Department of Electrical and Electronics Engineering

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Med-Fusion AI

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Name of Project Guide:
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Introduction:

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In the rapidly advancing field of medical science, Artificial Intelligence (AI) is transforming healthcare by delivering accurate diagnostics, predictive insights, and personalized treatment recommendations. **AI's potential** in healthcare spans from basic models for diabetes detection to complex methods like brain tumor segmentation, significantly enhancing the scope and precision of **disease detection**.

Our project, **Med-Fusion AI**, is an innovative online platform that consolidates **multiple disease detection** tools into a single, accessible system. Designed to provide quick and reliable health assessments, MedFusion AI marks a major step forward in the future of **AI-driven healthcare**, offering streamlined, AI-powered diagnostics to improve patient outcomes and broaden access to critical health insights.

Motivation:

- **Global Need for Accessible Diagnostics:**

  Quick, early diagnosis can significantly improve patient outcomes. However, in many regions, healthcare services are limited by infrastructure, travel distances, and costs.

- **Challenges in Traditional Diagnostics:**

  Costly and Time-Consuming: Diagnostic methods often require multiple visits and diverse tests.

  Delayed Treatment: Slow diagnostics can lead to delayed treatments, which can worsen patient outcomes.

- **MedFusion AI's Solution:**

  By integrating AI with affordable technology, MedFusion AI delivers timely and accurate health assessments accessible to all, regardless of geographical location or available resources.

Aim and Objectives:

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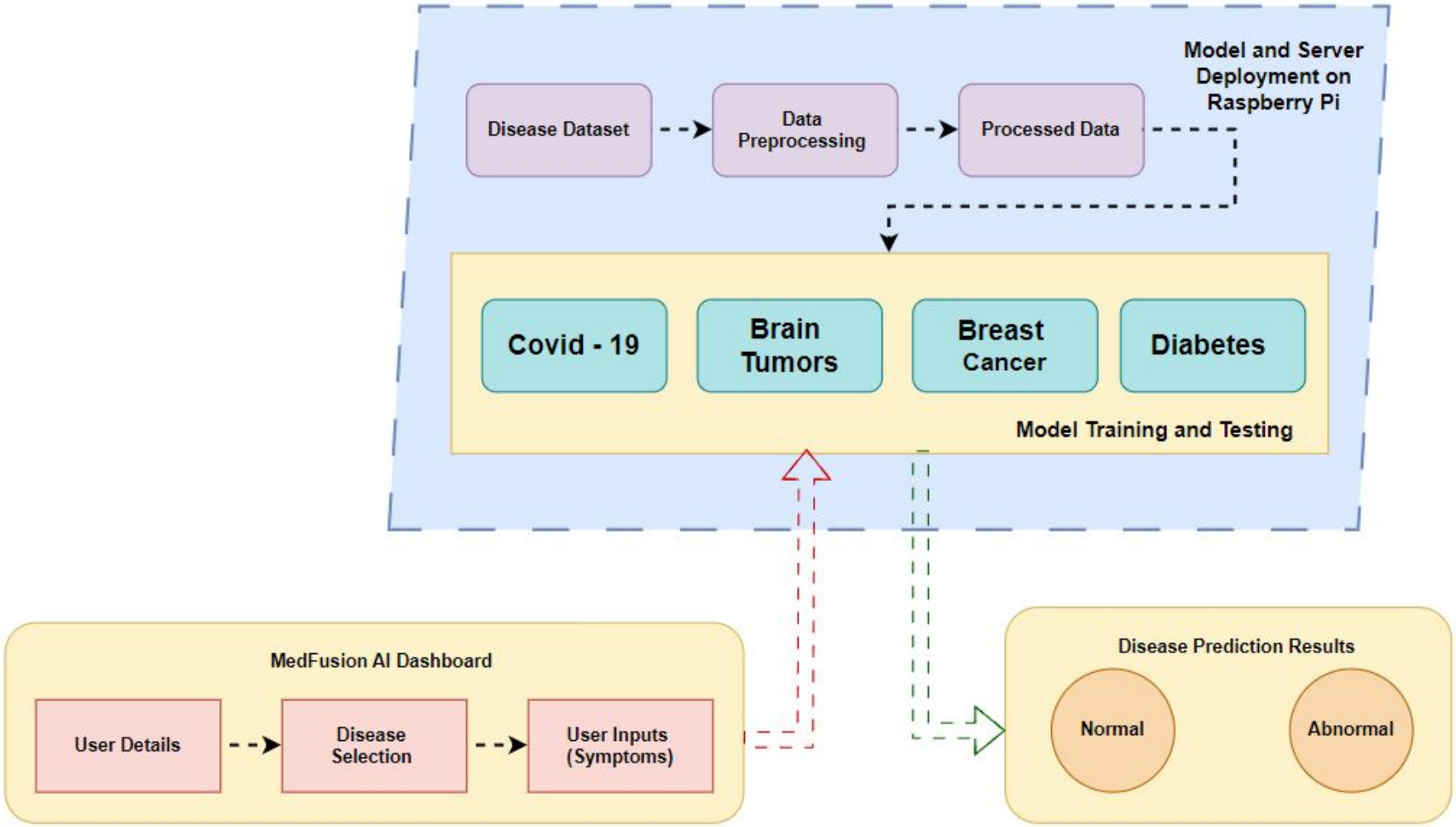
Aim:

To create a robust AI-powered diagnostic platform that consolidates multiple disease detection tools into a single, user-friendly interface, deployed on a Raspberry Pi for real-time, on-site analysis. This platform aims to provide accessible, rapid diagnostics for conditions such as COVID-19, diabetes, breast cancer, and brain tumors.

Objectives:

- **Model Development:** Create individual machine learning models for each disease.
- **Model Integration:** Unify models for COVID-19, diabetes, breast cancer, and brain tumors into a cohesive system.
- **Web Accessibility**: Build a user-friendly web interface and deploy it on Raspberry Pi.
- **Portability and Data Security:** Ensure local data processing and portability without heavy, centralized servers.

Project Block Diagram:



Project Description:

Platform Overview: MedFusion AI is an AI-powered, multi-disease diagnostic platform hosted on a Raspberry Pi 4, designed for remote, underserved regions.

Disease Coverage: Supports detection of COVID-19, Diabetes, Breast Cancer, and Brain Tumors.

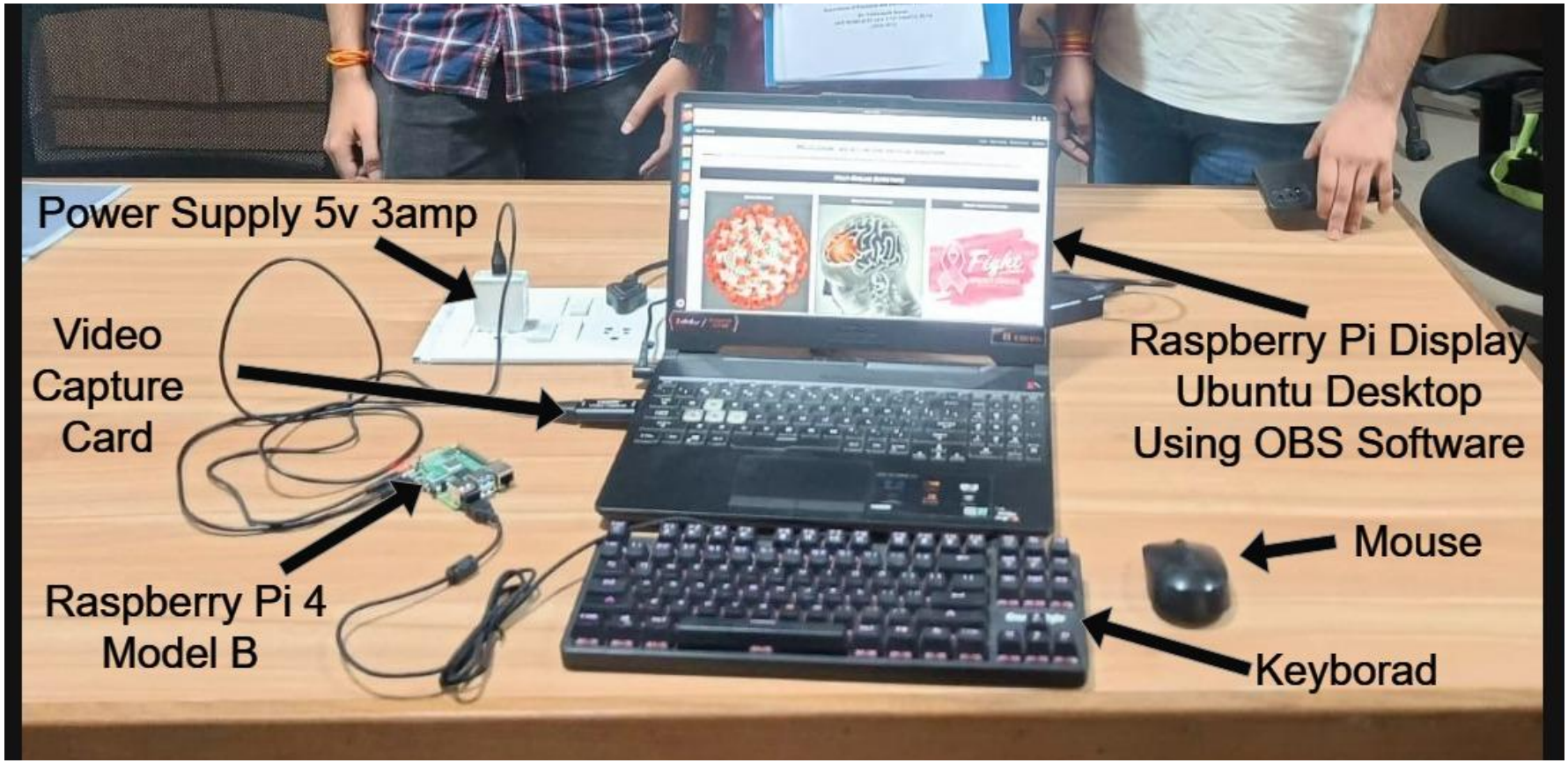
Model Architecture:

- **Image-Based Diagnoses:** Utilizes Convolutional Neural Networks (CNN) for detecting COVID-19 and brain tumors from medical images.
- **Data-Driven Diagnoses:** Uses Random Forest models for conditions like diabetes and breast cancer based on structured health metrics.

User Interface:

- Developed with Flask, providing a responsive, web-based dashboard.
- Allows users to upload medical images or input health metrics for real-time analysis.

MedFusion Setup:



Hardware Specifications:

1. Raspberry Pi 4 Model B (4GB RAM):

Used to host all software components and run Ubuntu as the operating system.

2. SD Card (32GB SanDisk):

Storage for the Raspberry Pi, containing the OS and other files.

3. Power Supply Cable and Adapter:

Provides stable power (5V, 3A) to the Raspberry Pi.

4. HDMI to Micro HDMI Cable:

Connects the Raspberry Pi to the video capture card for display purposes.

5. Video Capture Card:

Enables the Raspberry Pi's display to be viewed on a laptop, eliminating the need for an external monitor.

Software Specifications:

1. Ubuntu 2024 Desktop: Provides a stable, lightweight OS for deploying MedFusion - AI on Raspberry Pi.

2. Raspberry Pi Imager: Simplifies OS installation and setup on Raspberry Pi SD card.

3. Python 3.6+: Core language for model development, data processing, and web hosting.

4. Flask: Web framework handling user input, file uploads, and model integration.

5. TensorFlow/Keras: Libraries for training and deploying CNN-based deep learning models.

6. OpenCV: Used for image preprocessing, such as resizing and cropping for medical images.

7. **CNN:** Used for image-based detection of *COVID-19 and Brain Tumor*, extracting spatial features from medical images for accurate diagnosis.

8. **Random Forest:** Utilized for *Diabetes and Breast Cancer*, utilizing structured health metrics to provide robust, reliable classifications.

Methodology:

Data Collection and Preprocessing

- Collected datasets for COVID-19, brain tumors, diabetes, and breast cancer.
- Preprocessed data by resizing and normalizing images; scaled health metrics for model compatibility, enhancing consistency and accuracy.

Model Development

- Used CNNs for image-based models (COVID-19, brain tumors) and Random Forest for data-based models (diabetes, breast cancer).
- Trained and optimized models for high accuracy while balancing Raspberry Pi's processing limits.

UI Development

- Built a web-based UI with Flask, allowing intuitive navigation, data input, and real-time results.
- Organized disease-specific modules within a user-friendly dashboard accessible across devices.

Methodology:

Hardware Setup

- Deployed on Raspberry Pi 4 for affordability and portability, using a 32GB SD card, 5V, 3A power supply, and HDMI connectivity via video capture card.
- Setting up OBS and Video capture card
- Installing Proper OS on Raspberry Pi..

System Integration and Deployment

- Setting up proper libraries in a proper conda environment.
- Integrated models into a modular platform on Raspberry Pi, running Ubuntu and managed by Flask for streamlined backend processing.

COVID-19 Model Description:

Model Type: Convolutional Neural Network (CNN)

- CNNs are ideal for image-based data due to their ability to recognize patterns, edges, and textures.
- The model learns to identify features in chest X-rays that correlate with COVID-19, such as lung opacities and abnormalities.

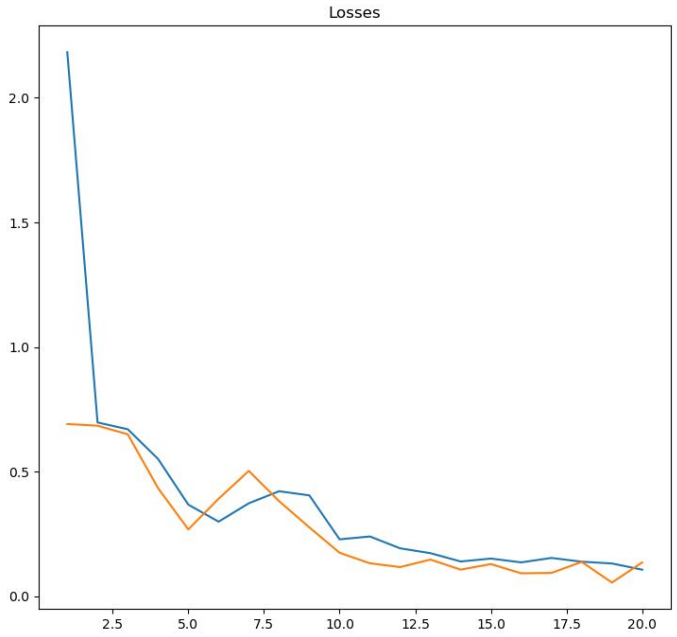
Inputs

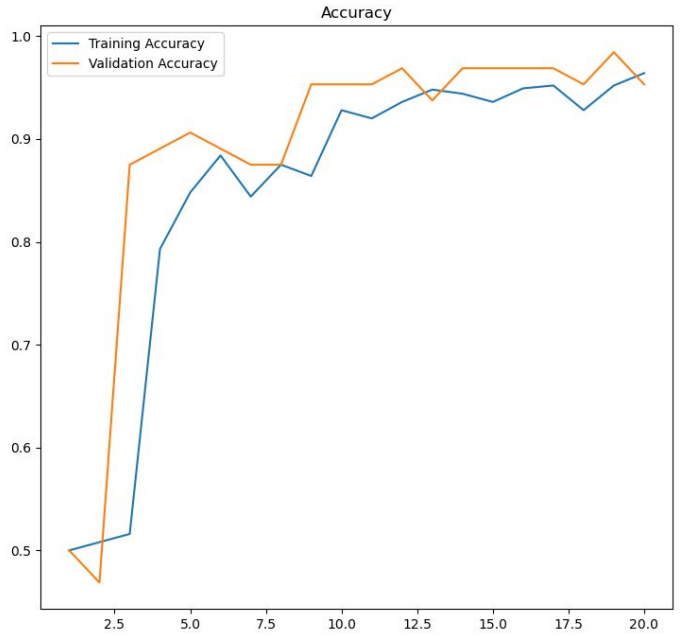
- **Required Patient Information**:
  - Name, Age, Gender, Contact Information.
- **Medical Image**:
  - Chest X-ray image of the patient, uploaded for analysis.

Process:

1. Patient data and X-ray image are entered.
2. The CNN model processes the image and identifies potential COVID-19 indicators.
3. Result is generated as either **Positive** or **Negative** for COVID-19.

COVID-19 Model Analysis:



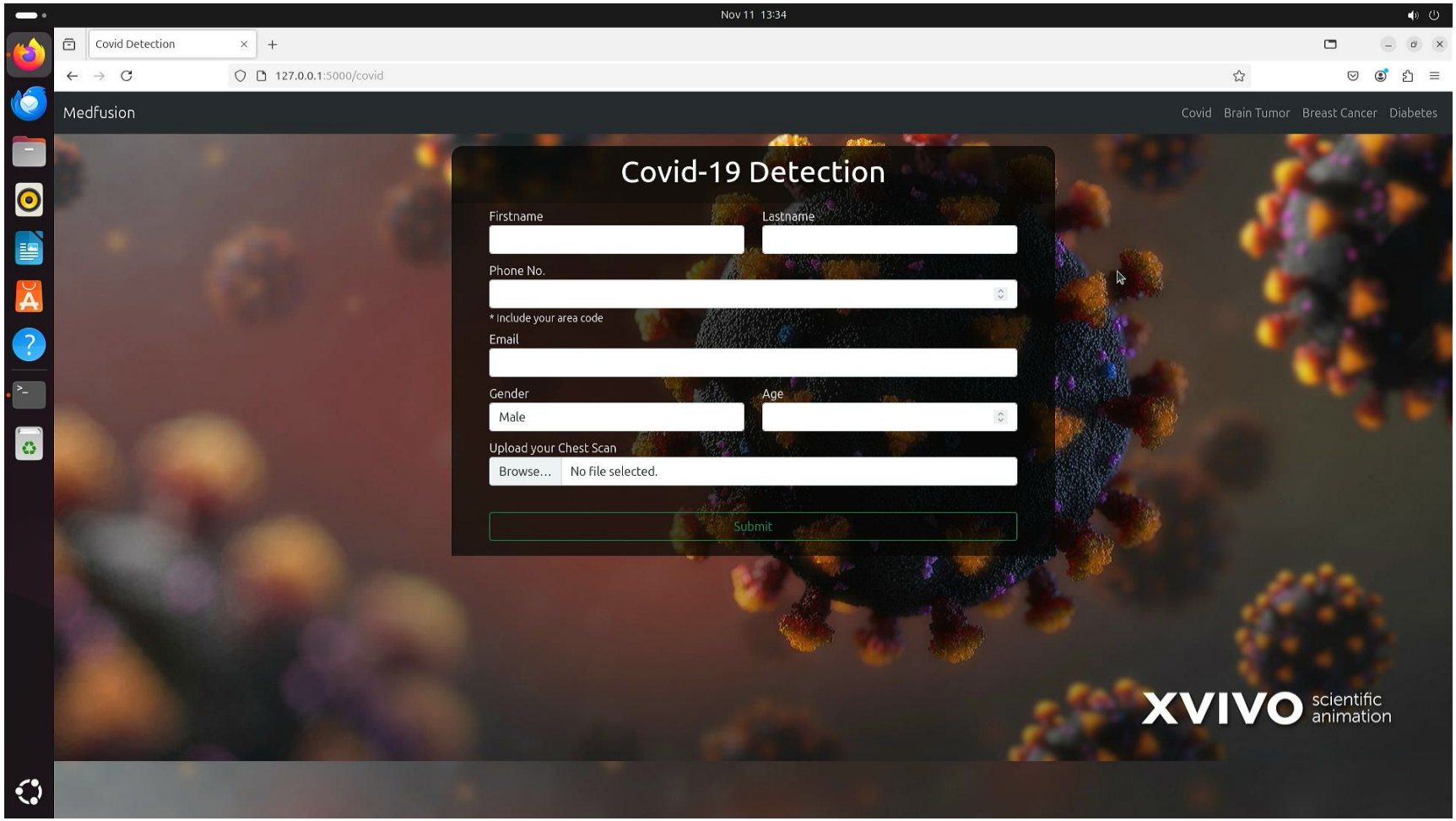


Model:Convolutional Neural Network (CNN)

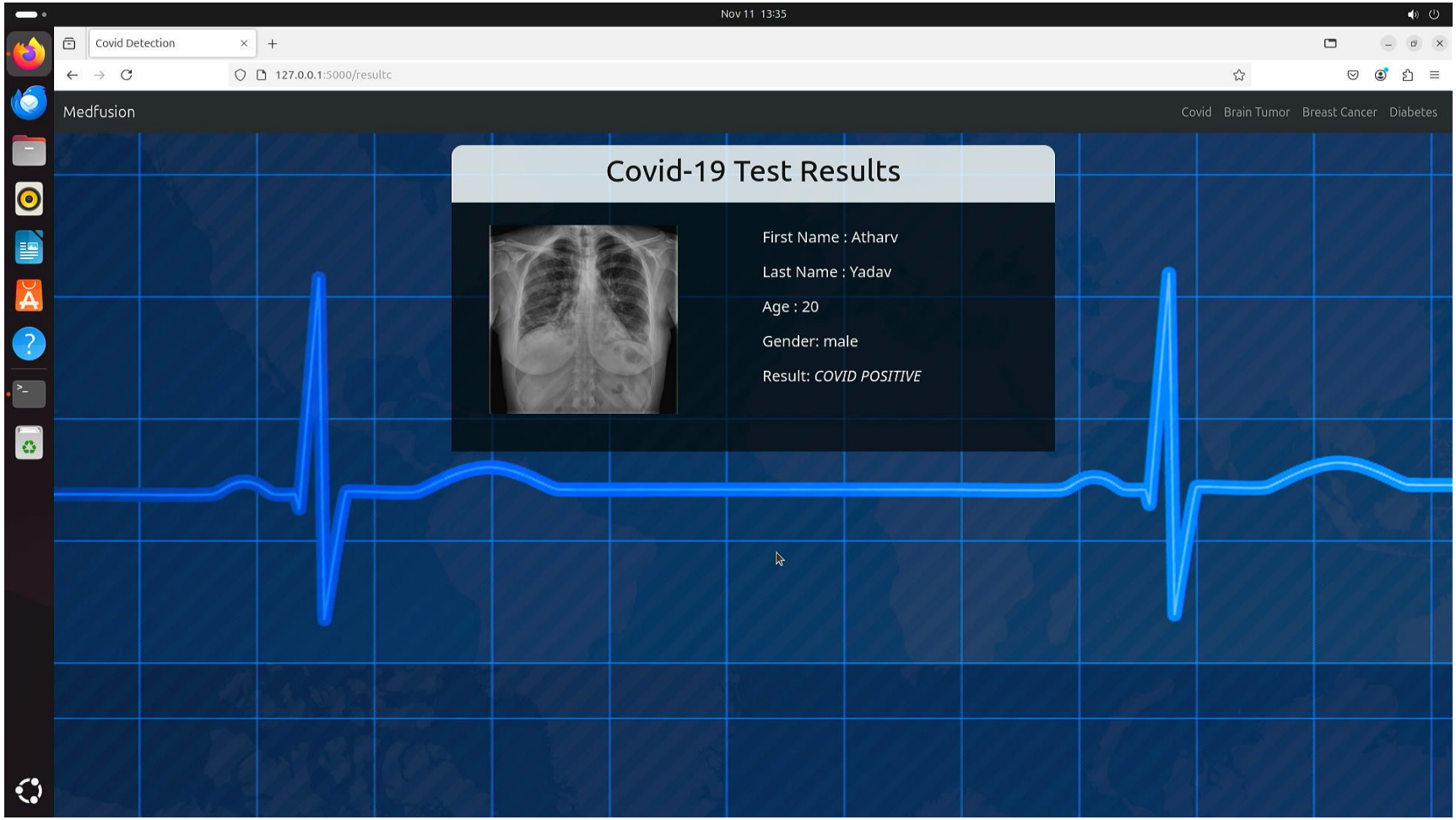
Accuracy:96.4%

Significance: High accuracy and minimal loss make this CNN model highly effective for COVID-19 detection from chest X-rays, ensuring reliable diagnostic results.

COVID-19 Dashboard:



COVID-19 detection results:



Breast Cancer Model Description:

Model Type

- **Random Forest Classifier**
  - The Random Forest algorithm is effective for structured data analysis, making it suitable for classifying breast cancer based on specific tissue characteristics.
  - The model is trained to distinguish between benign and malignant cases by analyzing a combination of cell features extracted from Fine Needle Aspiration (FNA) reports.

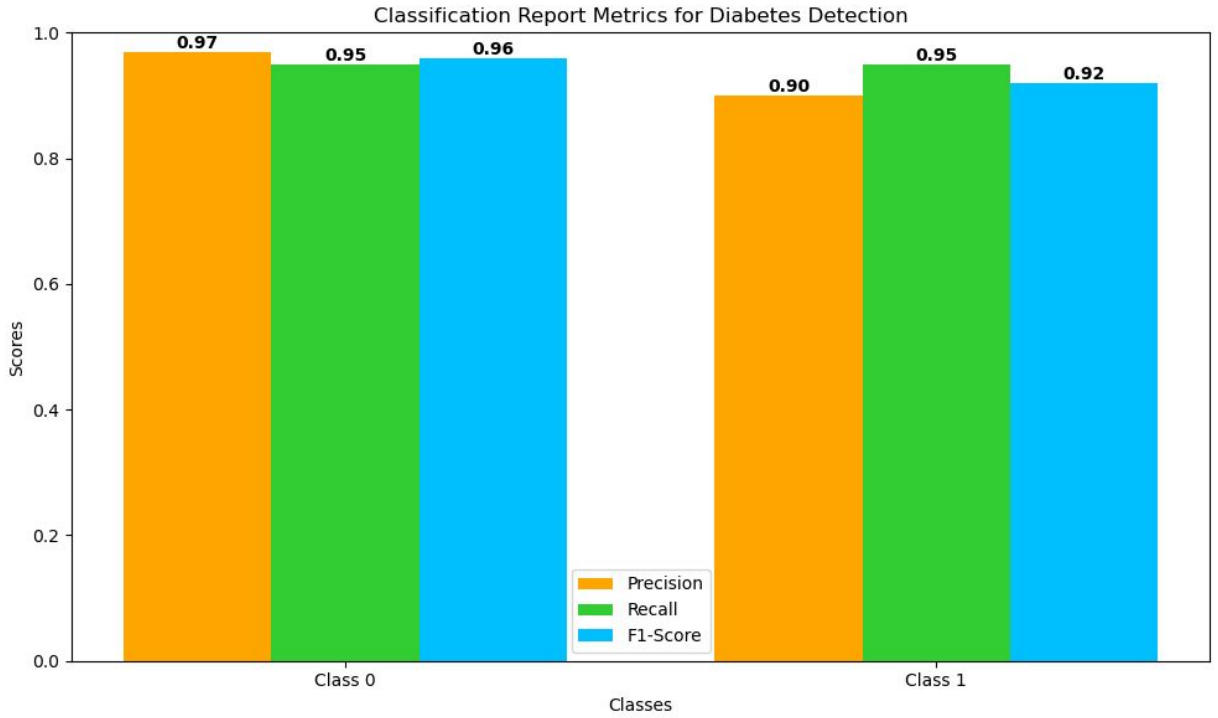
Inputs

- **Required Patient Information**:
  - Name, Age, Gender, Contact Information.
- **Clinical Measurements (from FNA Reports)**:
  - **Concave Points Mean, Area Mean, Radius Mean, Perimeter Mean, Concavity Mean**
  - These values are crucial in distinguishing between benign and malignant tumors.

Process

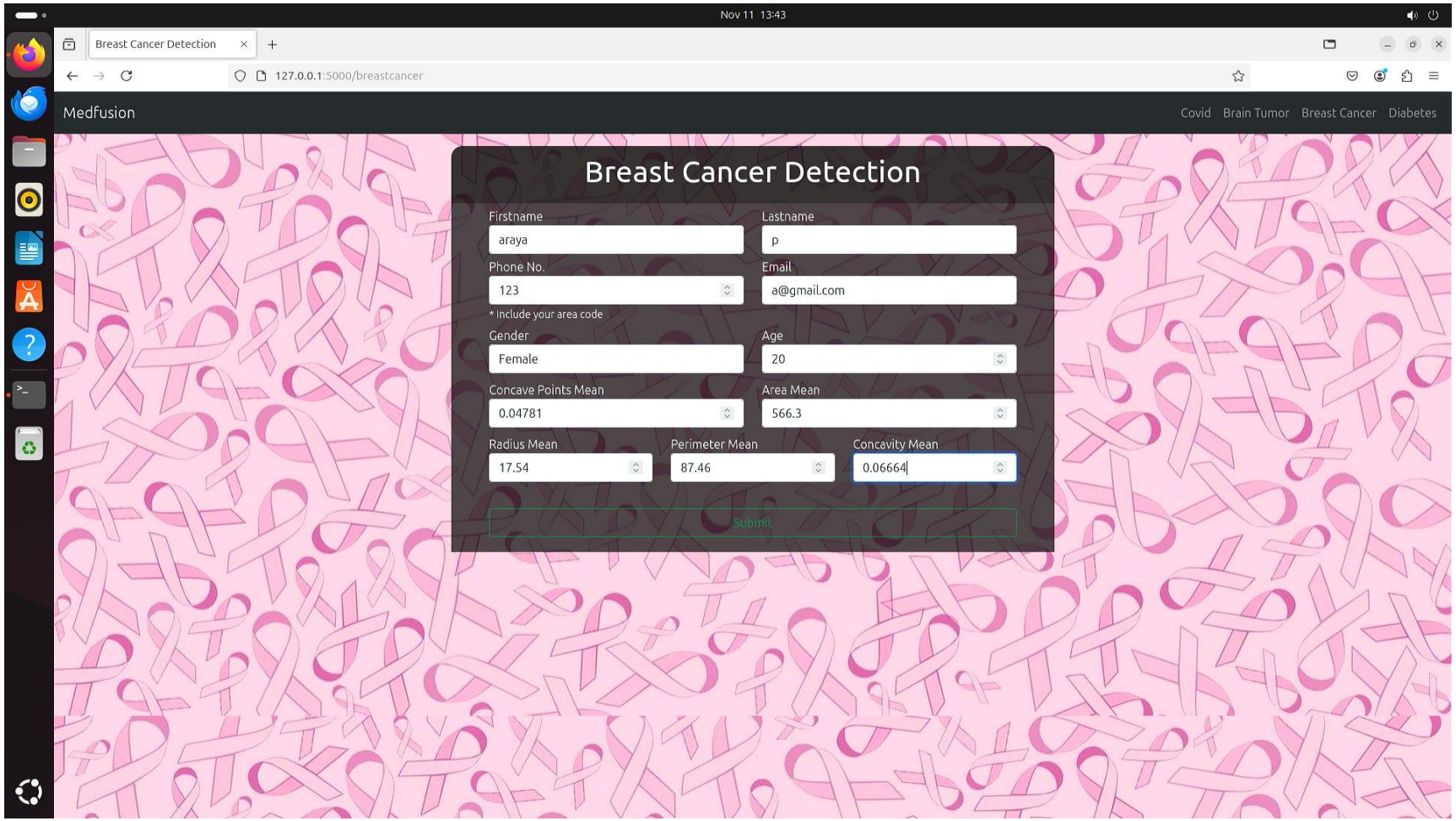
1. Patient information and FNA report values are entered into the system.
2. The Random Forest model evaluates the clinical measurements to identify potential indicators of malignancy.
3. The result is displayed as either **Malignant** (indicating a high likelihood of cancer) or **Benign** (indicating no cancerous activity).

Breast Cancer Model Analysis:

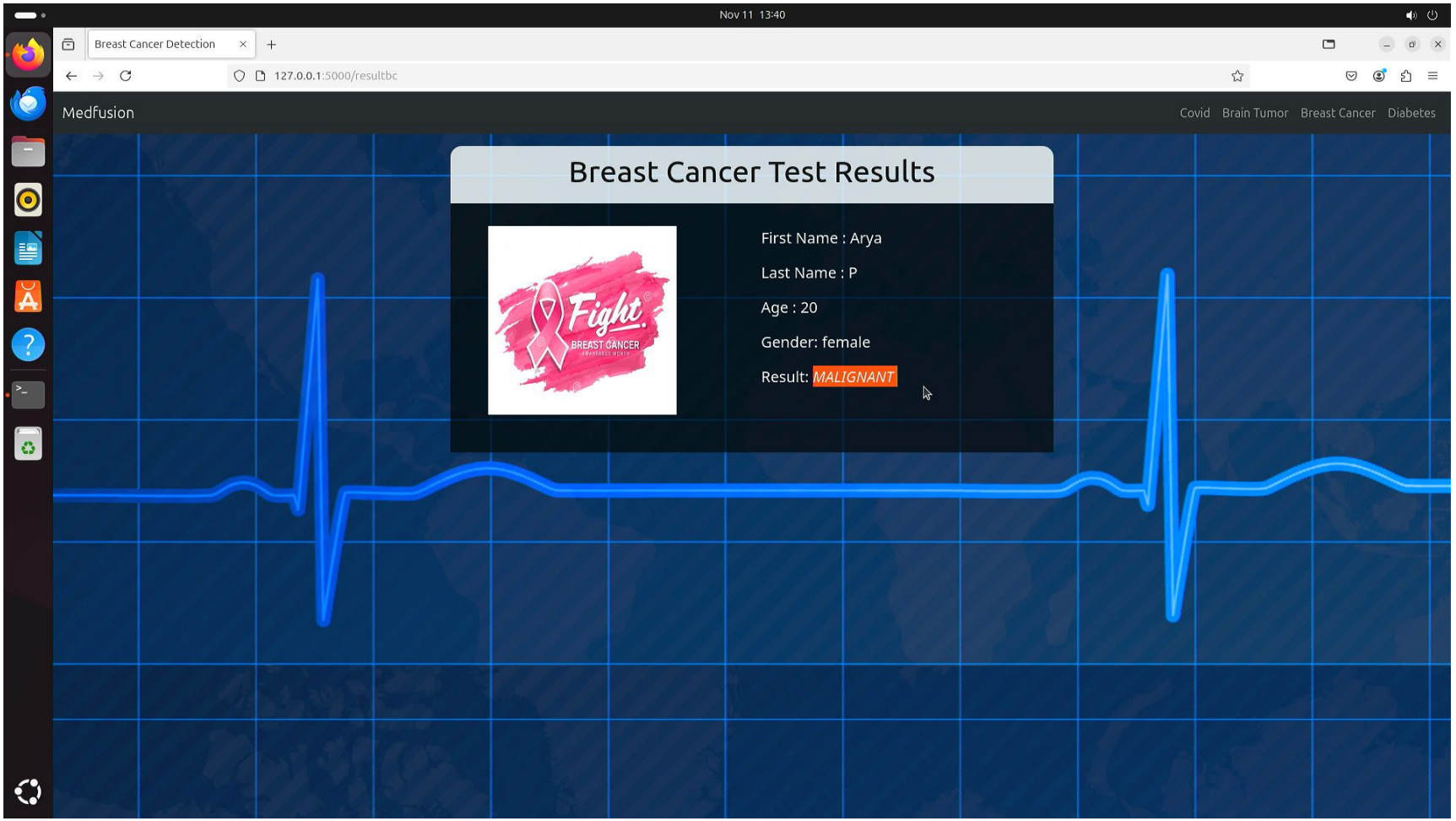


Model: Random Forest Classifier
Accuracy : 94.15%

Breast Cancer Dashboard:



Breast Cancer Results:



Diabetes Model Description:

Model Type

- **Random Forest Classifier**
  - Random Forest is highly effective for analyzing structured patient data, such as health metrics and risk factors associated with diabetes.
  - The model is trained on clinical and lifestyle data to assess the likelihood of diabetes, analyzing patterns across multiple health parameters.

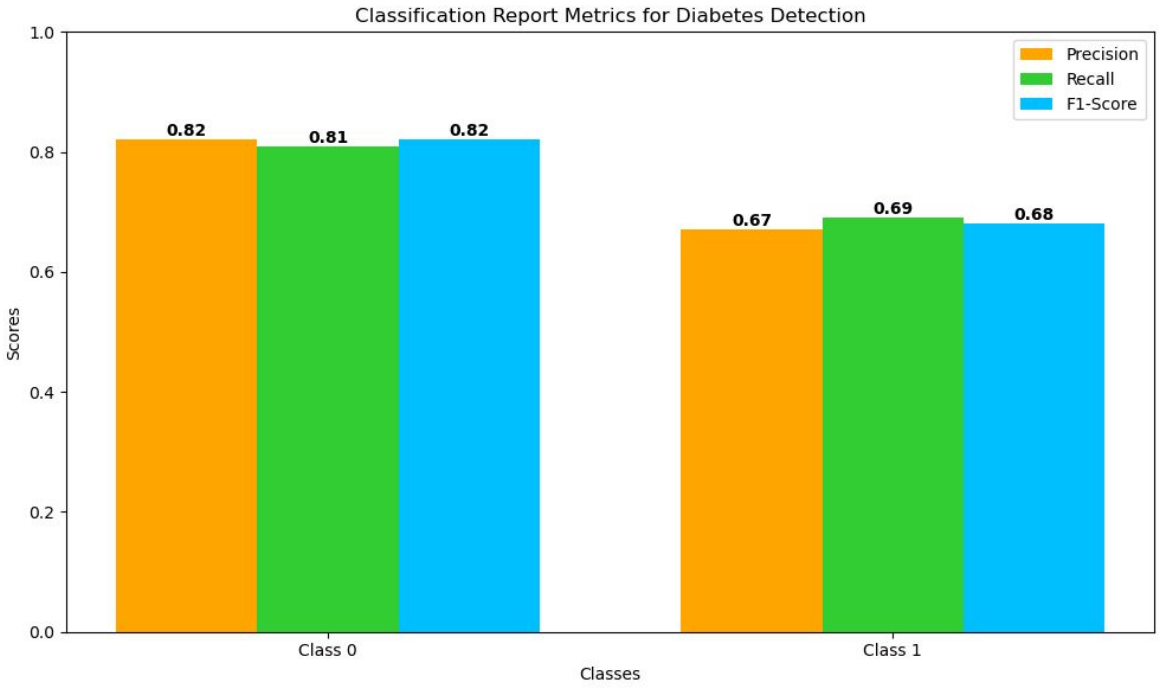
Inputs

- **Required Patient Information**:
  - Name, Age, Gender, Contact Information.
- **Health Metrics**:
  - **Number of Pregnancies, Glucose Level, Blood Pressure, Skin Thickness, Insulin Level BMI (Body Mass Index), Diabetes Pedigree Function, Age**

Process

1. Patient data and health metrics are input into the system.
2. The Random Forest model analyzes these metrics, identifying risk patterns associated with diabetes.
3. The result is provided as either **Positive** (indicating a high likelihood of diabetes) or **Negative** (indicating low risk).

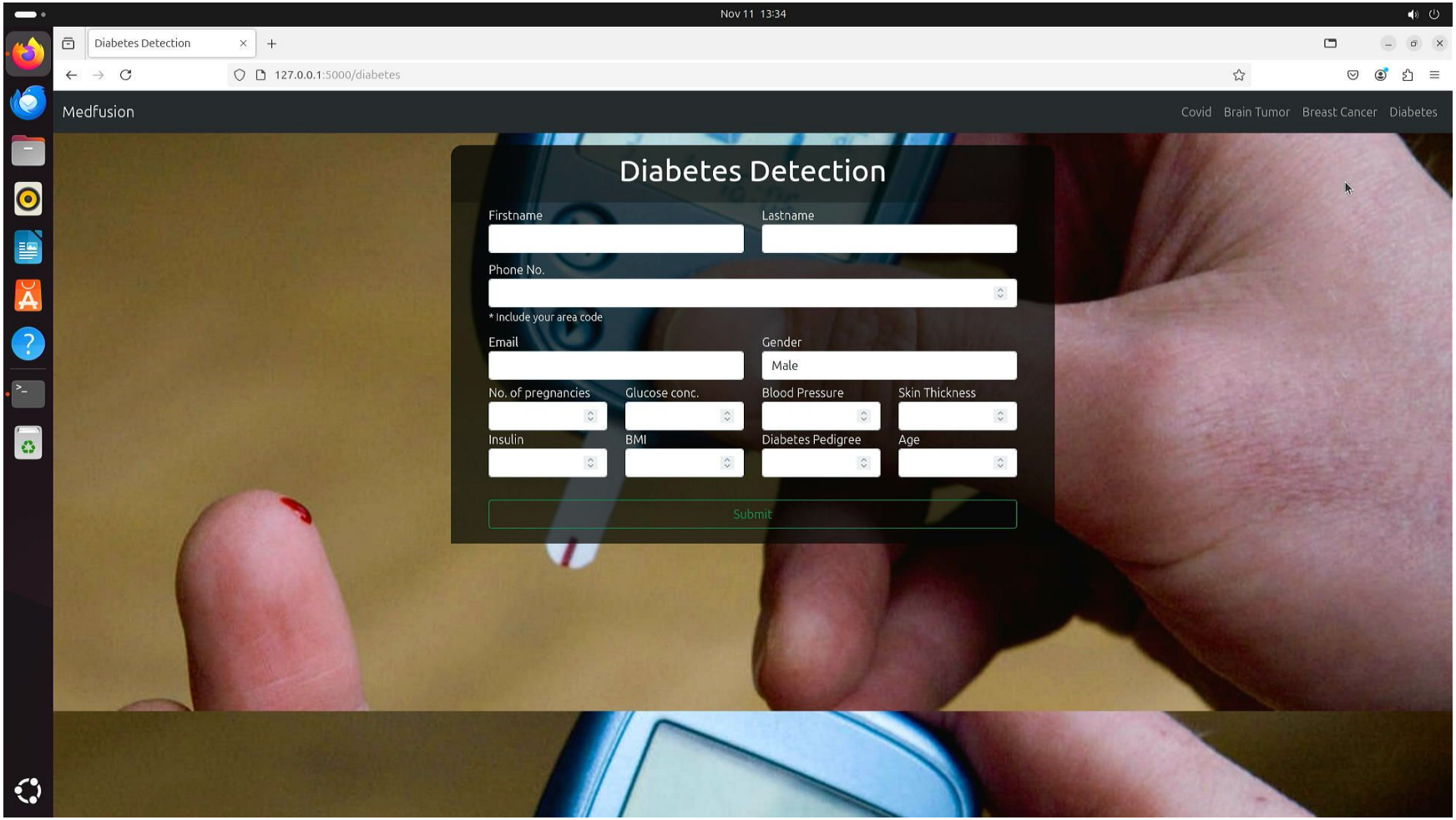
Diabetes Model Description:



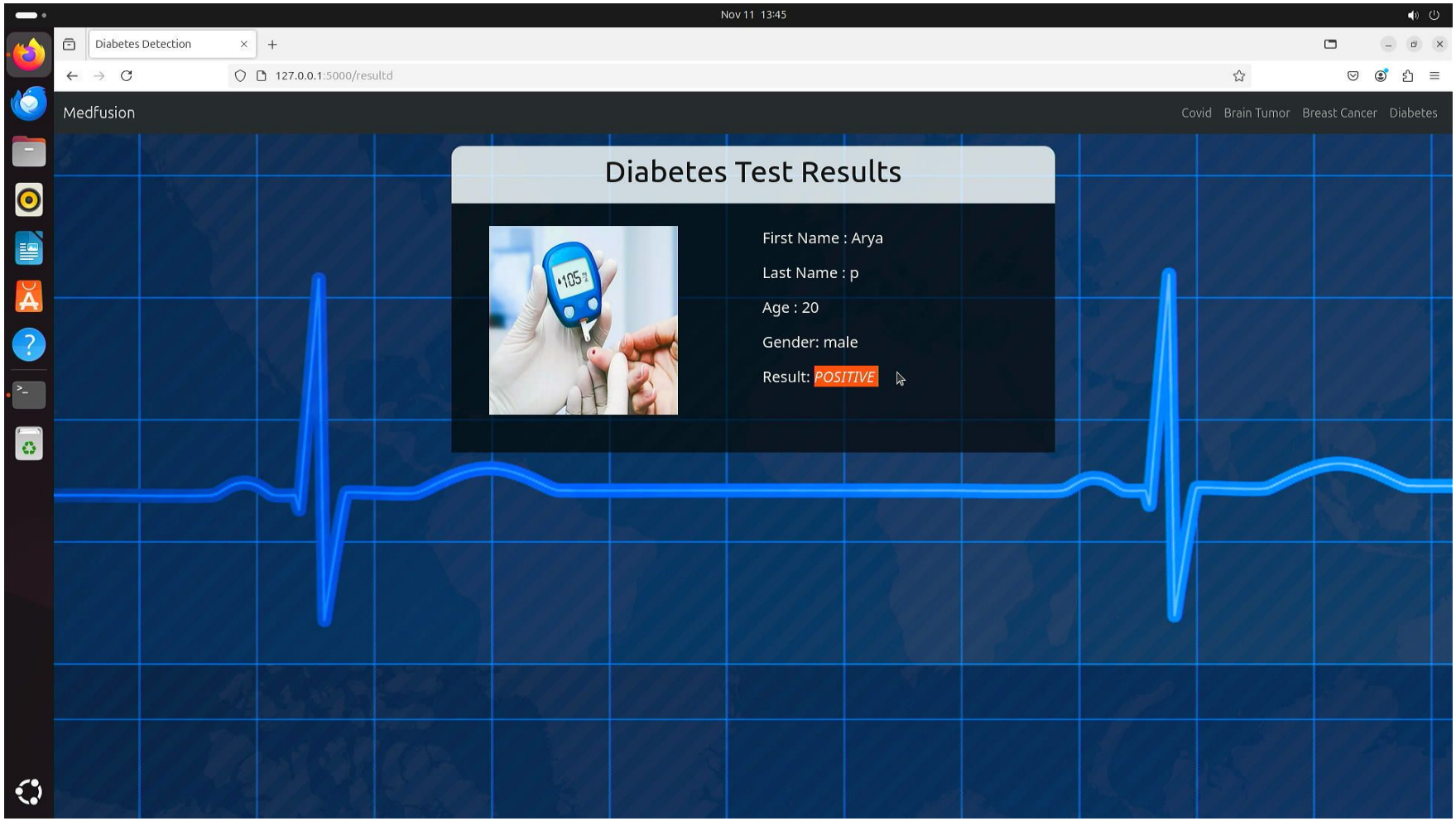
Model: Random Forest

Accuracy:77.27%

Diabetes Model Dashboard:



Diabetes Model Result:



Brain Tumor Model Description:

Model Type

- **Convolutional Neural Network (CNN)**
  - CNNs excel in image-based analysis by detecting patterns, textures, and structural irregularities.
  - The model is trained to identify features in MRI brain scans that are associated with tumors, such as irregular growth patterns and abnormal tissue structures.

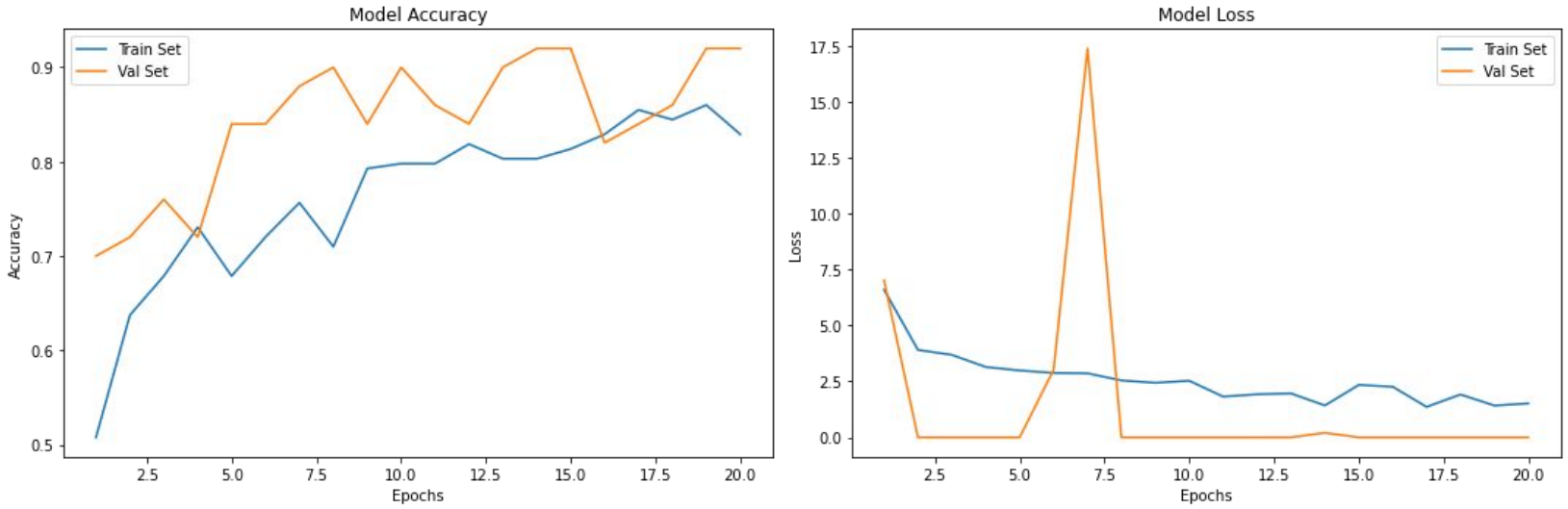
Inputs

- **Required Patient Information**:
  - Name, Age, Gender, Contact Information.
- **Medical Image**:
  - MRI brain scan of the patient, uploaded for analysis.

Process

1. Patient information and MRI image are submitted through the platform.
2. The CNN model analyzes the brain scan, identifying possible tumor indicators.
3. The result is generated as either **Positive** (indicating presence of a tumor) or **Negative** (indicating absence of a tumor).

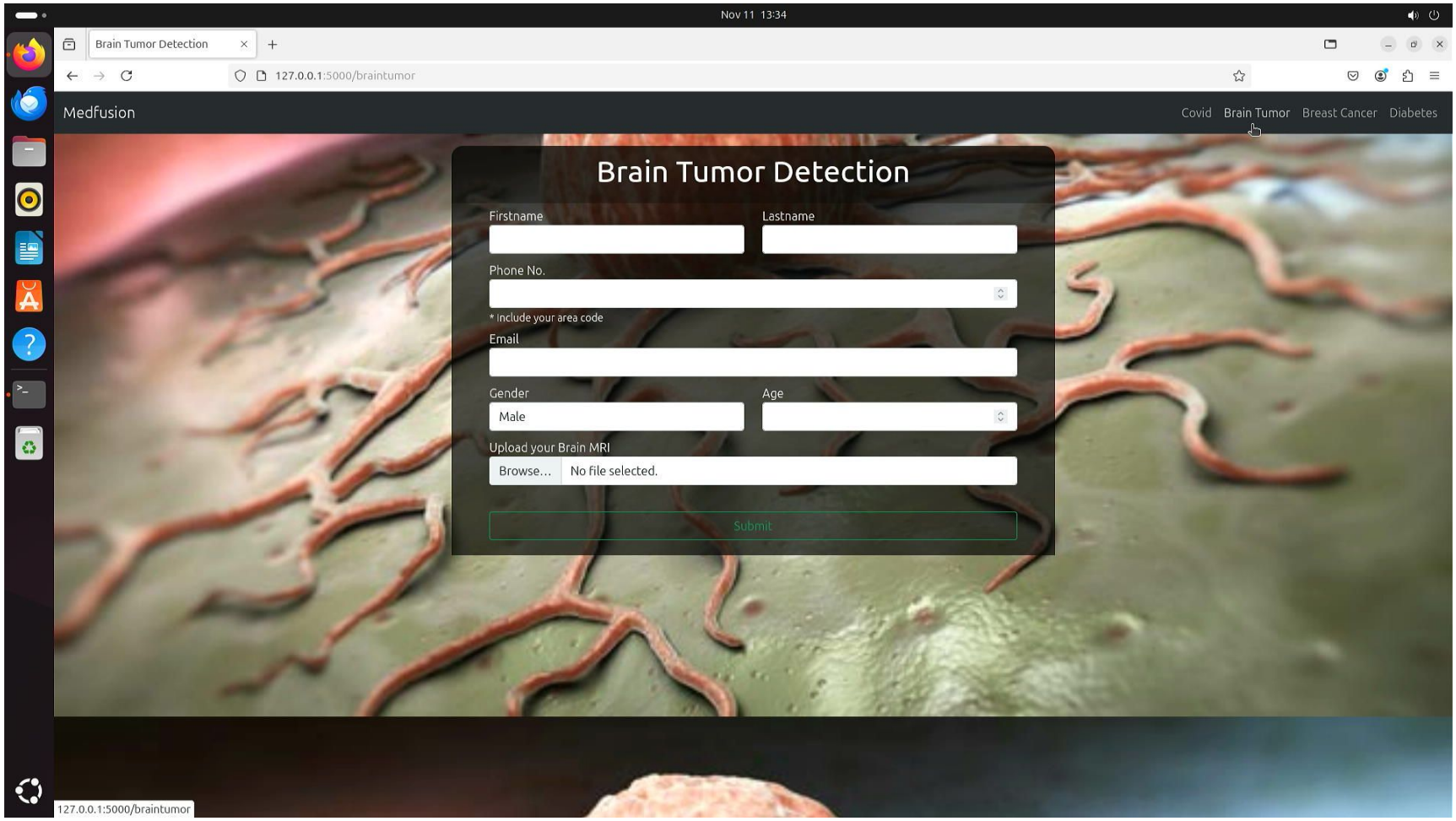
Brain Tumor Model Analysis:



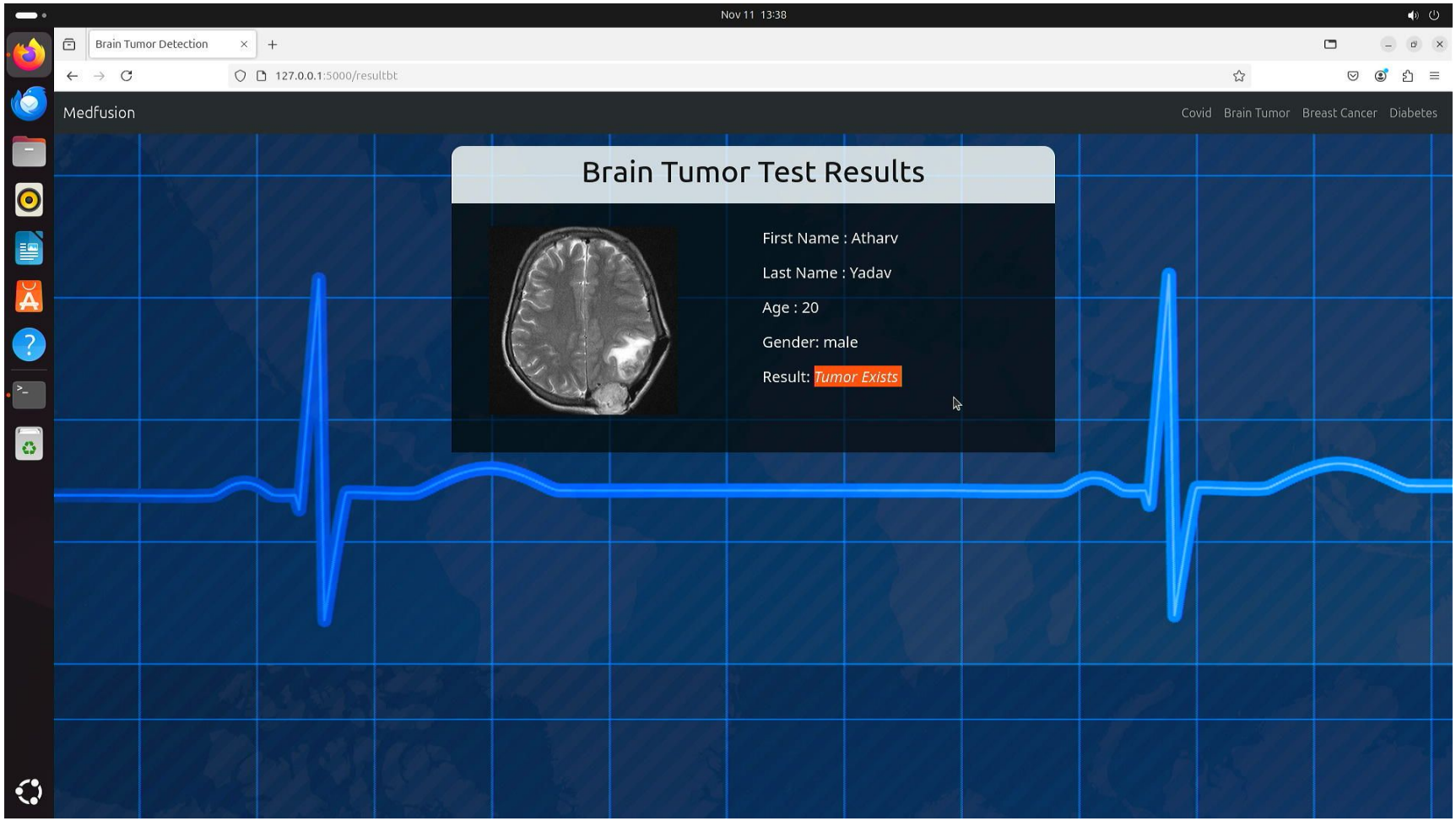
Model:Convolutional Neural Network (CNN)

Accuracy:90%

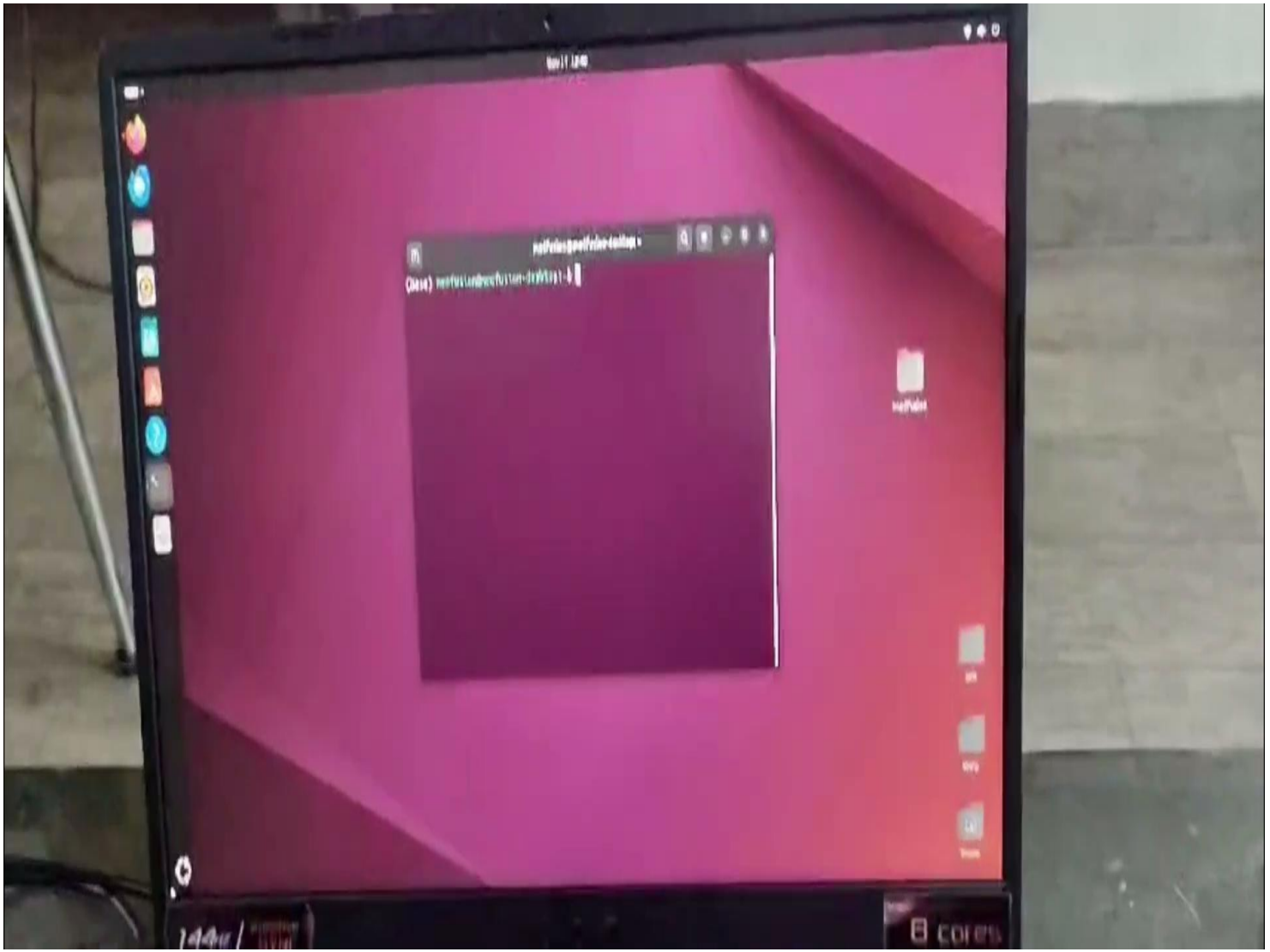
Brain Tumor Model Description:



Brain Tumor detection results:



Demonstration:



Future Scope:

Expanded Disease Detection: Add models for additional diseases such as malaria, tuberculosis, and cardiovascular conditions to broaden diagnostic capabilities and address a wider range of health issues.

Real-Time Data Integration: Integrate data from wearable devices, such as heart rate, blood pressure, and glucose monitors, to enable dynamic health monitoring and comprehensive assessments.

Enhanced User Interface: Improve the UI by adding visual aids, multi-language support, and personalized profiles for tracking patient history, making it accessible to diverse user groups.

Cloud Integration for Data Storage: Introduce optional cloud storage for secure data backup and remote consultations, enhancing scalability and data accessibility for healthcare providers.

Mobile Application Development: Create a mobile app to increase accessibility, allowing users to monitor health and receive diagnostics on-the-go, especially in areas with limited access to computers.

Conclusion:

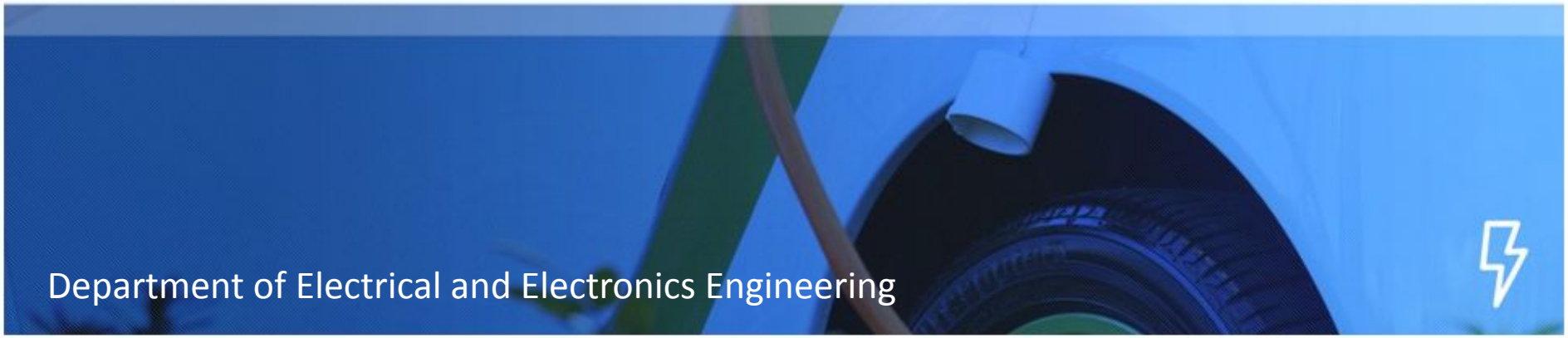
The MedFusion AI platform represents a significant advancement in accessible healthcare diagnostics, successfully integrating multiple disease detection models into a single, user-friendly system hosted on the Raspberry Pi. By leveraging AI-powered tools for detecting conditions such as COVID-19, diabetes, breast cancer, and brain tumors, MedFusion AI delivers accurate, real-time diagnostics that can operate offline, making it ideal for deployment in resource-limited and remote areas. This project has demonstrated the potential of combining affordable hardware with advanced machine learning models to create a scalable, secure, and impactful diagnostic solution. Moving forward, MedFusion AI's adaptability, coupled with future enhancements, positions it as a powerful tool for democratizing healthcare access and supporting proactive, community-based health management on a global scale.

References:

The below link contains all research papers referred for Literature Review

https://docs.google.com/spreadsheets/d/1HY43jncATuB54EW__IrWAHrPZ553wreMMzIMwPD8_XU/edit?usp=sharing

THANK YOU



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