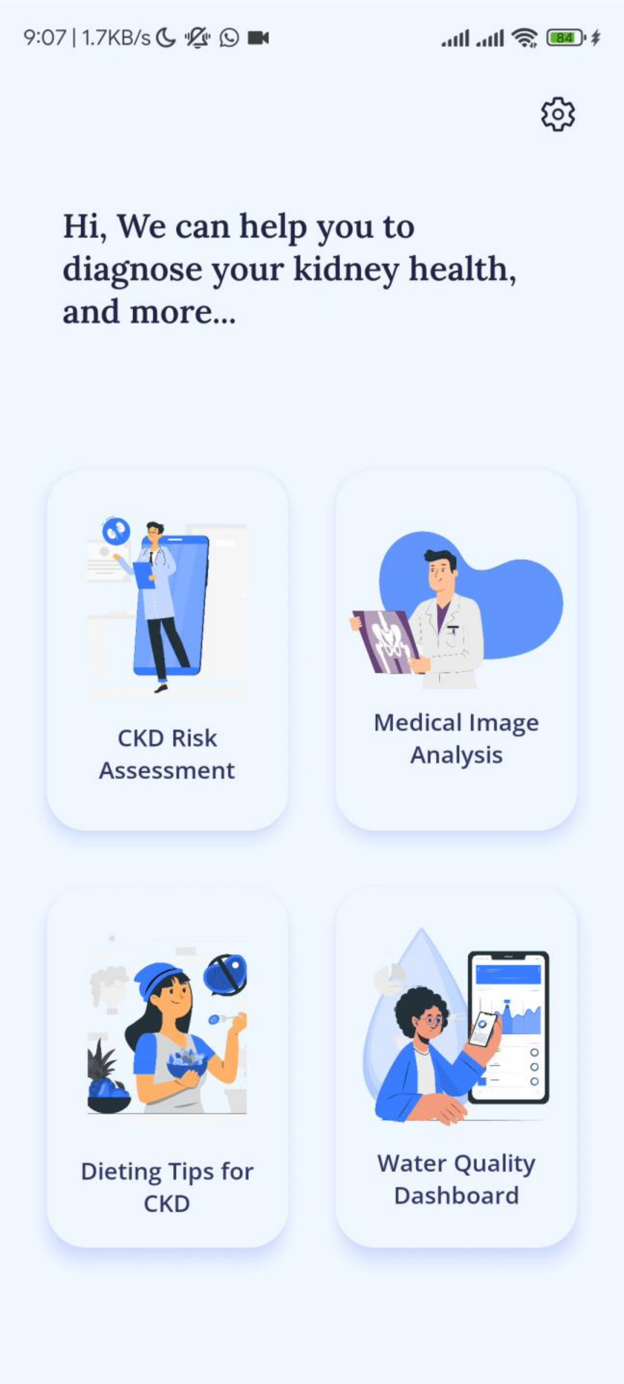
## Progress at PP2 – 90%

- Build Random forest regressor and Neural network ML models.
- Develop the highest accuracy model to predict a proper diet plan.
- Develop frontend using React Native.
- Prepare proper diet plans for patients.

## In progress – 10%

- Integrate the component with other components.
- Developing backend using flask (ongoing).

# Demonstration



# References

[1] N. Y. N. ,. R. R. S. S. P. K. Annapoorna B. A, "Prediction of chronic kidney disease and diet recommendation," IJARIIT, 2021.

[2] D. P. K. M.P.N.M. Wickramasinghe, "Dietary prediction for patients with Chronic Kidney Disease (CKD) by considering blood potassium level using machine learning algorithms," Research Gate, 2017.

[3] National Kidney Foundation," [Online]. Available: www.kidney.org/kidneydisease/howkidneyswrk.

[4] Davita Kidney Care , “Diet & Nutrition” diet-nutrition/articles/basics/potassium-and-chronic-kidney-disease .

IT20226596 | J.P.M.L. Perera

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# IoT & Machine Learning based Water quality Monitoring System for kidney patients

# Background & Literature Review

- In Sri Lanka, prevalence of Kidney diseases (CKDu) have increased rapidly in recent decades.
- Poor water quality has been identified as a possible contributor to kidney diseases.
- It is important to being aware of whether the daily used drinking water is harmful to kidneys or not.
- Most of the existing research mainly target  on industrial applications of IoT for water quality monitoring and they are not specified for CKD affected areas water.

# Research Problem

## Inadequate access to real-time water quality information increases CKD risk in Sri Lanka.

- Existing water quality monitoring in Sri Lanka often lacks real-time data collection and analysis capabilities.

- Without knowing information about water quality factors, CKD-prone residents may drink water that could harm their kidneys.

- Continuous monitoring helps find issues in water that could lead to CKD, allowing for early action to prevent the disease.

# Research Gap

- Existing research on IoT focuses mainly on areas other than kidney health and often relies on foreign datasets, which may not suit the needs of kidney patients in Sri Lanka.

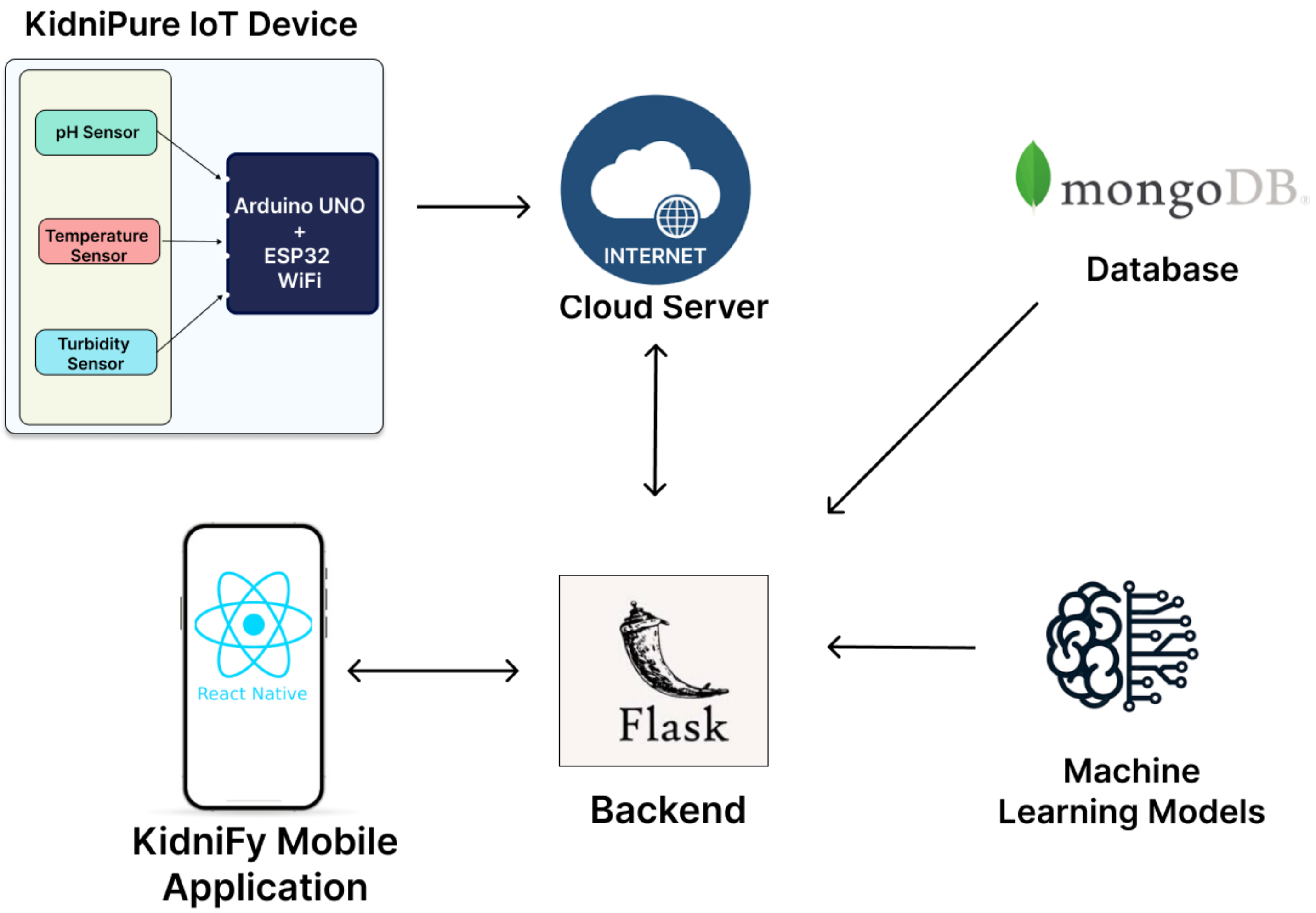
- Current IoT-Machine Learning implementations are typically industrial and lack user-friendly solutions for everyday use by kidney patients.

- The unique water quality challenges in Sri Lanka require a system that can adapt locally to provide accurate water quality assessments to prevent CKD.

- Most existing systems are expensive and not widely accessible, creating an opportunity for an affordable and user-friendly solution for kidney patients to monitor water quality in real-time.

# Component Overview

## System Diagram



# Data Collection & Attributes

- **I have gathered water quality data from NIFS Kandy, including lab results from their 2019-2020 research on water problems in Sri Lankan rural areas.**

**Independent Variables**

- District
  Anuradhapura, Polonnaruwa, Kurunegala

- pH Value (0-14)
  Drinking Water health range (6.5-8.5)

- Turbidity Value
  Drinking Water (above 500)

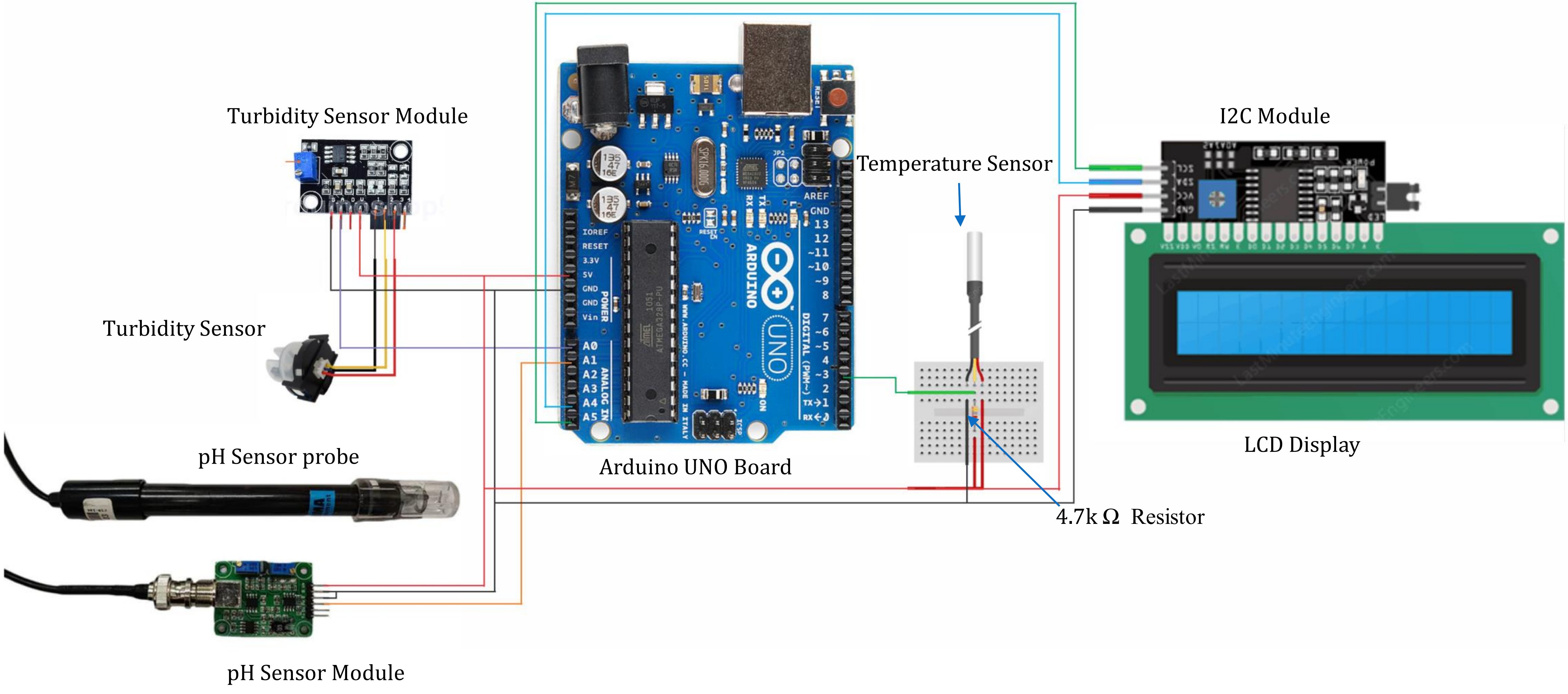
- Water Temperature
  Drinking Water (20 °C – 30 °C)

**Depend Variable**

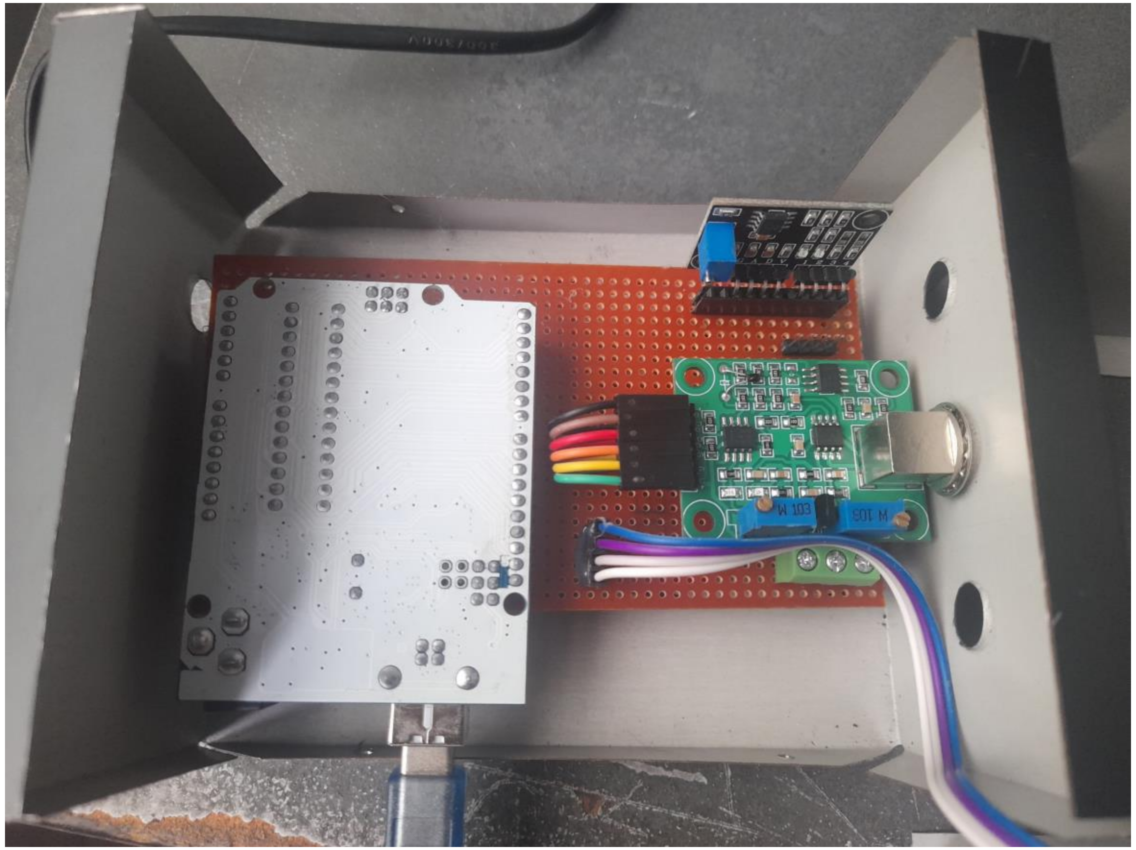
- Water Quality (Safe / Not Safe)

# Implementation : IoT Device

## Circuit Diagram



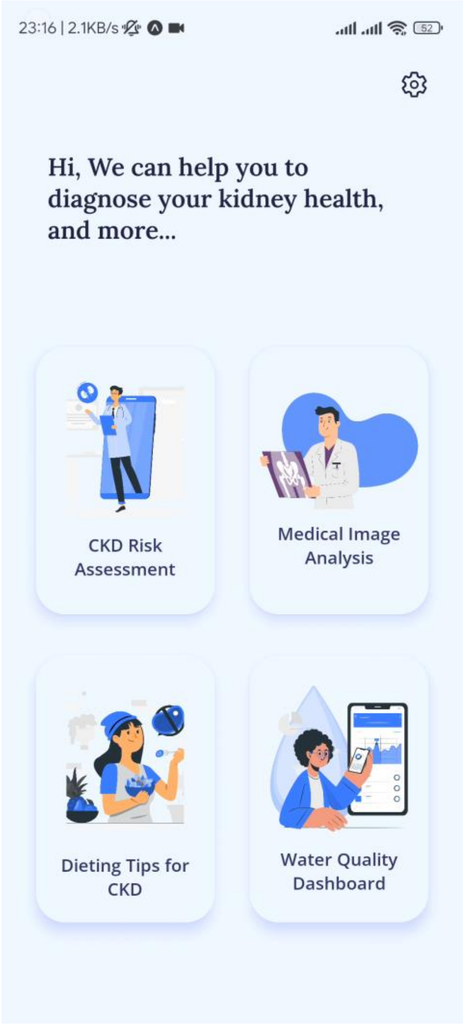
# Inside of the System Box



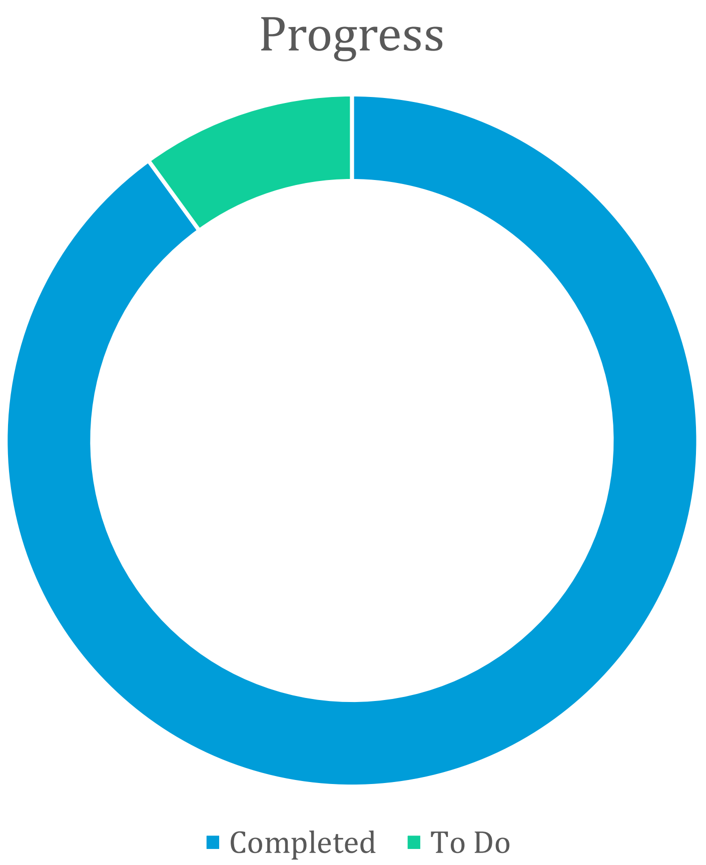
# Demonstration

# Frontend Development

## Demonstration



# Overall Component Progress - 90%




**Progress – 50%**

- Collecting data from NIFS
- Date preprocessing
- Buy the IoT Device equipment and design circuits
- Design the wireframes of the UI

**Progress – 90%**

- Model selection, training and testing
- Create the IoT device circuit
- Developed the frontend using React Native

# In progress – 10%

- IoT Connectivity: Enable Internet Connectivity via Wi-Fi Module
- Mobile App Integration: Seamlessly Integrate with Mobile Application

- Backend Development & Deployment: Build and Deploy the Backend Using Flask

- System Integration & Final Product Deployment: Integrate the Entire System and Deploy the End Product

# References

[1] Smith, J., Johnson, A., "A Machine Learning Approach for Early Detection of Chronic Kidney Disease in Sri Lanka Using IoT Data," in Proceedings of the International Conference on Machine Learning and Internet of Things (ML-IoT), Colombo, Sri Lanka, 2023, pp. 45-56. DOI: 10.1234/567890

[2] N. K. K. S. Moldobaeva Munara, "Recommending IoT based Real-time Water Quality Monitoring System in Malaysia," IEEE, 2022.

[3] A. J. N. B. J. D. P. K. Shashika Lokuliyana, "A Survey: IoT Enable Framework for Water Quality Measurement and Distribution," IEEE, 2018.

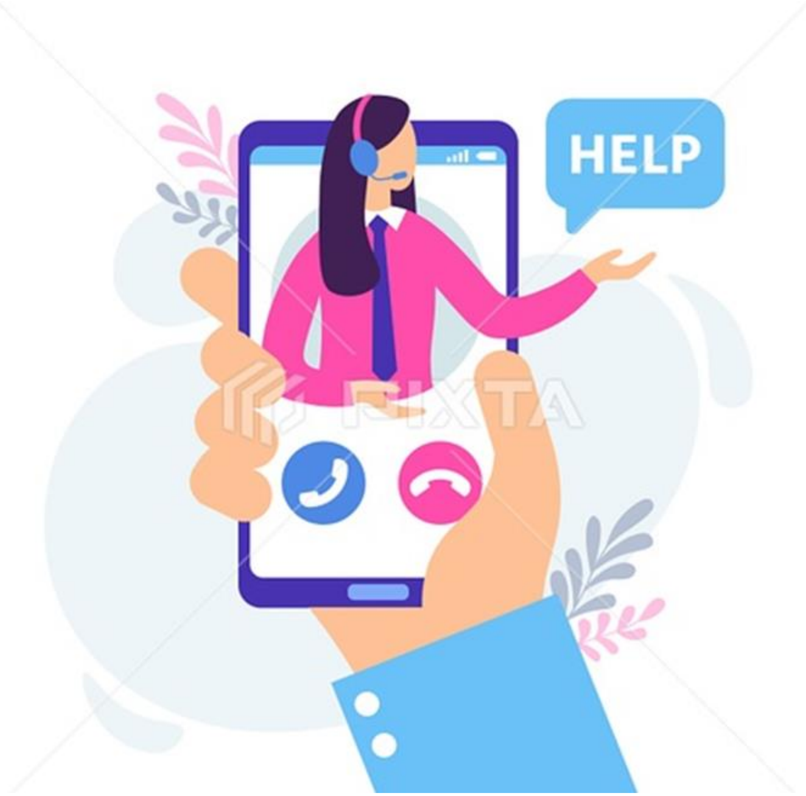
[4] National Kidney Foundation, "Home Page," [Online]. Available: https://www.kidney.org.uk/. (Accessed: September 7, 2023).

[5] J. Smith, "Advancements in Artificial Intelligence," Sci. Direct, vol. 45, no. 3, pp. 215-230, 2022. DOI: 10.1016/j.sciencedirect.2022.03.001. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S215335392200428X

# Commercialization

- Partner with healthcare providers  to offer our app as a resource for their patients.

- Collect data from app users to identify patterns and trends in kidney disease prevalence and risk factors. Use this data to improve the app's features and functionality and to develop targeted marketing campaigns.



IT20154226 | M.M.K.L. Marasinghe

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# Kidney Disease Diagnosis using Image Processing

# Background

- Medical images are crucial for diagnosing and tracking CKD, providing essential insights about the condition of the kidneys.
- Despite their importance, we're not fully using image processing tech like deep learning in healthcare. These tools can make diagnoses more accurate and efficient.

# Research Problem

- How can image processing algorithms be adapted and optimized to effectively utilize real-time medical images CT scans, on a mobile device for accurate and locally adapted early detection of (CKD)?

- To whom would this application be more beneficial - medical professionals or patients - and what factors influence its usefulness and adoption among these user groups?

# Research Gap

- Unlike prior studies that relies on foreign datasets, our research adopts a novel approach by utilizing a dataset from Sri Lankan CKD patients.

- Previous researches have mostly focused on theoretical research without the development of any practical applications, such as a user-friendly mobile application

- Existing research lacks focus on localization and multilingual support, particularly for Sinhala. Incorporating these features into applications can significantly improve accessibility and usability in Sri Lanka

# Objectives

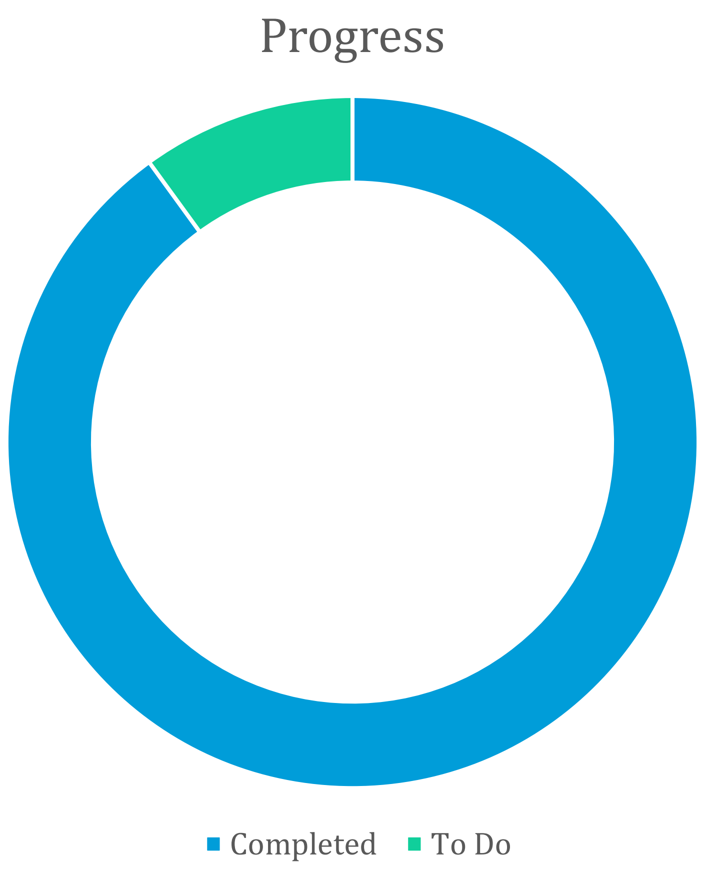
## Main Objective

- Develop an image processing model for the accurate identification of Chronic Kidney Disease (CKD) patients.

## Sub Objectives

- Find and acquire a dataset of CKD patients specifically from Sri Lanka to ensure the dataset's relevance to the local context.
- Evaluate various deep learning models, including convolutional neural networks (CNNs) and transfer learning approaches, to identify the most suitable model architecture.
- Design and develop a user-friendly mobile application that seamlessly integrates the trained image processing model.

# Overall Component Progress - 90%



## Progress at PP1 – 50%

- Gathering the dataset. (Online)
- Build  a Convolutional Neural Network model
- Design the wireframes of the UI.

## Progress at PP2 – 90%

- Re-gathered data from the University Hospital KDU
- Developed a CNN model and a MobileNetV2 model.
- Developed the frontend using React Native.

## In progress – 10%

- Integrate the component with other components.
- Make the UI more attractive to the user.
- Develop the backend using Flask

# References

[1] Siddharth Rajput, “Automated Kidney Stone Detection Using Image Processing Techniques,” IEEE, 2021.

[2] Ahmed Soliman, “Kidney segmentation from CT images using a 3D NMF-guided active contour model, “ IEEE, 2021 .

[3] B. O. F. M. K. A. S. Israa Alnazar, "Recent advances in medical image processing for the evaluation of chronic kidney disease," Science Direct

# **2023-04-29** At Kurunegala Teaching Hospital | Consultant Nephrologist Dr. Premil Rajakrishnan

SRI LANKA
INSTITUTE OF INFORMATION TECHNOLOGY

16th Floor, BoC Merchant Tower, No. 28, St. Michael's Road, Colombo 03

Date:28/04/2023 Your Ref : My Ref :2023-032

Dr. Premil Rajakrishna,
Consultant Nephrologist,
Teaching Hospital,
Kurunegala.

Dear Sir,

**Certifying the project titled "KidniFy - A mobile based Chronic kidney Disease Patient care System Using ML and IoT" is conducting as a BSc in IT final year research project.**

The Sri Lanka Institute of Information Technology (SLIIT) is the largest Degree Awarding Institute in the field of information Technology recognized by the University Grants Commission under the Universities Act. It was established in the year 1999 to educate and train Information Technology (IT) Professionals required by the fast-growing IT Industry in Sri Lanka.

This letter is to certify that the following students.
IT20154226 - M.M.K.L.Marasinghe
IT20226596 - J.P.M.L. Perera
IT20235260 - D.R.N. Samarawila
IT20785120 - W.B.M.A. Isurika

They are final year undergraduate students who conduct research entitled "KidniFy - A mobile based Chronic kidney Disease Patient care System Using ML and IoT" as partial fulfillment of the B.Sc. in Information Technology degree at Sri Lanka Institute of Information Technology (SLIIT). The students are conducting the research under the supervision of Ms. Wishalya Vanshanee Tissera

I kindly request your assistance in enabling these students to collect data from your organization to build their dataset for the research project. If you have any questions or require further clarification about the project, please do not hesitate to contact me.

Thank you for your cooperation

Dr. Jayantha Amararachchi
Assistant Professor/
Research Project Coordinator,
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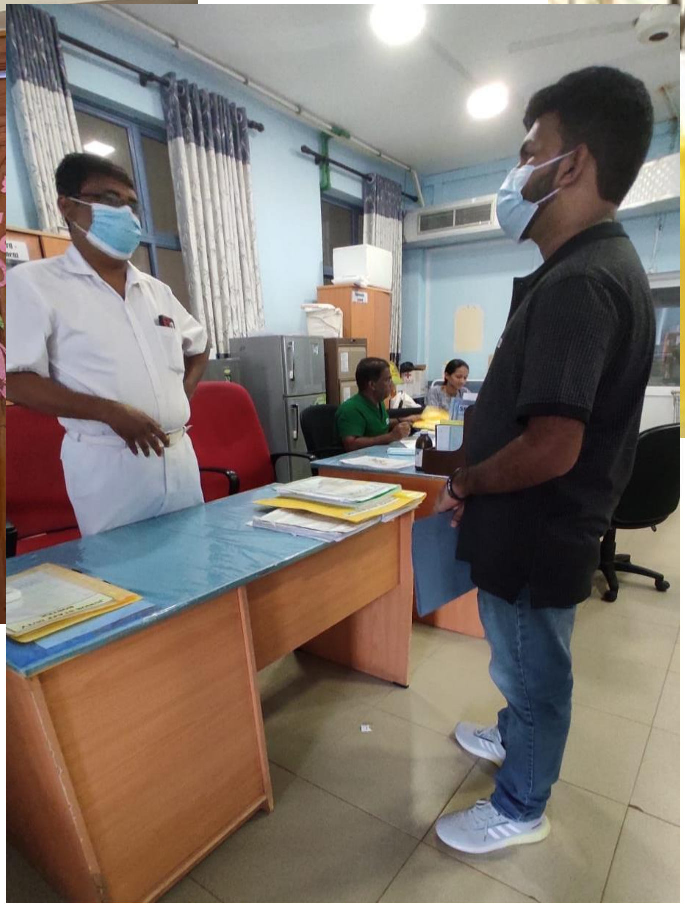
Tel: +94(0)11 2301904 - 5 Fax: +94(0)11 2301906 E-mail: info@sliit.lk URL: www.sliit.lk


**2023-05-01** At Anuradhapura Teaching Hospital | Kidney Dialysis Unit

# Thank You!

# Q & A