BODY SCANNER SENSOR ASSESSMENT USING ARTIFICIAL INTELLIGENCE

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL

This project titled "**BODY SCANNER SENSOR ASSESSMENT USING ARTIFICIAL INTELLIGENCE**", submitted by Tanbhirul Islam, ID No: 211-15-14608 to the Department of Computer Science and Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering (B.Sc) and approved as to its style and contents. The presentation has been held in July 16, 2024.

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We hereby declare that this thesis has been done by us under the supervision of, **Md. Sazzadur Ahamed, Assistant Professor, Department of CSE** Daffodil International University. We also declare that neither this thesis nor any part of this thesis has been submitted elsewhere for the award of any degree or diploma.

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ABSTRACT

An autonomous scanner sensor recognition system depending on the DenseNet201 Transfer Learning model is recommended in the present research. consumption of sensor image is significantly influenced by the image's condition. If we consume sensor image that is not fresh, it might damage the immune system of the human body and create several kinds of diseases. Therefore, it is imperative that we ingest scanner sensor. Since it is initially exceedingly challenging to distinguish between fresh and sick image manually observing scanner, we propose in this study to replace the monitoring tactic with an automated computer program. The goal of this study is to distinguish between fresh and sick image by evaluating how they seem on the outside. The factor that affects the prediction results in this study is the collection of datasets before the training process is carried out consisting of scanner image samples obtained from the Cumilla medical college. For categorizing image freshness, we divided our six different bespoke datasets for sensor image into three categories using a variety of transfer learning models. However, the scanner sensor image dataset, which had an accuracy score of 97.10%, showed DenseNet201 to be incredibly effective. Therefore, the goal of this study is to precisely determine an image's freshness conditions while minimizing dependency on human vision.

Keywords: Artificial intelligence, Transfer learning, Convolutional neural network, DenseNet201, Custom dataset, sensor image.

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CHAPTER 1
Introduction

1.1 Introduction

In the modern era, the integration of artificial intelligence (AI) into technological systems has paved the way for unprecedented advancements in various sectors, including security and healthcare. One notable application [1] of AI is in the enhancement of body scanner sensor assessments, which holds significant potential for improving operational efficiencies and capabilities. Body scanners, equipped with advanced sensors, are essential tools used primarily in security settings such as airports and border controls, as well as in medical environments for non-invasive diagnostics.

Bangladesh, a rapidly developing nation in South Asia, is experiencing considerable growth in technology adoption across different domains. As part of its "Digital Bangladesh" [2] initiative, the government is actively seeking to incorporate digital solutions to drive national progress. The adoption of AI-driven body scanner sensor assessment within this context could offer substantial benefits, enhancing security measures and healthcare services through improved accuracy, efficiency, and cost-effectiveness.

AI can significantly enhance the capabilities of body scanner sensors by improving image recognition, anomaly detection, and threat identification. Traditional body scanners often rely on manual analysis, which can be time-consuming and subject to human error. In contrast, AI algorithms, particularly those based on machine learning and deep learning, can process and analyze vast amounts of data rapidly and with high precision. This automation reduces the likelihood of oversight and improves overall reliability.

Despite the technological advancements, the implementation of AI in body scanner sensor technology in Bangladesh is still in its early stages. In the security sector, traditional scanning methods are predominantly used at airports and public venues, with limited integration of AI. In the healthcare sector, there is a growing need for advanced diagnostic tools that can provide accurate and timely analysis, which AI-driven body scanners can fulfill.

1.2 Motivation

The motivation behind using artificial intelligence (AI) for body scanner sensor assessment stems from the need to enhance the performance, reliability, and utility of body scanning technologies across various fields. Here are the key motivating factors:

Improving Accuracy and Reducing Errors:

1. Current Challenges: Traditional body scanners often rely on manual interpretation, which can be prone to human error, leading to false positives (incorrectly flagging harmless items) and false negatives (missing actual threats or issues).
2. AI Benefits: AI algorithms can analyze scan data with higher precision and consistency, significantly reducing these errors and increasing the overall reliability of body scanning systems.

Enhancing Security:

1. Current Challenges: In security-critical environments like airports and government buildings, there is a constant need to accurately detect concealed weapons, explosives, and other threats.
2. AI Benefits: AI can quickly and accurately identify potential threats from body scan data, improving security measures and response times, and reducing the risk of human oversight.

Advancing Medical Diagnostics:

1. Current Challenges: In medical settings, body scanners are used to detect abnormalities such as tumors, fractures, and other medical conditions. The accuracy of diagnosis heavily depends on the expertise of medical professionals.

2. AI Benefits: AI can assist in early and accurate detection of medical conditions by analyzing scan data more thoroughly and quickly than humans, leading to better patient outcomes and optimized treatment plans.

Improving Efficiency and Throughput:

1. Current Challenges: High-traffic areas like airports and large events face significant delays due to the time required for manual scan analysis and secondary inspections.
2. AI Benefits: AI can process body scan data in real-time, speeding up the screening process, reducing wait times, and increasing the throughput of scanning systems without compromising security or accuracy.

1.3 Rationale of the Study

The rationale for studying the integration of artificial intelligence (AI) in body scanner sensor assessments in Bangladesh is multifaceted, encompassing the need to enhance national security, improve healthcare diagnostics, and drive technological innovation. This study aims to provide a comprehensive analysis of how AI can be effectively implemented in these critical areas to address current challenges and leverage emerging opportunities.

Addressing Security Challenges:

1. Increased Threat Levels: In a global context marked by increasing security threats, ensuring the safety of citizens and infrastructure is paramount. Traditional body scanners, while useful, have limitations in terms of accuracy and efficiency. AI-enhanced body scanners can significantly improve threat detection capabilities, identifying concealed weapons, explosives, and other contraband more reliably. This study will explore how AI can reduce false positives and negatives, thereby enhancing security protocols.
2. Operational Efficiency: Long wait times and bottlenecks at security checkpoints are common issues that can cause significant inconvenience. By automating and speeding up the scanning process, AI-driven systems can streamline operations and

reduce congestion. This study will assess the potential improvements in throughput and the overall efficiency of security operations through AI integration.

Advancing Healthcare Diagnostics:

1. Need for Early and Accurate Diagnosis: Early detection of diseases is crucial for effective treatment. AI-powered body scanners can provide high-resolution imaging and real-time analysis, facilitating early diagnosis of conditions such as cancers and cardiovascular diseases. This study will examine the effectiveness of AI in improving diagnostic accuracy and patient outcomes.
2. Reducing Invasive Procedures: Non-invasive diagnostic methods are less stressful for patients and reduce the risk of complications. AI-enhanced body scanners can offer a viable alternative to more invasive techniques, making healthcare more accessible and patient-friendly. The study will evaluate the potential benefits of AI-driven non-invasive diagnostics in the Bangladeshi healthcare context.

Technological Innovation and Economic Growth:

1. Supporting Digital Transformation: Aligning with the "Digital Bangladesh" initiative, integrating AI into body scanner technology can drive the nation's digital transformation. This study will explore how AI integration can serve as a catalyst for broader technological advancements, influencing other sectors and promoting a culture of innovation.
2. Enhancing Global Competitiveness: By adopting advanced AI technologies, Bangladesh can position itself as a leader in digital innovation, attracting foreign investment and fostering economic growth. The study will assess the long-term economic impacts of AI adoption, including job creation in high-tech sectors and the development of a skilled workforce.

1.4 Expected Output

The expected output of this study on the integration of artificial intelligence (AI) into body scanner sensor assessments in Bangladesh includes a comprehensive set of findings, analyses, and recommendations that can guide policymakers, security professionals, and healthcare providers in effectively implementing AI technologies. The study aims to deliver the following key outputs:

Current State Assessment:

1. A detailed overview of the existing body scanner technologies in use within Bangladesh's security and healthcare sectors.
2. Identification of the limitations and challenges associated with current systems.

AI Integration Potential:

1. An analysis of how AI can enhance the capabilities of body scanner sensors.
2. Case studies and examples from other countries or regions where AI integration has been successfully implemented.
3. Potential improvements in accuracy, efficiency, and operational scalability.

Security Enhancements:

1. Expected improvements in threat detection accuracy and the reduction of false positives and negatives.
2. Analysis of the impact on operational efficiency at security checkpoints, including reduced wait times and increased throughput.

Healthcare Improvements:

1. Evaluation of the benefits of AI-powered body scanners in early disease detection and non-invasive diagnostics.
2. Case studies on the impact of AI on diagnostic accuracy and patient outcomes.

Economic and Technological Impact:

1. Assessment of the economic benefits of adopting AI technologies, including potential cost savings and ROI.
2. Analysis of the role of AI integration in supporting Bangladesh's "Digital Bangladesh" initiative.
3. Discussion on the potential for job creation and skill development in high-tech sectors.

CHAPTER 2

Background Study

2.1 Terminologies

1. Body Scanners:

Body scanners are devices used to detect objects concealed under a person’s clothing without physical contact. They are often used for security purposes in airports, public buildings, and other secure locations. There are two primary types of body scanners:

- **Millimeter Wave Scanners:** These use non-ionizing radio frequency waves to create an image of the body.
- **Backscatter X-ray Scanners:** These use low-energy X-rays to create an image of the body.

2. Artificial Intelligence (AI):

AI refers to the simulation of human intelligence in machines that are programmed to think and learn like humans. Key components of AI relevant to body scanners include:

- **Machine Learning (ML):** "A subset of AI that involves the use of algorithms and statistical models to enable a system to improve its performance on a task through experience"[20].
- **Deep Learning:** "A subset of ML that uses neural networks with many layers (deep networks) to analyze various levels of data abstraction"[20].

3. Sensor Technology:

Sensors are devices that detect and respond to changes in the environment. In the context of body scanners, sensors detect various signals that are processed to create images. Key types include:

- **Electromagnetic Sensors:** Used in millimeter wave scanners to detect electromagnetic waves.
- **X-ray Sensors:** Used in backscatter X-ray scanners to detect X-ray signals.

4. Image Processing:

Image processing involves techniques to enhance, analyze, and interpret images captured by sensors. Relevant techniques include:

- **Image Segmentation:** Dividing an image into parts for easier analysis.
- **Pattern Recognition:** Identifying patterns and regularities in data.

5. Threat Detection:

Threat detection involves identifying concealed objects that pose a security risk. AI can enhance threat detection by:

- **Object Recognition:** Identifying and classifying objects within the body scanner images.
- **Anomaly Detection:** Identifying objects that deviate from normal patterns.

6. Neural Networks:

Neural networks are computational models inspired by the human brain, consisting of interconnected nodes (neurons) that process data. Types include:

- **Convolutional Neural Networks (CNNs):** Primarily used for image recognition and classification tasks.
- **Recurrent Neural Networks (RNNs):** Used for sequential data analysis.

7. Data Annotation:

Data annotation involves labeling data to train machine learning models. In the context of body scanners, this means labeling images to indicate the presence or absence of threats.

8. Privacy Concerns:

Body scanners raise privacy issues due to the detailed images they capture. AI can help mitigate these concerns by:

- **Image Anonymization:** Blurring or masking personal features while retaining threat-relevant details.
- **Automated Analysis:** Reducing the need for human operators to view detailed images.

9. Regulatory Standards:

Body scanners must comply with regulatory standards for safety and privacy, such as those set by aviation authorities and health organizations. AI systems used in body scanners must also adhere to ethical guidelines to ensure they are used responsibly.

10. Performance Metrics:

Evaluating the effectiveness of body scanners involves several performance metrics:

- **Accuracy:** The ability of the scanner to correctly identify threats.
- **False Positive Rate:** The frequency of non-threats being incorrectly identified as threats.
- **False Negative Rate:** The frequency of actual threats being missed.

2.2 Related Work

1. Automated Threat Recognition (ATR)

Overview: Automated Threat Recognition (ATR) systems employ AI to enhance security screening by automatically identifying potential threats in body scanner images. These systems reduce the need for manual inspection, thereby increasing efficiency and throughput in high-traffic areas like airports.

Key Studies:

- **Department of Homeland Security (DHS) Research**: The DHS has funded several projects aimed at developing ATR systems for airport security. These systems utilize machine learning algorithms to detect weapons, explosives, and other contraband [3].
- **EU-funded IMARS Project**: This project focuses on the integration of AI with millimeter-wave scanners to improve the detection of non-metallic threats. The AI algorithms are trained on extensive datasets to enhance their accuracy and reduce false positives [4].

Techniques:

- **Deep Learning**: Convolutional Neural Networks (CNNs) are commonly used for image recognition tasks, such as detecting concealed items on passengers.
- **Ensemble Learning**: Combining multiple models to improve detection accuracy and robustness.

2. AI in Medical Imaging

Overview: AI has been widely adopted in medical imaging to assist in the diagnosis and treatment of various diseases. AI algorithms analyze images from MRI, CT scans, and other imaging modalities to identify abnormalities with high precision.

Key Studies:

- **Stanford University's CheXNet**: A deep learning algorithm that can diagnose pneumonia from chest X-rays with accuracy comparable to radiologists. The model uses a 121-layer CNN trained on a large dataset of labeled X-ray images [5].
- **Google Health's AI for Breast Cancer Screening**: Google Health developed an AI model that outperforms human radiologists in detecting breast cancer from mammograms [6]. The model reduces false positives and negatives, leading to more accurate diagnoses.

Techniques:

- **Transfer Learning**: Using pre-trained models on large datasets to improve the performance of AI algorithms on specific medical imaging tasks [7].
- **Generative Adversarial Networks (GANs)**: Enhancing image quality and resolution, which is crucial for accurate diagnosis [8].

3. Sensor Fusion Techniques

Overview: Sensor fusion involves integrating data from multiple sensors to create a more comprehensive understanding of the scanned subject. This approach enhances the accuracy and reliability of body scanner assessments.

Key Studies and:

- **MIT's Lincoln Laboratory Research**: Researchers at MIT have developed sensor fusion techniques that combine data from millimeter-wave scanners and backscatter X-ray systems to improve threat detection capabilities [9].
- **DARPA's Multispectral Sensor Fusion**: The Defense Advanced Research Projects Agency (DARPA) has explored multispectral sensor fusion to enhance battlefield awareness and threat detection [10]. The project combines data from visible, infrared, and radar sensors [10].

Techniques:

- **Kalman Filtering**: A mathematical technique used to estimate the state of a system by minimizing the mean of the squared error [11].
- **Bayesian Networks**: Probabilistic models that combine sensor data to improve decision-making processes [12].

4. AI for Industrial Safety

Overview: In industrial settings, AI-enhanced body scanners monitor workers for the presence of hazardous materials and ensure compliance with safety protocols. These systems help prevent accidents and maintain a safe working environment.

Key Studies and Projects:

- **OSHA's AI Initiatives**: The Occupational Safety and Health Administration (OSHA) has supported the development of AI tools that use body scanners to detect harmful substances and ensure workers' safety [13].
- **IBM Watson for Industrial Safety**: IBM's AI platform, Watson, is used in conjunction with body scanners to analyze safety data and predict potential risks in industrial environments [14].

Techniques:

- **Predictive Analytics**: Using historical data to predict future safety incidents and take preventive measures [15].
- **Anomaly Detection**: Identifying unusual patterns that may indicate the presence of hazardous materials or unsafe conditions [15].

2.3 Comparative Analysis and Summary

Automated Threat Recognition (ATR) vs. AI in Medical Imaging

- **Objective**:
  - ATR focuses on detecting threats such as weapons and explosives in security scans to enhance public safety.
  - AI in medical imaging aims to improve diagnostic accuracy and efficiency by identifying abnormalities and diseases from medical scans.

- **Techniques**:
  - **ATR**: Utilizes machine learning algorithms, particularly CNNs, for image recognition and classification of potential threats in scanned images.
  - **Medical Imaging**: Applies deep learning techniques like transfer learning and GANs to analyze complex medical data and improve diagnostic outcomes.
- **Challenges**:
  - ATR faces challenges in reducing false positives and adapting to diverse environmental conditions in real-time security settings.
  - Medical imaging encounters challenges related to data privacy, ensuring the reliability of AI models across different patient demographics, and integrating AI seamlessly into clinical workflows.

Sensor Fusion Techniques vs. AI for Industrial Safety

- **Objective**:
  - **Sensor Fusion**: Integrates data from multiple sensors (e.g., millimeter-wave, X-ray) to enhance the accuracy and reliability of body scanner assessments.
  - **AI for Industrial Safety**: Uses body scanners and predictive analytics to monitor workplace environments for hazardous materials and ensure worker safety.
- **Techniques**:
  - **Sensor Fusion**: Applies advanced algorithms such as Kalman filtering and Bayesian networks to fuse data from heterogeneous sensor sources and provide comprehensive insights.
  - **AI for Industrial Safety**: Utilizes predictive analytics and anomaly detection to forecast potential safety incidents and maintain safe working conditions.
- **Challenges**:
  - Sensor fusion must address technical complexities in integrating and synchronizing data from disparate sensor types while maintaining real-time processing capabilities.
  - AI for industrial safety faces challenges concerning data privacy, ethical considerations, and the need for robust predictive models capable of handling diverse industrial environments.

3. Summary

Historical Development and Types of Body Scanners:

- Body scanners have evolved from basic X-ray machines to advanced systems incorporating MRI, CT scans, and millimeter-wave technologies.
- Each type of body scanner offers unique capabilities suited to specific applications in security, healthcare diagnostics, and industrial safety.

AI Techniques:

- Machine learning, computer vision, and data analytics play pivotal roles in interpreting body scanner data, enhancing detection capabilities, and improving operational efficiency.

Applications:

- **Security**: Enhanced threat detection capabilities in airports and public venues using AI-driven body scanners.
- **Healthcare**: Improved diagnostic accuracy and early disease detection through AI-enhanced medical imaging.
- **Industrial Safety**: Monitoring and ensuring worker safety by detecting hazardous materials and predicting safety incidents.

Challenges:

- Addressing data privacy concerns, ethical implications, and technological limitations (e.g., resolution, model generalization) are critical for the widespread adoption and effectiveness of AI-driven body scanner systems.

2.4 Scope of the Problem

Technological Advancements and Integration Challenges:

- **Complexity of Sensor Data**: Body scanners utilize diverse technologies such as millimeter-wave imaging, X-ray backscatter, MRI, and CT scans. Integrating data from these heterogeneous sources poses challenges in data fusion and interpretation.

- **Resolution and Accuracy**: Enhancing the resolution and accuracy of body scanners is crucial for detecting subtle anomalies and ensuring reliable assessments, especially in medical and security contexts.
- **Real-Time Processing**: Body scanners must operate in real-time environments, requiring AI algorithms capable of rapid data analysis and decision-making without compromising accuracy.

Security Applications:

- **Threat Detection**: AI enhances the ability to detect concealed weapons, explosives, and other threats in high-traffic areas like airports and public venues.
- **Privacy and Ethical Concerns**: Balancing security needs with individual privacy rights remains a critical challenge. AI algorithms must minimize false positives while respecting privacy regulations.

Healthcare Applications:

- **Diagnostic Accuracy**: AI algorithms in medical imaging improve diagnostic accuracy by identifying abnormalities in MRI and CT scans. However, challenges include the need for large datasets and robust models applicable across diverse patient demographics.
- **Integration into Clinical Workflows**: Integrating AI seamlessly into clinical workflows requires addressing regulatory compliance, data interoperability, and physician acceptance.

Industrial Safety Applications:

- **Hazardous Material Detection**: AI-driven body scanners monitor industrial environments for hazardous materials, ensuring worker safety. Challenges include predicting rare safety incidents and integrating AI with existing safety protocols.
- **Regulatory Compliance**: Ensuring compliance with safety regulations and ethical considerations in using AI for worker safety is crucial for widespread adoption in industrial settings.

CHAPTER 3

Research Methodology

3.1 Introduction

My research's methodological section aims to supply readers with an in-depth overview of the approaches and strategies used in conducting the investigation. We provide comprehensive explanations of the procedures used to create, preprocess, and enhance the data we have collected in this section of our investigation. We also include examples of how the collected data and related processes are depicted. We also discuss the issue of categorization that we aim to tackle with the model we have recommended, the specific classification models picked out, the various levels and factors of these models, and the information set that we have put together to accomplish the optimum precision and alleviate the loss. The methods used in information manufacturing, preliminary processing, enhancing, graphical representation, and the choice and design of classification frameworks are all covered in full and in great detail in this analytical section. Establishing an authoritative and educated technique is the goal in order to tackle the current subject of research. While we followed the data collection part and data cleaning part it was very crucial for us as the process was depending on these two sections. We also faced some challenges while we were in classification model training as selecting the perfect approach to train the model was not that much easy task. But we successfully completed the study, and this is a relief. By choosing the topic of Scanner Sensor from the perspective of Bangladesh, you can delve into various aspects such as storage technologies, infrastructure, market demands, and regulatory frameworks. It offers an opportunity to explore the intersection of safety, consumer preferences, economic development, and sustainability within the unique context of Bangladesh's technology industry. The methodology of this research is demonstrated in figure 3.1 which is called the proposed system architecture. It briefly explains every step of the research, and how we conducted this at every point which we followed.

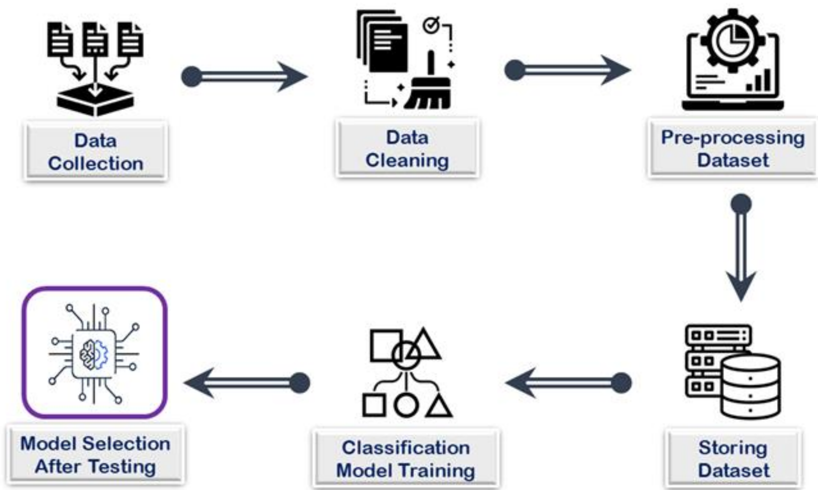

Figure 3.1: Proposed System Architecture

3.2 Data Collection Procedure

For that categorization problem associated with comprehending the fresh and new images conditions, we employed a uniquely developed dataset. The first step in the dataset-gathering process was to photograph several Pangasius species scanning image from the Cumilla medical college. The pictures feature different views of the same image as well as a few singular shots taken from a single angle for dataset discrepancies. The majority of the photographs are made with the intention of being clear of any pointless barriers, allowing for effective training without concern for stray objects. A total of 1076 images were captured during the data collection procedure. After the dataset has been cleaned, the final one, which is divided into 6 labels, has 750 photos of X-rey image in three various states (which encompasses fresh & new, aged, and sick image).

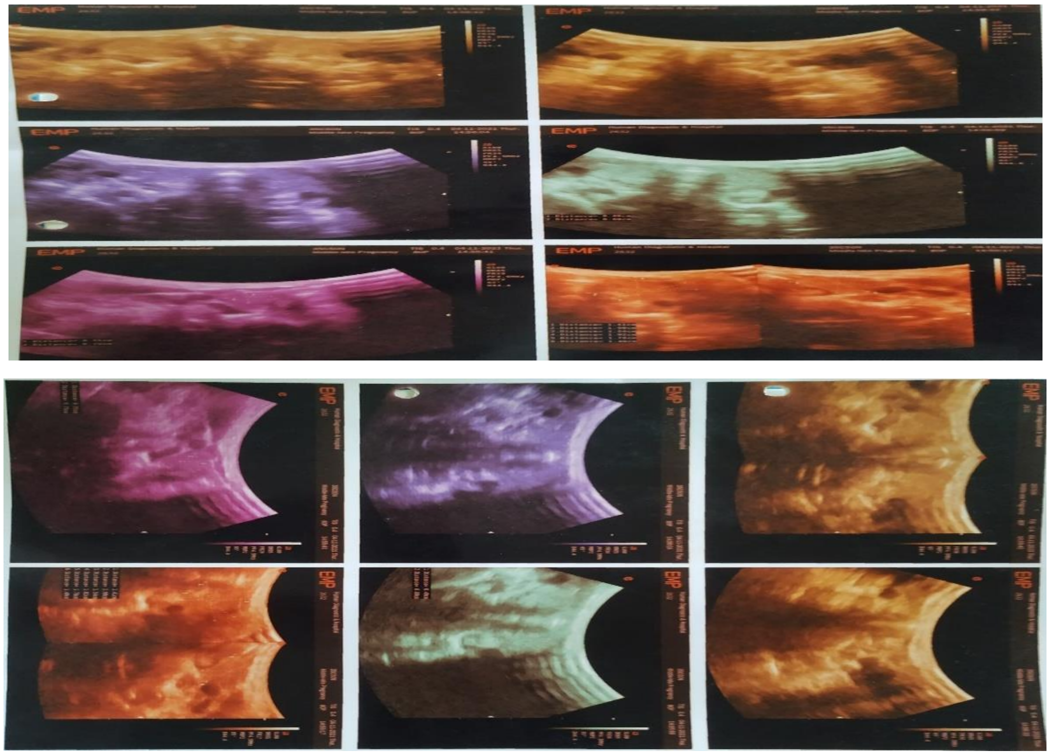

Figure 3.2: Sample Dataset

3.3 Dataset Cleaning

We have to meticulously examine all of the photographs that have been snapped mostly because we assembled datasets from the medical college and we tend to save only those pictures that are distraction-free and only highlight the patient's body and eyes. During the selection of the intended photos, it eventually emerged that several of the photographs had exposure-related and ambiguous difficulties that could be harmful to the simulation. For safety hazards, these photos were additionally eliminated from the dataset and kept both in local and cloud storage (Google Drive). The ultimate set of data is determined after cleaning them. Table 3.3 demonstrates the final dataset table:

Image Condition	Classes	Numbers of Images
Fresh & new	Fresh image (Eye)	125
	Fresh image (Body)	125
Aged	Aged image (Eye)	125
	Aged image (Body)	125
Sick	Sick image (Eye)	125
	Sick image (Body)	125
Total	**6 classes**	**750**

Table 3.3: The Final Dataset Table

3.4 Dataset Preprocessing

A critical stage in the data assessment segment is data preparation. It entails preparing raw data for evaluation and training models by cleaning, converting, and arranging it. The 4608*3456-pixel images that snapped from the open circumstances had a high brightness and weren't appropriate for our simulation models. In order to make rescaling the photos less daunting, we changed the pixels' dimension from (0,255) to (0,1), which will allow them to contribute impartially in the event of damage. The transformed images' resolution is preserved at 350*350 pixels. Additionally, a denoise approach was applied particularly to those images that had very slight noise, but not enough to be perceived. To simulate the artificial intelligence model, the dataset ought to be partitioned. The dataset photos are initially separated into two divisions (train and test) for maximizing the diversity of the images which are 70% and 30%. Once more, the training (those 70% of data) depictions are split into the training and validation phases and this is also split in a 70 - 30 ratio for maximizing the accuracy and diversity of the data. Table 3.4 demonstrate the size of the train, test, and validation data.

Split Percentage	Dataset Splitting	Number of Images
70%	Training 70%	600
	Validation 30%	76
30%	Testing	74

Table 3.4: The Number of Images in Each Dataset

3.5 Proposed Methodology

Transfer learning, which is used in deep learning is the process of using previous designs to tackle a brand-new problem or obstacle. Not any particular kind of artificial intelligence procedure, propagate learning is an instructional technique or approach used while training models. Reusing prior instruction materials allows for the completion of an entirely novel task. The specific task will be related in some way to the one in which it was rehearsed; for example, it might include classifying items into an identifiable file type. The old modeled system frequently requires a large degree of extrapolation to adapt to the new, unseen input. This transfer methodology for learning has been employed to create three distinct deep neural network algorithms and uses fewer components yet promising enhanced precision from its constructed weights.

3.5.1 InceptionV3

The Inception segment, which enables the neural network to learn numerous scale characteristics, is the foundation of InceptionV3. To capture features at various scales and resolutions, it combines 1x1, 3x3, and 5x5 convolutions in order with pooling workflows. Convolutional levels, pooling levels, as well as completely associated layers, are among the 48 layers in InceptionV3. The ImageNet information set, which has millions of accompanying images from different categories, is regularly utilized as a foundational dataset on which the model is pre-trained. The high efficiency of computation of InceptionV3 was deliberately manufactured. It is more effective than prior models because it makes employing of methods like simplifying convolutions and employing dimension reduction to minimize the number of parameters and calculations needed. Supplementary classifiers have been implemented in InceptionV3 at crucial locations in the network. In order to overcome the problem of gradients vanishing during training, these classifiers are included. They add extra gradients and supervision signals to the network's development process [16].

3.5.2 VGG19

16 layers of convolution and 3 entirely connected layers comprise the 19 layers which constitute VGG19. Tiny 3x3 filters with a stride of 1 and max-pooling stages with a 2x2 window and a stride of 2 are utilized in the layers that are convolutional. The network has a simple architecture with numerous stacked convolutional layer structures, making it reasonably simple to comprehend and employ. The deep framework of VGG19 consists of 19 levels altogether. Improved visualization and comprehension of pictures are made possible by the depth of the system, which enables it to acquire hierarchical attributes with escalating degrees of complexity. 3x3 filters and layers with maximum pooling are frequently deployed across the network by VGG19 to maintain an identical design. The network's conception and execution are made easier by this homogeneity. Large-scale image categorization databases like ImageNet, which has millions of annotated visuals, are frequently used as pre-training instances for VGG19. Through pre-training, the model has the capacity to pick up basic characteristics from a wide variety of photographs, which can later be tailored for use on particular assignments or datasets. Similar to other pre-trained models, VGG19 can be used as a feature extractor for transfer learning. By removing the last fully connected layers and using the activations from an earlier layer, the model can be adapted to different image-related tasks [17].

3.5.3 ResNet50

50 layers comprise ResNet50, the majority of which are layers with convolution, regularization by batch, and block residuals. To accumulate features at different

heights and legislation, the network combines 1x1, 3x3, and 1x1 convolutions with layers of pooling. ResNet50 has frequently been pre-trained on immense image categorization databases like ImageNet, just like other well-known techniques. Pre-training enables the statistical framework to be customized for particular tasks or datasets while learning attainable features from a wide variety of pictures. Identity linkages are used by ResNet50 in residual blocks of code, where input is appended straight to the output. This aids in maintaining data and gradients across the network, making it easier to learn complex abstractions. For transfer learning, ResNet50 can be adopted as an extraction mechanism for features. The model can be modified to do other image-related tasks like identifying items, picture segmentation, or the extraction of features by eliminating the completely connected layers and utilizing the activation signals from the prior layer. Relative connections have rendered it possible to train much more extensive networks and have sparked further architectural developments [18].

3.5.4 DenseNet201

Relative connections have made it possible to train far deeper networks and have sparked further aesthetically pleasing developments. Being a member of the DenseNet family, DenseNet201 is an advanced convolutional neural network design. In their article "Densely Connected Convolutional Networks" (CVPR 2017), Gao Huang, Zhuang Liu, Laurens van der Maaten, and Kilian Q. Weinberger presented it. A development of DenseNet121 and DenseNet169, DenseNet201 provides even more layers and attributes for enhanced performance on tasks relating to image recognition. The idea of thick blocks is the organizing principle of DenseNet201. Each layer in a block of material obtains its characteristic maps from all of the layers that came before it as input. Due to the direct information transfer between layers made possible by this extensive connectivity, feature reuse is encouraged and the issue of diminishing gradients is lessened. With DenseNet201, the number of maps containing features and spatial dimensions is decreased by using transitioning blocks between dense blocks. A batch equalization layer, a compression 1x1 convolution layer, and an average pooling 2x2 layer make up these transitional blocks. A 1x1 convolution layer is subsequent to a 3x3 convolution phase in the bottleneck layer structure [21].

3.5.5 MobileNetV2

The "Inverted Residual" is a newly created building element that MobileNetV2 incentives. A convolution that is separable depth-wise is accompanied by a linear constriction layer in this block. The simulation may boost the number of pathways (width) while decreasing the network's physical dimensions (i.e. width and height) thanks to the inverted residual, creating a network that is more effective and lightweight. Prior to performing the main depth-wise separable convergence, the linear restriction layer within the inversion residual performs a convolution in the form of 1x1 with a low-dimensional bottleneck. The depth-dependent separable convolution is improved and features that are lost are prevented by the linear bottleneck. A new expanding factor dimension indicated as "t," is added by MobileNetV2. The depth-wise separable convolution's input channel capacity is controlled by the extension factor. It enables the model to quickly scale up or down depending on hardware constraints and achieve an equilibrium between simulation dimension and performance. Additionally, MobileNetV2 adds the "α"-designated width scaling argument. Each layer's quantity of channels is scaled by a factor of the width converter $\alpha < 1$. It is simpler to deploy the model on devices with constrained computational resources thanks to this factor, which enables the simulation to trade-off between accuracy and model complexity [22].

3.6 Model Training

We employed the available data in each of the aforementioned CNN-based topologies. Nevertheless, DenseNet201 accomplishes more efficiently than the other architectures of CNN. We determined to put forward our model leveraging the DenseNet201 architecture for this reason. Figure 3.6 shows the DenseNet201 architecture will be thoroughly clarified in the statements that follow.

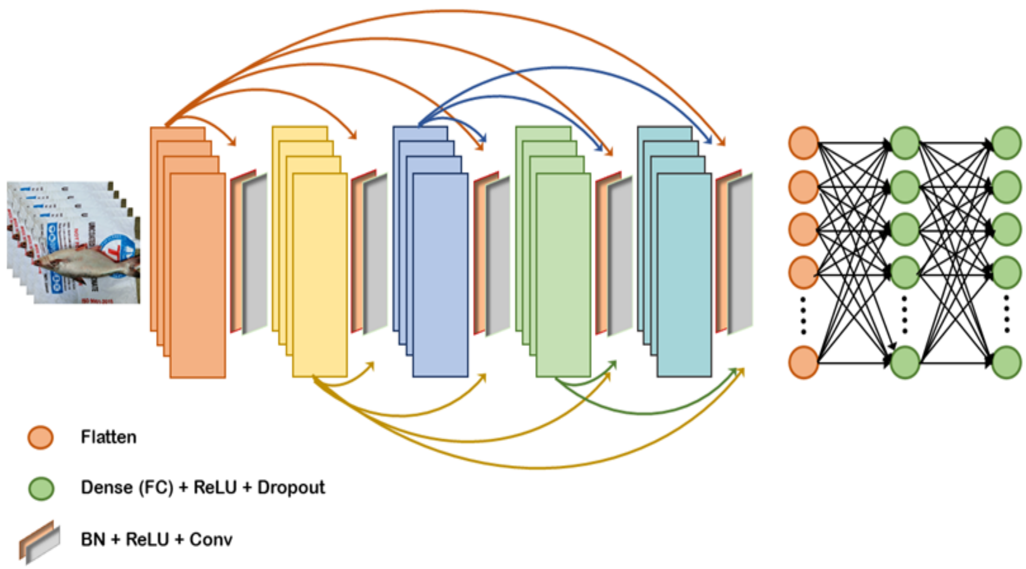

Figure 3.6: DenseNet201 Network Architecture

DenseNet201 can be implemented as an extractor of features for transfer learning, just like other models that have been previously trained. The model can be modified to do many visual-related tasks, including detecting objects and picture segmentation, by eliminating the ultimate categorization layer and using activation data from an earlier layer. Similar to other deep neural network models, DenseNet201 is frequently pre-trained using sizable image categorization datasets like ImageNet. Before being fine-tuned on particular tasks or datasets, pre-training enables the algorithm to learn general features from a wide variety of images [21].

3.7 Implementation Requirements

- Different Artificial intelligence Frameworks and Libraries
- Windows 10
- Google Colab with runtime TPU

- Kaggle enabling TPU runtime
- Google Drive
- Huawei Nova 3i for Image Gathering

CHAPTER 4

Result Analysis and Discussion

4.1 Introduction

We deployed five distinct artificial intelligence learning models to achieve the highest level of precision on our custom-made dataset. Transfer learning has been utilized to construct InceptinV3, VGG19, MobileNetV2, DenseNet201, and ResNet50 individually on our custom-made dataset, eliminating the time needed to construct the model from the ground up. Here, utilizing the transfer methodology of learning, we can develop models using our particular dataset while preserving the weights that have been previously trained for each model.

4.2 Experiment Results and Analysis

Experiment Result Analysis is the procedure of applying a variety of criteria for assessment to measure how effectively an artificial intelligence learning algorithm performs. Early on in the investigation process, a model's effectiveness must be evaluated, and the assessment of models also aids in model supervision. Our model can only be judged on its preciseness during its validation and training phases. We have to take into consideration numerous kinds of reports in order to validate our model. We must construct a categorization report and Confusion Matrix in order to check out our model. The brief introductory paragraph will be addressed in the sections that come afterward. Looking at the contrasting table between the simulators allows us to quickly determine which approach is operating with the strongest potential to detect photographs from scenarios. The outcomes of each model and their accompanying assessment grades are listed in the table below.

Transfer Learning Model	Test Accuracy	Test Loss
VGG19	95.90%	3.30
InceptionV3	87.80%	0.30
ResNet50	78.20%	6.45
MobileNetV2	93.10%	9.08
DenseNet201	97.10%	3.70

Table 4.2: The Experiment Result of the Evaluated Model

4.3 Generating Classification Report

A categorization report is an oral presentation that offers an in-depth examination of the performance of an approach to classification across several classes or types. Table 4.3 shows the it displays significant statistics for each class, including the overall percentages for accuracy, recollection, F1 score, and support. The averages that are presented include sample average, and overall median. The categorization report aids in evaluating the model's overall efficacy and provides knowledge about how the model operates for specific demographics. When confronting unbalanced Datasets or when many classes have differing degrees of relevance, it is especially helpful.

Class name	Precision	Recall	f-1 Score	Support
Aged Image (Body)	0.95	0.95	0.95	16
Aged Image (Eye)	0.95	0.95	0.95	16
Fresh Image (Body)	0.97	0.97	0.97	16
Fresh Image (Eye)	0.90	0.90	0.90	16
Sick Image (Body)	0.97	0.97	0.97	16
Sick Image (Eye)	0.89	0.89	0.89	16

Table 4.3: Classification Report of DenseNet201

4.4 Training and Validation Accuracy and Loss Curve

We first ran 20 epochs of DenseNet201 using the Kera’s Callback function with verbose set to 1, shuffle set to True, and validation steps set to none. Figure 4.4 shows the training and evaluation curves after 20 training epochs. The best epoch, with nearly flawless training and validation preciseness, was recorded as epoch 19, although the result was not deemed very pleasing.

Figure 4.4: Training-Validation Curve with 20 Epochs

4.5 Discussion

In the current work, five artificial intelligence topologies have been recommended for the scanner sensor image recognition system. These structures are employed to distinguish between fresh, aged, and Sick scan image when determining how fresh it is. We demonstrate the step-by-step process of our endeavor as well as the precision of its outcomes in the study's findings and analysis results. InceptionV3, ResNet50, DenseNet201, MobileNetV2, and VGG19 models each obtained accuracy scores of 87.80%, 78.20%, 97.10%, 93.10%, and 95.90%once our experiment was completed. The DenseNet201 model outperformed the other suggested simulations, according to the results of the trial. The model offered decent detection precision when compared to other appliances.

CHAPTER 5

Impact on Society, Environment, and Sustainability

5.1 Impact on Society

The integration of artificial intelligence (AI) into body scanner sensor assessment has transformative implications for various sectors, including security, healthcare, and industrial safety. These advancements not only enhance the efficiency and accuracy of body scanning technologies but also bring significant societal impacts. This section explores the multifaceted impacts of AI-driven body scanner systems on society.

Enhanced Security and Public Safety

1. **Improved Threat Detection**:

- AI-driven body scanners improve the detection of concealed weapons, explosives, and other threats, thereby enhancing security at airports, public venues, and border checkpoints.
- These advancements reduce the likelihood of terrorist attacks and criminal activities, contributing to overall public safety.

2. **Reduced Human Error:**

- AI algorithms minimize human error in threat detection by providing consistent and accurate analysis of scanned images.
- This leads to more reliable security screenings and reduces the potential for dangerous items to be overlooked.

Advancements in Healthcare

1. **Early Disease Detection**:

- AI-enhanced body scanners in medical imaging (e.g., MRI, CT scans) enable early detection of diseases such as cancer, cardiovascular conditions, and neurological disorders.
- Early diagnosis improves treatment outcomes and survival rates for patients.

2. **Enhanced Diagnostic Accuracy:**

- AI algorithms analyze medical images with high precision, assisting radiologists in identifying abnormalities that may be difficult to detect with the human eye.
- This leads to more accurate and timely diagnoses, reducing the likelihood of misdiagnosis and unnecessary treatments.

Industrial Safety and Efficiency

1. **Workplace Safety**:

- AI-driven body scanners monitor industrial environments for the presence of hazardous materials and ensure compliance with safety protocols.
- This reduces workplace accidents and enhances the overall safety of workers in high-risk industries.

2. **Operational Efficiency:**

- The automation of safety inspections and assessments through AI technologies increases operational efficiency by reducing the need for manual checks.
- This allows industries to allocate resources more effectively and maintain productivity without compromising safety.

Economic and Social Impacts

1. **Job Displacement and Creation:**

- The automation of body scanner assessments may lead to job displacement in roles traditionally performed by humans, such as security personnel and radiologists.
- Conversely, new job opportunities will emerge in AI development, system maintenance, and data analysis, requiring a workforce with advanced technical skills.

2. **Accessibility and Affordability:**

- The widespread adoption of AI-driven body scanners can make advanced diagnostic and security technologies more accessible and affordable to a broader population.
- This democratization of technology has the potential to improve health outcomes and security for underserved communities.

5.2 Impact on Environment

The integration of artificial intelligence (AI) into body scanner sensor assessment has the potential to impact the environment in several ways. These impacts can be both positive and negative, depending on how the technology is implemented and managed. This section explores the various environmental implications of AI-driven body scanner systems.

Positive Environmental Impacts

1. **Energy Efficiency**:

- **Optimized Operations**: AI algorithms can optimize the operation of body scanners, reducing energy consumption by minimizing idle time and efficiently managing power use.
- **Smart Maintenance**: Predictive maintenance powered by AI can ensure that body scanners operate at peak efficiency, reducing the energy waste associated with malfunctions and prolonged downtimes.

2. **Reduced Resource Use**:

- **Less Paperwork**: AI-driven systems can digitize records and processes, reducing the need for paper and other physical resources traditionally used in documentation and reporting.
- **Efficient Material Use**: Advanced AI algorithms can optimize the design and manufacturing of body scanner components, leading to more efficient use of materials and less waste.

3. **Environmental Monitoring**:

- **Hazard Detection**: AI-driven body scanners used in industrial safety can detect hazardous materials and conditions, helping to prevent environmental contamination and ensuring compliance with environmental regulations.
- **Data Analysis for Sustainability**: AI systems can analyze data from body scanners to identify patterns and trends that can inform more sustainable practices and policies.

Negative Environmental Impacts

1. **Energy Consumption**:

- **High Power Requirements**: Advanced AI algorithms and high-resolution body scanners can be energy-intensive, leading to increased power consumption and a larger carbon footprint.
- **Data Centers**: The AI models used in body scanners require substantial computational power, often provided by data centers that consume significant amounts of electricity and produce heat.

2. **Electronic Waste (E-Waste)**:

- **Obsolescence**: Rapid advancements in AI and body scanner technology can lead to frequent hardware upgrades, resulting in increased electronic waste.

- **Disposal Challenges**: Proper disposal and recycling of outdated or broken body scanner components can be challenging, contributing to environmental pollution if not managed correctly.

3. **Material Use**:

- **Rare Earth Metals**: Body scanners often use rare earth metals and other non-renewable resources in their construction. The extraction and processing of these materials have significant environmental impacts, including habitat destruction and pollution.
- **Manufacturing Footprint**: The production of sophisticated AI-driven body scanners involves complex manufacturing processes that can contribute to environmental degradation through emissions, waste, and resource use.

5.3 Sustainability Plan

The integration of artificial intelligence (AI) into body scanner sensor assessment brings numerous benefits, but it also necessitates a comprehensive sustainability plan to ensure these technologies are environmentally friendly, socially responsible, and economically viable. This section outlines a sustainability plan focusing on the development, implementation, and operation of AI-driven body scanner systems.

1. Sustainable Design and Manufacturing

Eco-Friendly Materials:

- **Sustainable Resources**: Use recyclable and biodegradable materials in the manufacturing of body scanner components to reduce environmental impact.
- **Reduced Toxicity**: Minimize the use of hazardous substances in the production process to decrease pollution and health risks.

Energy-Efficient Components:

- **Low-Power Electronics**: Incorporate energy-efficient chips and circuits to reduce overall power consumption.

- **Smart Sensors**: Develop sensors that operate efficiently without compromising performance, thereby conserving energy.

Modular Design:

- **Upgradability**: Design body scanners with modular components that can be easily upgraded or replaced, extending the device's lifespan and reducing electronic waste.
- **Repairability**: Ensure that components are easily accessible for repairs, promoting longevity and reducing the need for complete replacements.

2. Energy Management

Operational Efficiency:

- **AI-Optimized Energy Use**: Implement AI algorithms that optimize energy consumption by adjusting power use based on real-time demand and operational conditions.
- **Idle Mode**: Equip body scanners with low-power idle modes that activate during periods of inactivity to conserve energy.

Renewable Energy Sources:

- **Green Power**: Power data centers and manufacturing facilities with renewable energy sources such as solar, wind, or hydroelectric power.
- **Energy Partnerships**: Partner with green energy providers to ensure a steady supply of renewable energy.

CHAPTER 6

Overview of the Study, Conclusion, and Future Work

6.1 Overview of the Study

The area of artificial intelligence is a tremendous discipline that is capable of recognizing anything in particular. The scanner sensor of the image is vital for reliability as well as security considerations. We demonstrated how to distinguish scanner sensor image in this evaluation. We construct a prototype that can swiftly identify sensor image. To do this, we use artificial intelligence techniques to conduct automatic assessments. Adopt various artificial intelligence methods into account. The entire endeavor is broken down into six phases, which include image gathering reducing the size of the image, preliminary image processing, training, milestone update, and diagnosis. Additionally, using samples for three distinct kinds of body scanner sensor image, Analyze artificial intelligence topologies.

6.2 Conclusions

Evaluating the quality of good scanner sensor image from various classes and distinguishing between sick and good scanner image by simply examining the outer shell is conducted in this study. Automate this classification process with the help of computer vision, artificial intelligence, and Convolutional Neural Networks. In the case of usable, and unusable image, we can classify more accurately and reduce unusable. DenseNet201's unique input layered model achieves 97.10% accuracy on our custom dataset of 750 images. Accordingly, this shows that maintaining data availability is the most challenging procedure for us.

6.3 Limitations

In this present article, the dataset that is used contains a few data. Since we were unable to consider the temperature, weather conditions, and vicinity the information that is used in the research also has certain limitations. Additionally, because we captured the photos cumilla medical college, the background is obscured, which lowers the quality of the information. The dataset was also not verified by medical college and this is the biggest limitation so far. The scanner image quantity was also less than expected.

6.4 Future Work

Employed a few pre-built CNN and artificial intelligence models in the present article. To achieve improved precision, we will be demonstrating a framework in the future. Since we were unable to consider the temperature, weather conditions, and vicinity the information that is used in the research also has certain limitations. Additionally, because we captured the photos cumilla medical college, the background is obscured, which lowers the quality of the information. When creating datasets in the future, we should always keep this in mind. We only utilized one type of image, the pangasius, and we used fewer species overall. Therefore, in the future, we'll aim to use a greater quantity and variety of scanner sensor image overall. Due to the processing limitations of our current gadget, we encountered some issues while analyzing the model. As a result, we will take this into account in future releases and employ a device with a more powerful GPU & CPU. The model training epochs were analogously constrained; thus, the epochs must be extended. We'll strive to create a smartphone application that will allow users to verify the current state of scanner image in the real world.

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