Empowering Intelligent Systems

Vision and Image Processing in the Age of AI, IoT, and Data Analytics

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A University for The Excellence

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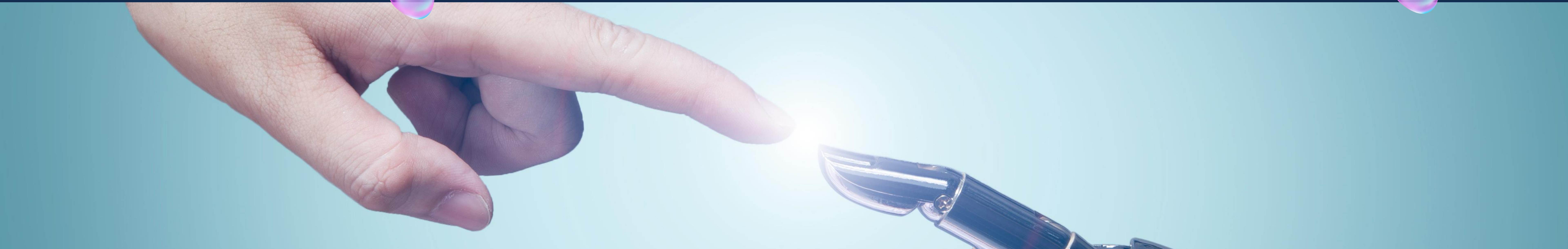
Introduction to Intelligent System

AI, IoT and Data analytics in the modern industry

Role of **vision and image processing** in enabling intelligent, autonomous systems

Industries impacted: Healthcare, manufacturing, agriculture, disaster management.



Tesla Autonomous Driving System

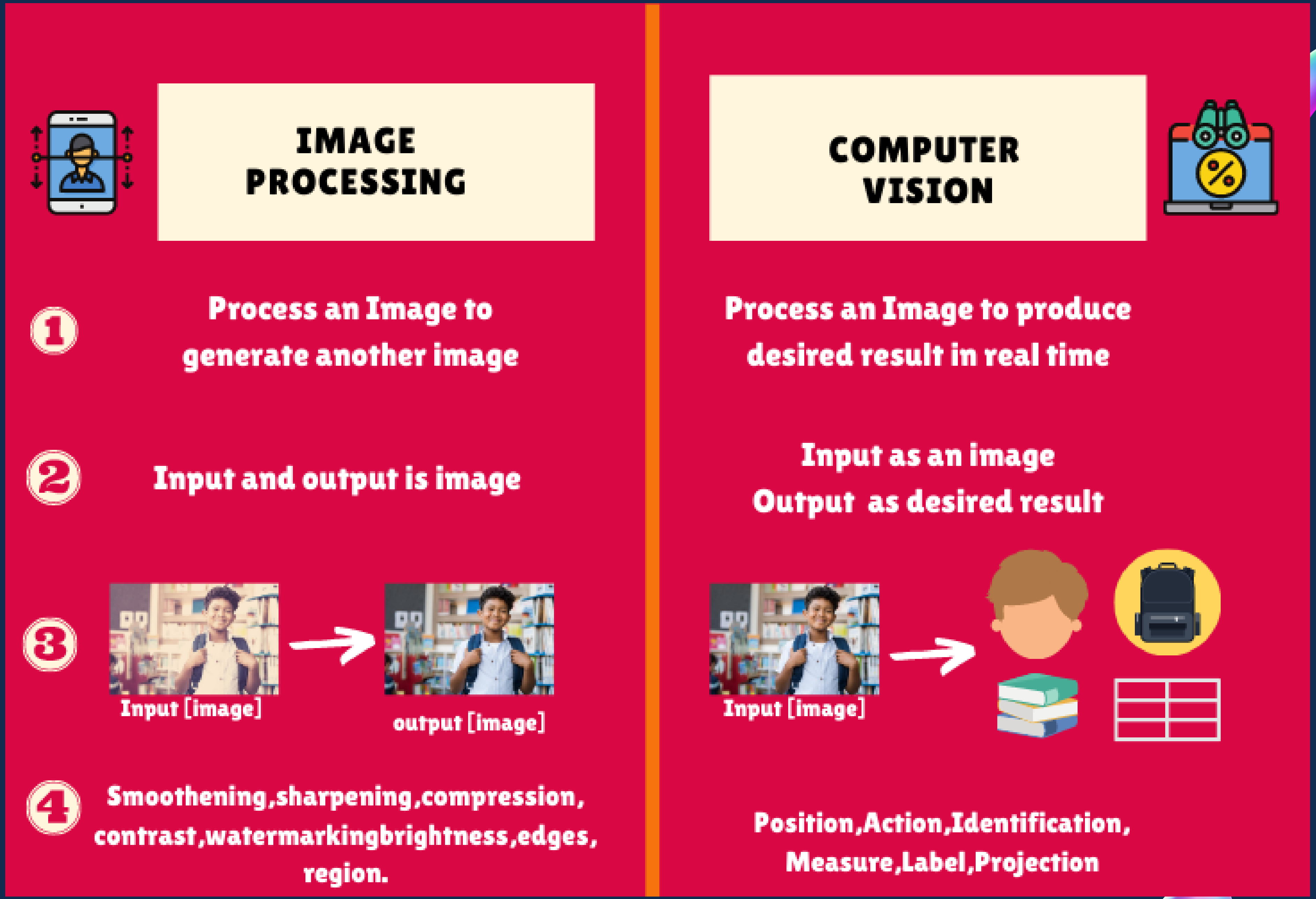
Vision cameras capture real-time images around the vehicle, which are processed by deep learning algorithms to recognize objects, predict traffic patterns, and make driving decisions. IoT connectivity provides real-time updates and data sharing across Tesla’s fleet.

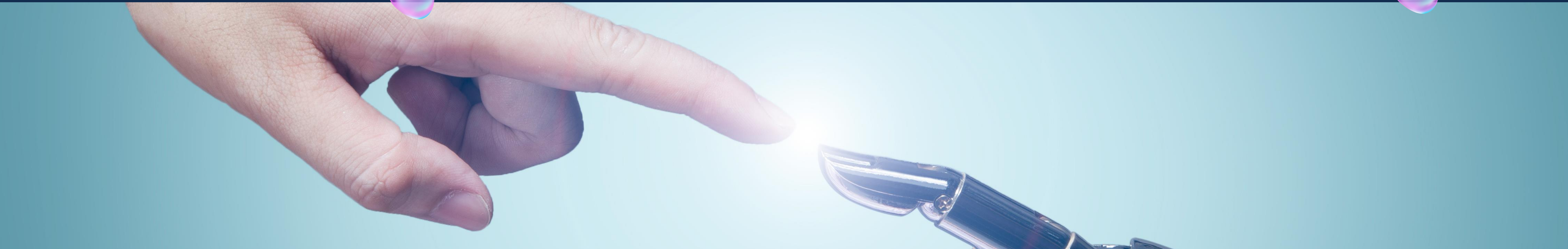
Technology: Combines AI, computer vision, and sensor fusion to track items customers pick up and automatically charge them when they leave.

How It Works: Vision systems and sensors detect when products are taken or returned to shelves, while machine learning models analyze this data to manage inventory and customer behavior.

The Power of Vision and Image Processing

- How vision systems interpret and analyze visual data in real-time.
- Advances in Deep Learning (DL) and Machine Learning (ML) in image processing.
- Benefits: Autonomous decision-making, improved efficiency, and higher accuracy.





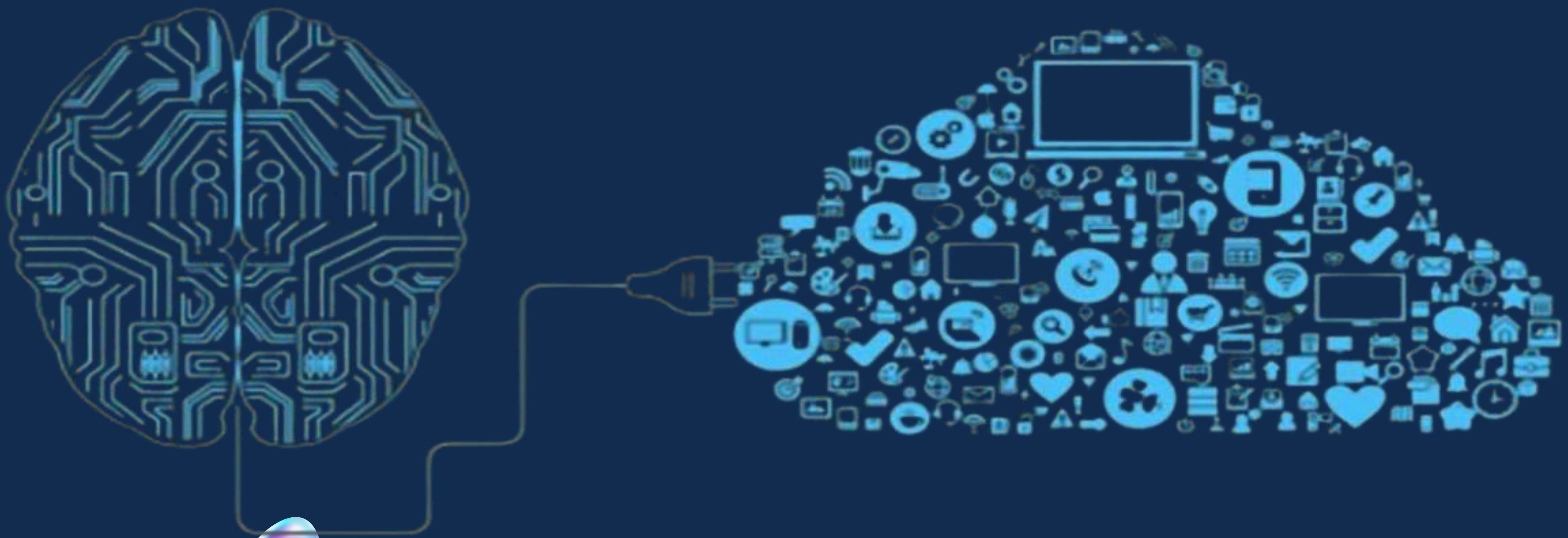
Vision-Based Navigation

Similar to Tesla vehicles, Optimus relies on multiple cameras and vision sensors to "see" its surroundings. It uses real-time image processing and depth perception to identify obstacles, people, and objects, helping it perform tasks accurately.

List of the vision system components

1. Multi-Camera Array
2. Depth Sensors (Stereo cameras or LiDAR)
3. Image Processing Unit
4. Object Recognition and Tracking
5. SLAM (Simultaneous Localization and Mapping)
6. Infrared (IR) and Low-Light Vision
7. Gesture and Facial Recognition
8. Self-Calibration System

ROLE OF IoT in Intelligent Vision System



ROLE OF IoT in Intelligent Vision System

Seamless Connectivity

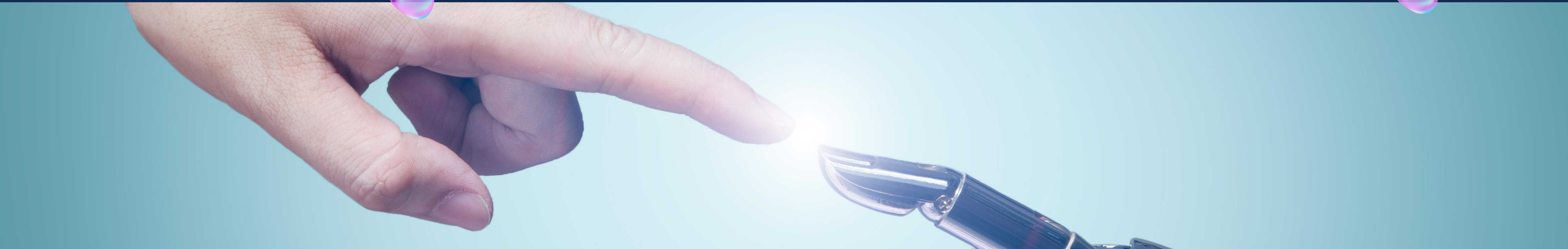
In smart manufacturing, cameras connected through IoT capture real-time data on assembly lines, and adjustments can be made instantly based on detected defects.

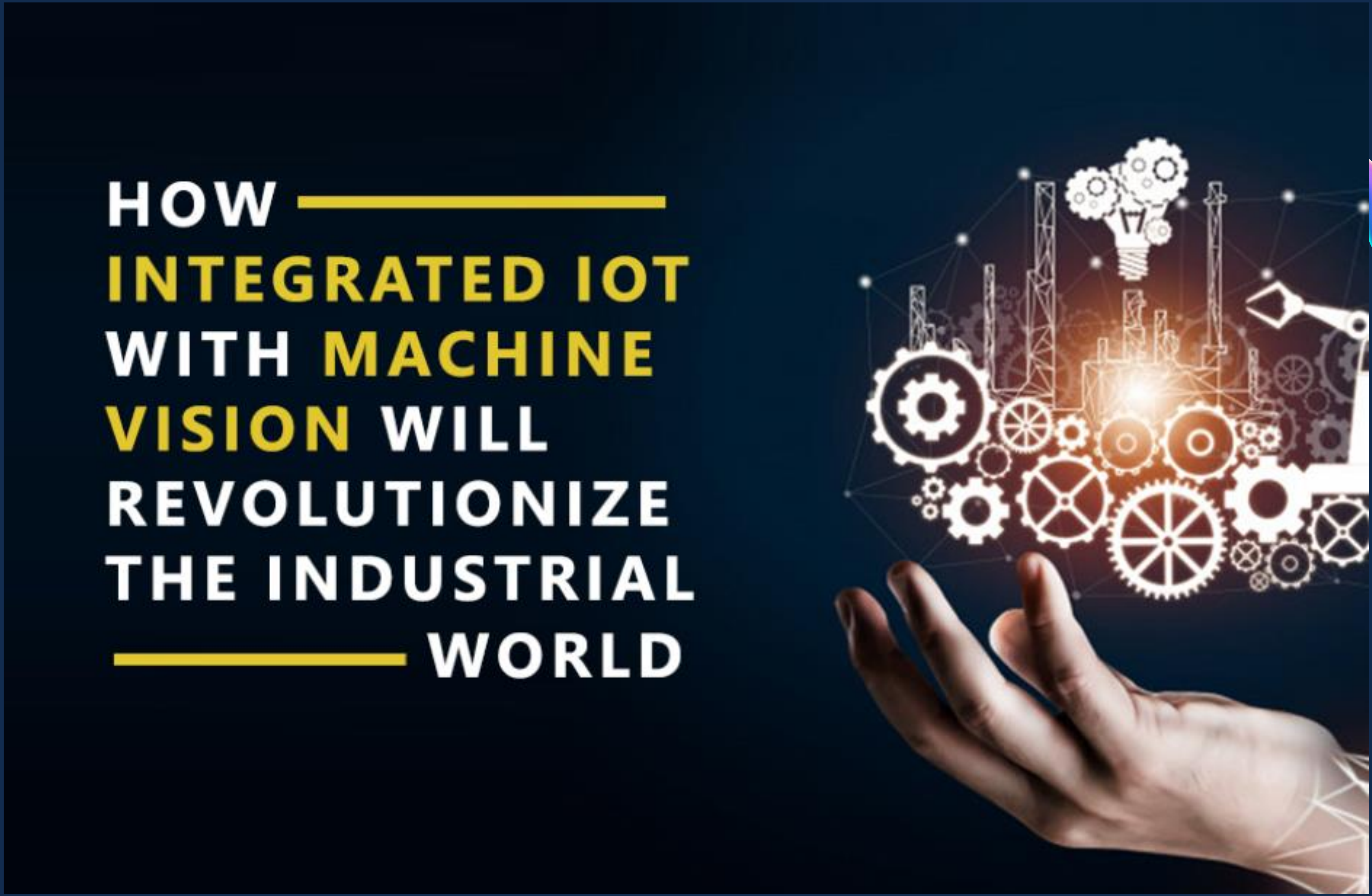
Real-Time Data Processing

With IoT-enabled vision systems, data can be sent to the cloud or edge computing devices where AI algorithms analyze it in real-time.

Enhanced Decision-Making and Insights

The combination of IoT and vision allows for data-driven decision-making by integrating additional data sources such as temperature, location, and other environmental factors




HOW
INTEGRATED IOT
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HOW INTEGRATED IOT WITH MACHINE VISION WILL REVOLUTIONIZE THE INDUSTRIAL WORLD

Machine Vision as Part of IIoT

- Machine vision systems are integral to IIoT, where the visual data captured by these systems serves as a sensor input. This visual data can be processed and transmitted over IoT networks, allowing for real-time monitoring and control of manufacturing processes.

Broader Sensing Capabilities

- Unlike traditional sensors that measure specific parameters, machine vision provides a wider sensing capability. It can detect a variety of visual cues like shape, color, and texture, making it applicable to multiple use cases, such as quality inspection, assembly verification, and object tracking.

Data Analysis and Machine Learning

- The rich data captured by machine vision systems can be fed into data analytics platforms. Through machine learning, this data can be analyzed to detect patterns, predict defects, and optimize processes, thereby improving decision-making and overall manufacturing efficiency.

THE EVOLUTION OF MACHINE VISION

Traditional Machine Vision

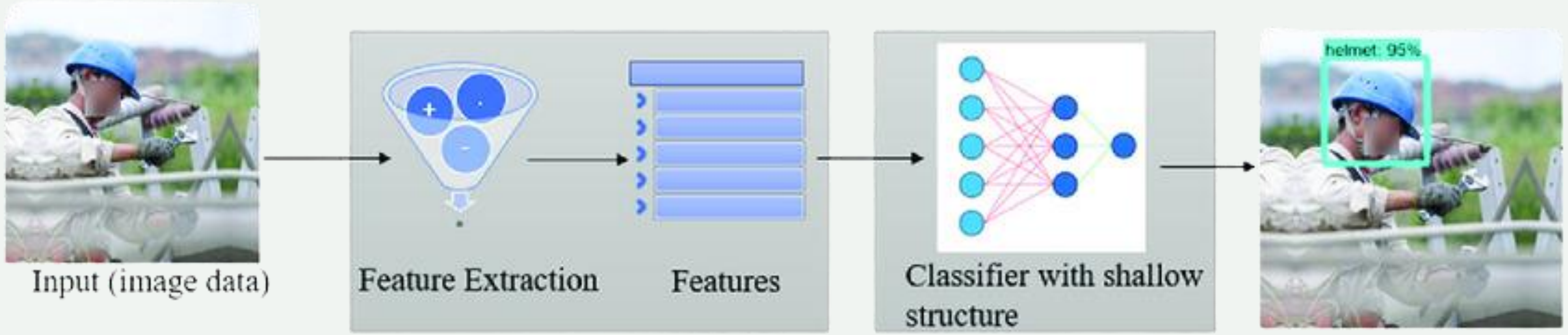
Modern Enhancements

Advancements in Camera Technology

Integration with Robotics and other applications

THE EVOLUTION OF MACHINE VISION

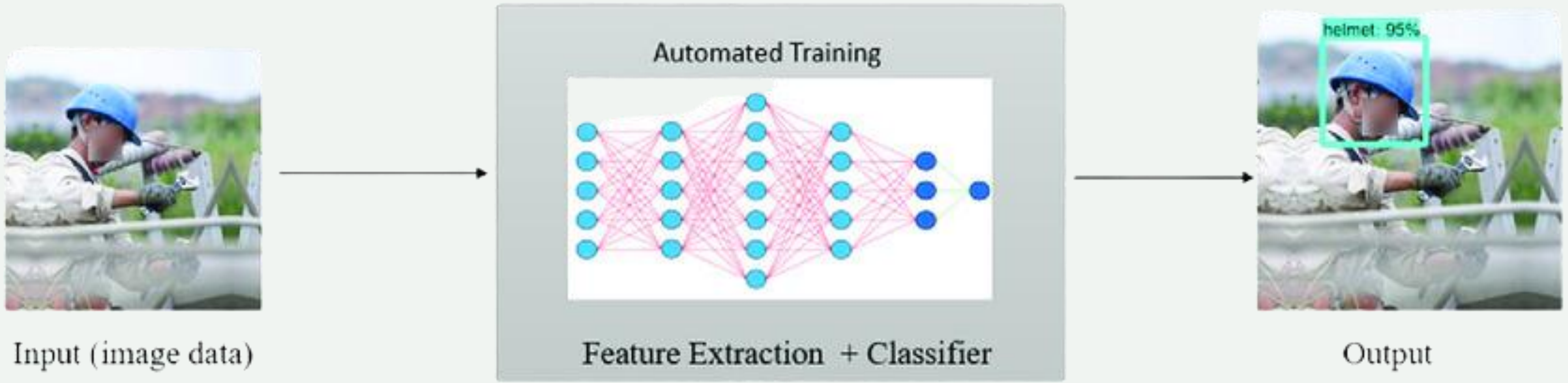
Traditional Machine Vision



(a)

THE EVOLUTION OF MACHINE VISION

Modern Enhancements



(b)

THE EVOLUTION OF MACHINE VISION

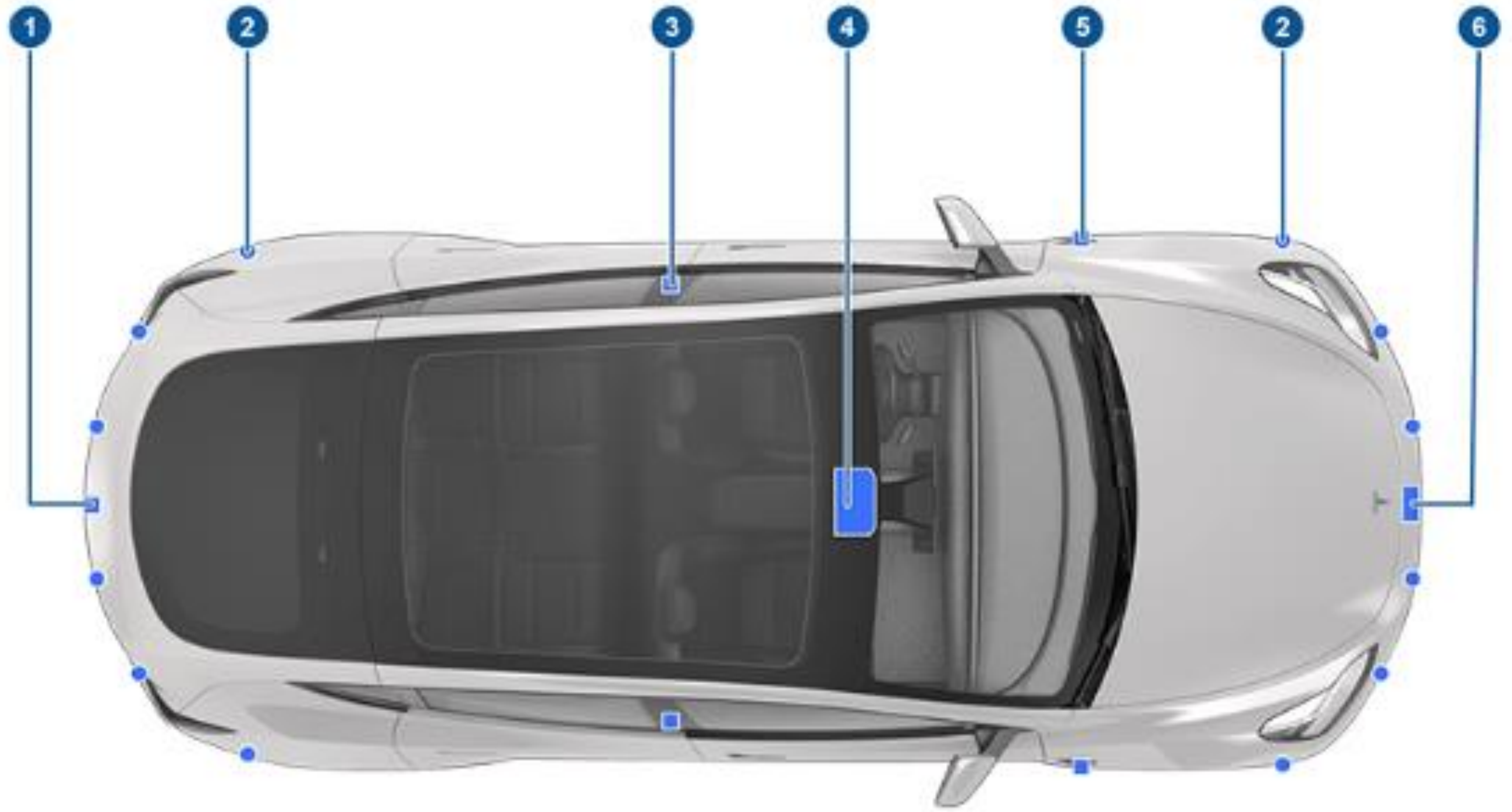
- Higher Resolution and Sensitivity - Captures finer details, improving inspection accuracy.
- Faster Processing Speeds - Enables real-time analysis and quicker decision-making.
- Enhanced Imaging Capabilities - Includes 3D, infrared, and multispectral imaging for broader applications.
- Improved Durability and Reliability - Withstands harsh environments for continuous operation.
- Smart Cameras with Integrated Processing - Reduces latency by processing data directly on the camera, boosting efficiency.

Advancements in Camera Technology

Rearward Looking Side Cameras
Max distance 100m
Wide Forward Camera
Max distance 60m
Main Forward Camera
Max distance 150m
Narrow Forward Camera
Max distance 250m
Rear View Camera
Max distance 50m
Forward Looking Side Cameras
Max distance 80m

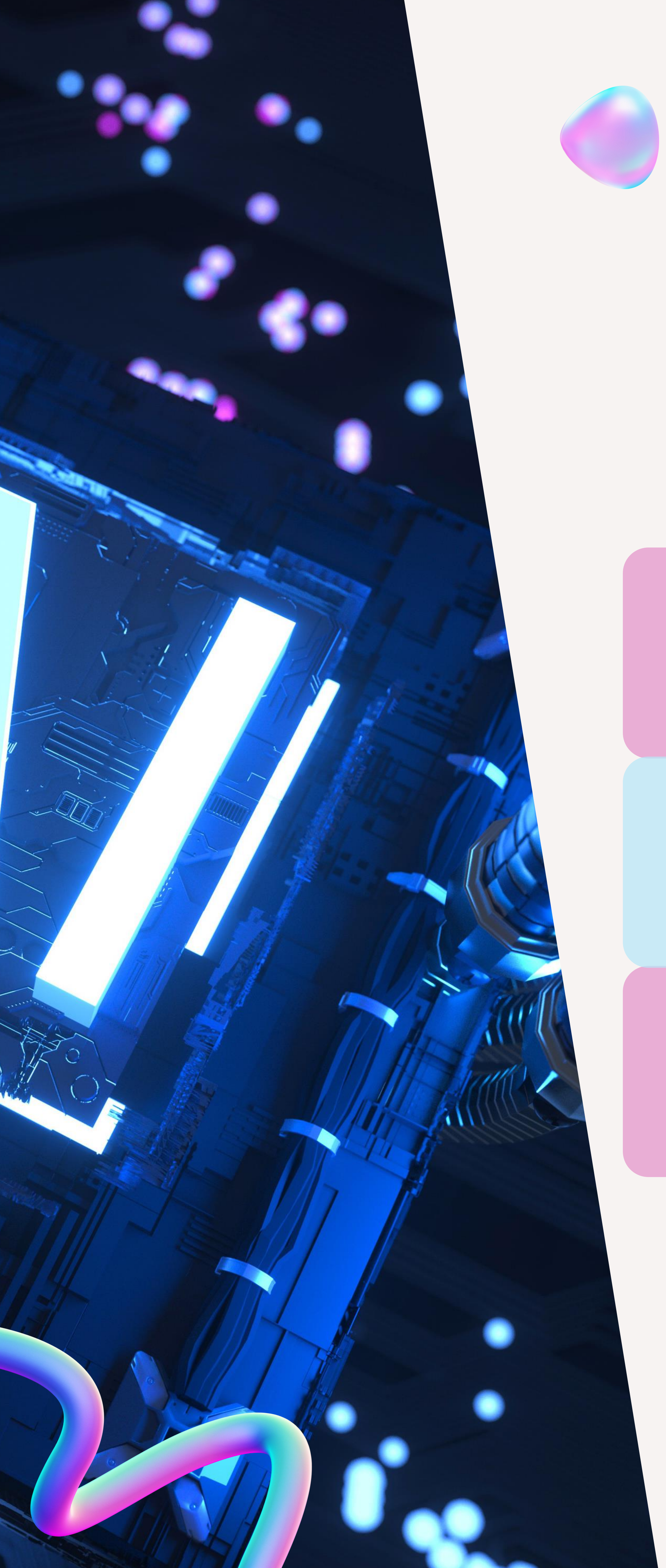
Cameras

Your Model Y includes the following components that actively monitor the surrounding area:



1. A camera is mounted above the rear license plate.
2. Ultrasonic sensors (if equipped) are located in the front and rear bumpers.
3. A camera is mounted in each door pillar.
4. Three cameras are mounted to the windshield above the rear view mirror.
5. A camera is mounted to each front fender.
6. Radar (if equipped) is mounted behind the front bumper.

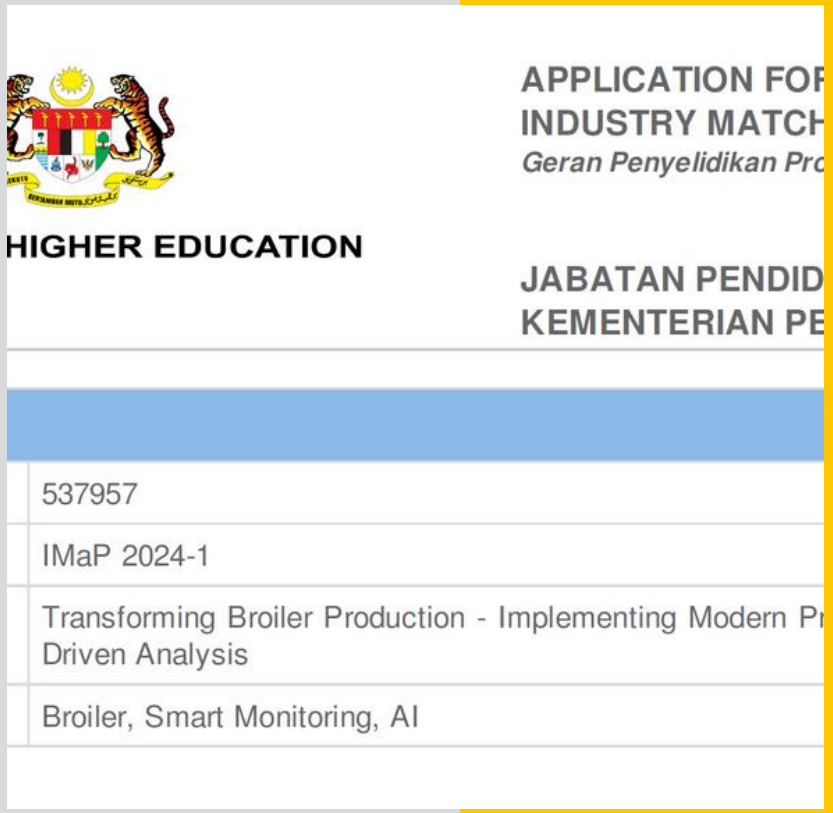
Model Y is also equipped with high precision electronically-assisted braking and steering systems.



AI AND DEEP LEARNING IN MACHINE VISION

AI-Driven Image Processing	refers to the use of artificial intelligence techniques, such as machine learning and deep learning, to analyze and interpret images.
Real-time data processing	involves the immediate analysis and response to data as it is generated
Deep Learning Techniques	Vision Transformers (ViTs) Convolutional Neural Networks (CNNs) Enhancements Generative Adversarial Networks (GANs) Self-Supervised Learning Attention Mechanisms

CASE STUDY - ENHANCING SME PRODUCTIVITY THROUGH SMART PROCESSES.


APPLICATION FOR
INDUSTRY MATCH
Geran Penyelidikan Pro

HIGHER EDUCATION

JABATAN PENDID
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537957
IMaP 2024-1
Transforming Broiler Production - Implementing Modern Pr Driven Analysis
Broiler, Smart Monitoring, AI

QUALITY INSPECTION OF ‘BISCUITWARE’

INDUSTRIAL GRANT

IMPROVING FISH FARM MANAGEMENT THROUGH AI AND DATA ANALYTICS

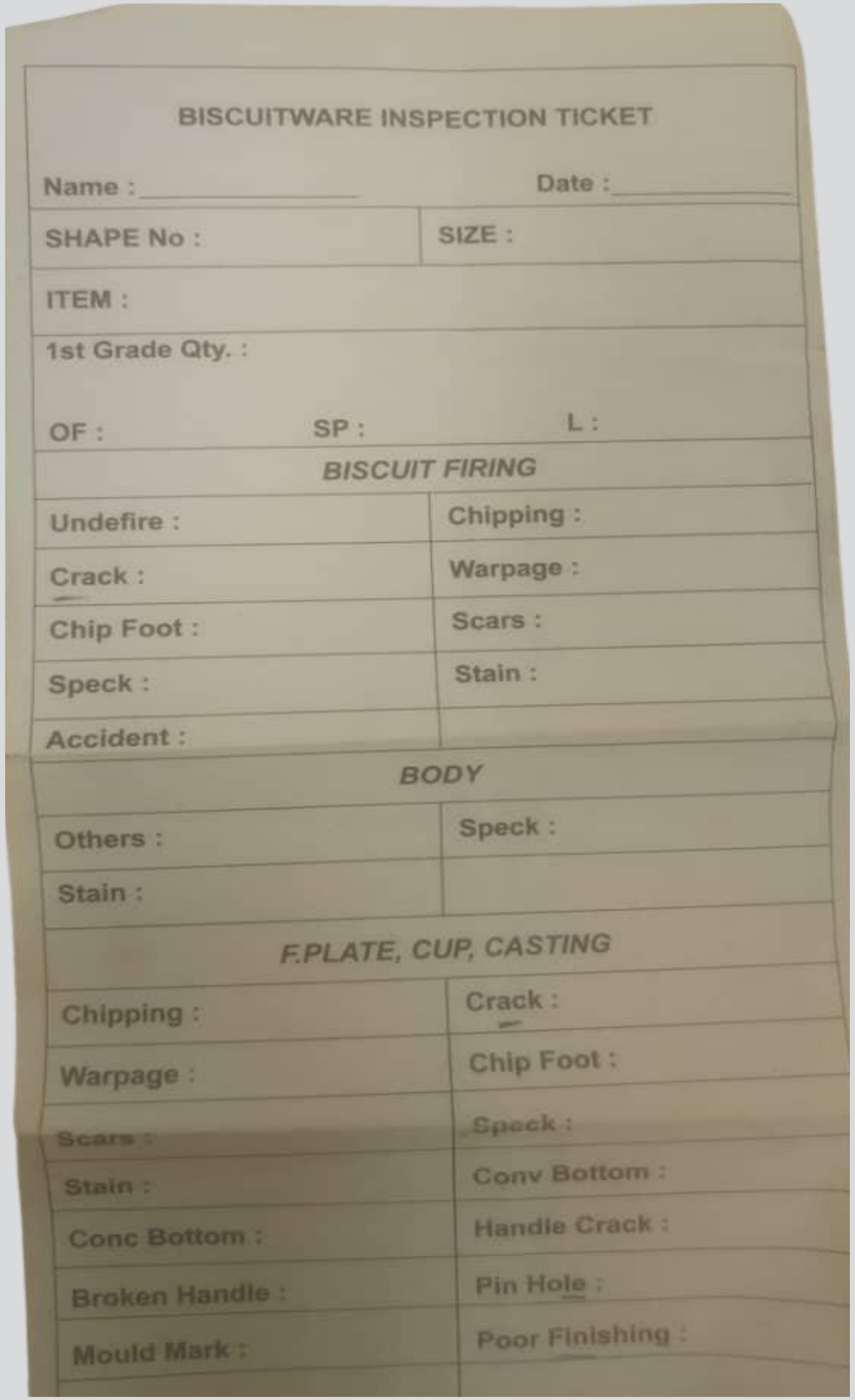
TRANSLATIONAL GRANT

SMART FARMING

Transforming Broiler Production - Implementing Modern Practices with Smart Monitoring and AIDriven Analysis - IMAP GRANT

QUALITY INSPECTION OF ‘BISCUITWARE’

Quality inspection of biscuitware currently requires 8 operators to inspect over 22 types of defects. By implementing a smart process, the number of operators can be reduced to 2, saving RM16,000 per month (RM2000 x 8) and RM192,000 annually. The investment can achieve ROI within 2 years.



BISCUITWARE INSPECTION TICKET

Name : ______________ Date : ______________

SHAPE No :	SIZE :
ITEM :	
1st Grade Qty. :	
OF : SP : L :	
BISCUIT FIRING	
Undefire :	Chipping :
Crack :	Warpage :
Chip Foot :	Scars :
Speck :	Stain :
Accident :	
BODY	
Others :	Speck :
Stain :	
F.PLATE, CUP, CASTING	
Chipping :	Crack :
Warpage :	Chip Foot :
Scars :	Speck :
Stain :	Conv Bottom :
Conc Bottom :	Handle Crack :
Broken Handle :	Pin Hole :
Mould Mark :	Poor Finishing :

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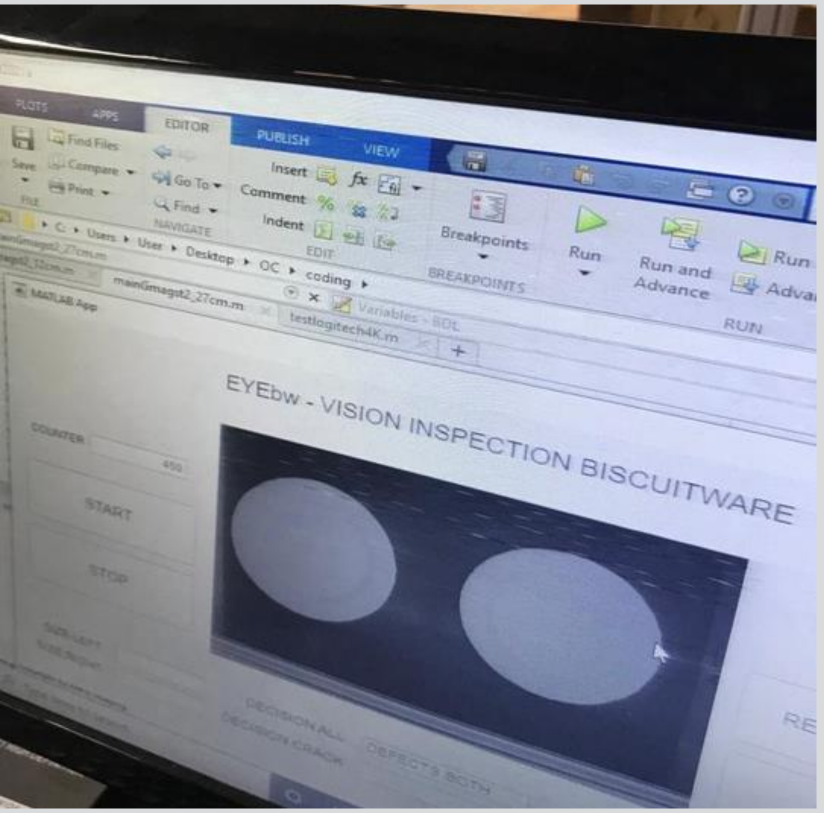

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- Traditional methods utilized MATLAB for processing.
- The program was converted into an .exe file for practical use.
- Preprocessing involved Region of Interest (ROI) selection.
- Pixel Analysis
  - Thresholding - Simple method to segment images by converting grayscale images to binary, separating cracks from the background.
  - Edge Detection - Techniques like Sobel or Canny edge detection were used to identify the boundaries of cracks.
- Detection sensitivity was refined to identify defects as small as 0.4mm.
- The method was tested on six specific types of defects.

QUALITY INSPECTION OF 'BISCUITWARE'

FUTURE OF MACHINE VISION

- IoT Integration - Deploy IoT sensors to monitor real-time data from the biscuit inspection process, capturing visual data for further analysis.
- Data Analysis - Utilize machine learning algorithms to analyze collected data, identifying patterns and improving defect detection accuracy.
- Real-Time Alerts - Implement IoT to trigger alerts for operators when defects are detected, enhancing the responsiveness of the inspection process.
- **Process Insights - Analyze defect types to trace back to specific departments; for example, detecting a crack may indicate an issue in the molding process, allowing targeted improvements.**
- Continuous Improvement - Use analytics to refine the defect detection model over time, improving the system's accuracy and efficiency based on the data collected.

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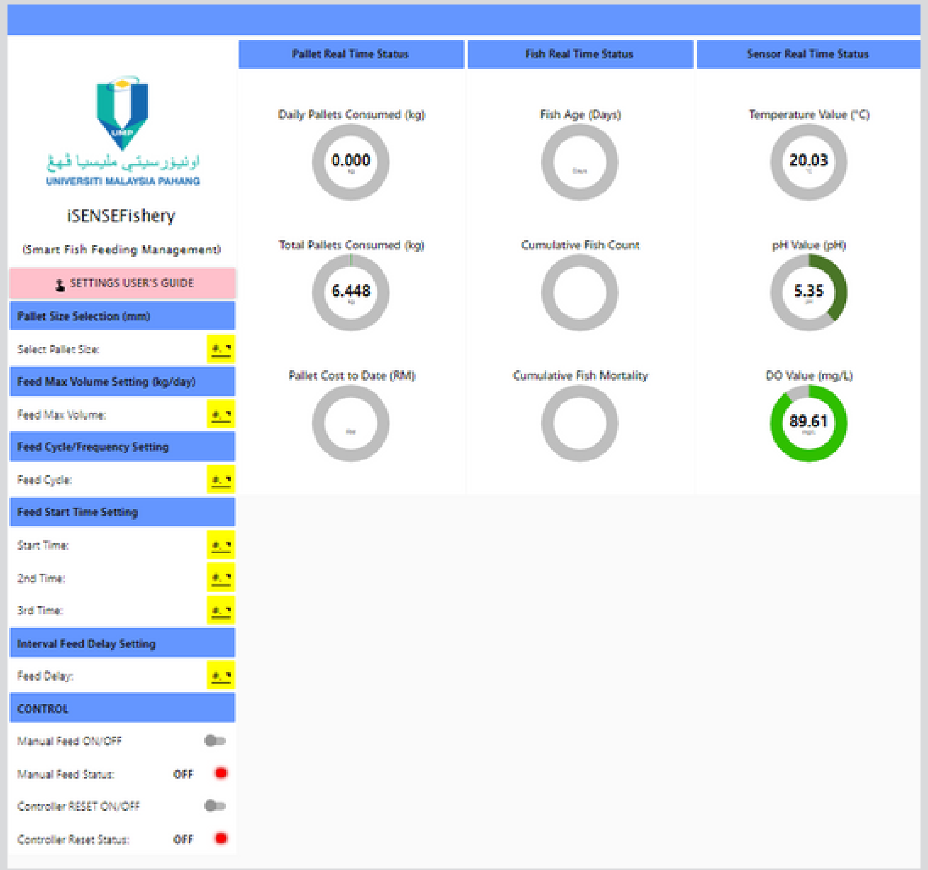
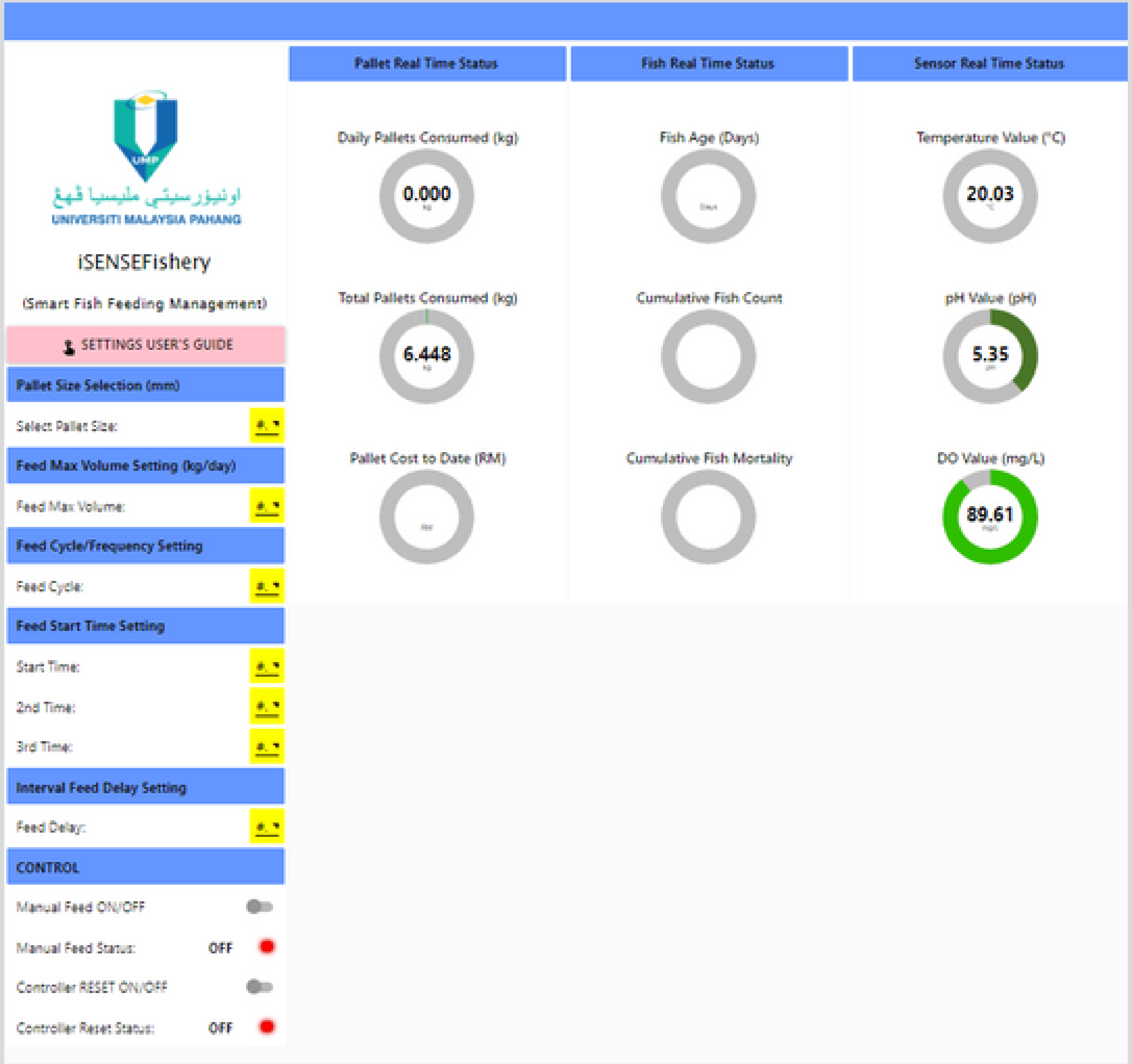


IMPROVING FISH FARM MANAGEMENT THROUGH AI AND DATA ANALYTICS

Smart fish farming uses AI and data analytics to optimize feeding by delivering food as needed, minimizing waste, and promoting healthier growth. The system collects data on water quality, fish mortality, and feeding patterns, which AI analyzes to monitor conditions and predict issues. This enables real-time adjustments, improving efficiency, reducing costs, and enhancing fish health and yields while ensuring sustainability.

Vision System with Deep Learning for Fish Behavior Detection

- Deep Learning-Powered Vision System. Uses cameras to monitor fish behavior in real-time.
- Behavior Detection - Analyzes visual data to identify when fish are active and ready to eat.
- Optimized Feeding - Adjusts feeding schedules based on detected behavior, reducing food waste.
- Improved Growth and Health - Ensures fish receive the correct amount of food, promoting better growth and overall health.
- Adaptive Learning - Continuously learns from fish behavior to improve feeding efficiency over time.



CASE STUDY - ENHANCING SME PRODUCTIVITY THROUGH SMART PROCESSES.

IMPROVING FISH FARM MANAGEMENT THROUGH AI AND DATA ANALYTICS

- Optimized Feeding - AI delivers food as needed, reducing waste and improving growth.
- Data Collection - Gathers data on water quality, fish mortality, and feeding patterns.
- AI Analysis - Analyzes collected data to monitor conditions and predict potential issues.
- Real-Time Adjustments - Enables immediate changes to improve efficiency and reduce costs.
- Enhanced Health and Yields - Promotes better fish health and higher yields while ensuring sustainability.

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FISH BEHAVIOR ANALYSIS USING DEEP LEARNING

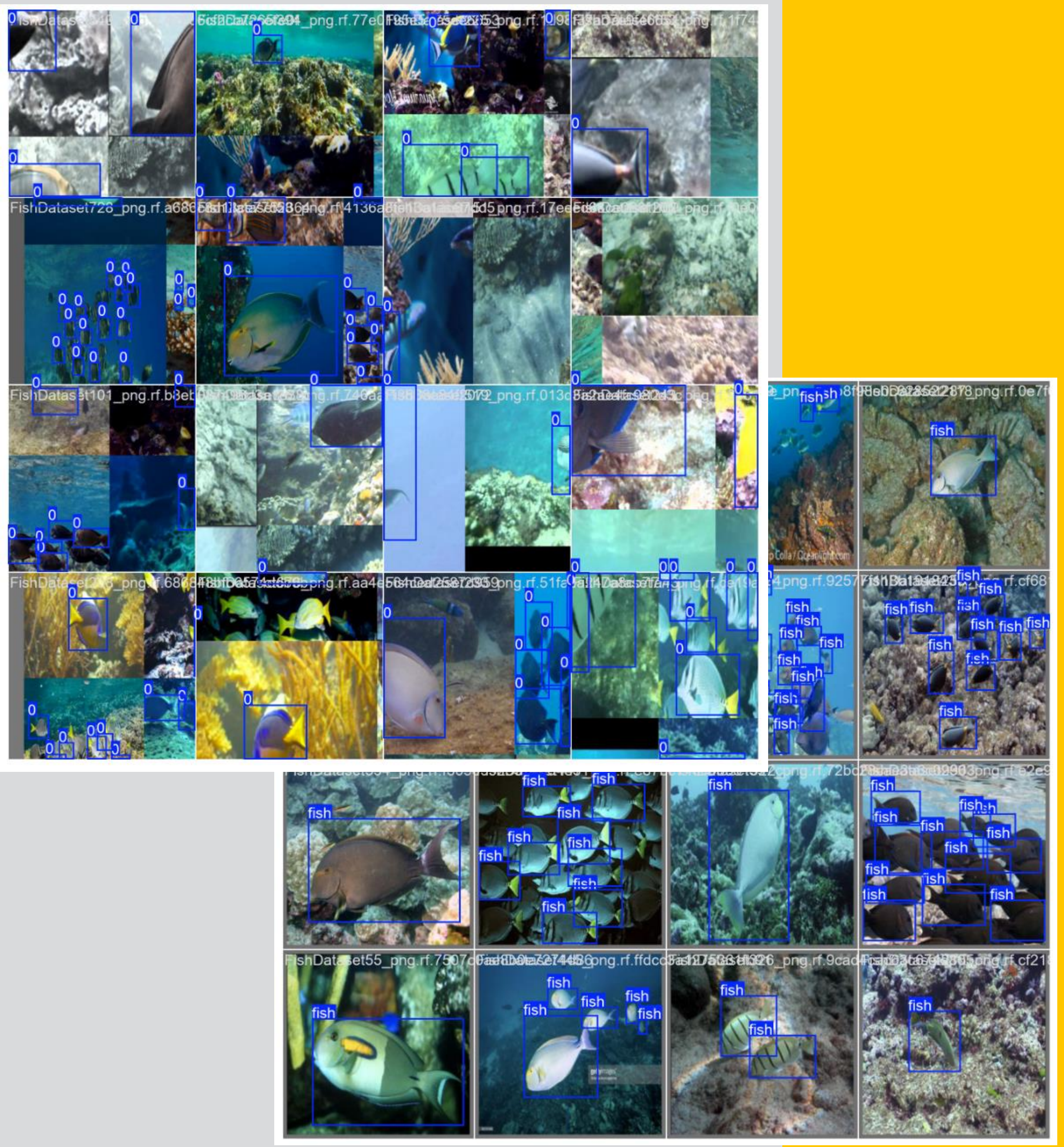
1.Convolutional Long Short-Term Memory (ConvLSTM) Networks

- Overview: ConvLSTM networks combine the spatial processing capabilities of Convolutional Neural Networks (CNNs) with the temporal processing capabilities of Long Short-Term Memory (LSTM) networks. This architecture is well-suited for tasks that involve both spatial and temporal dynamics, such as analyzing fish behavior over time.

2. 3D Convolutional Neural Networks (3D CNNs)

- Overview: 3D CNNs extend the traditional 2D CNNs by adding a third dimension (time) to the convolutional layers, making them suitable for processing video or volumetric data. This allows the network to capture temporal dynamics in addition to spatial features.

Vision System with Deep Learning for Fish Behavior Detection



EMPOWERING SMES WITH AI, DATA ANALYTICS, AND VISION SYSTEMS

SME IS BACKBONE OF ECONOMIES ACROSS THE WORLD

Small and medium-sized enterprises are the backbone of economies across the world, with the 1.15 million SMEs in Malaysia comprising more than 97 percent of the nation's businesses and delivering 38.2 percent of GDP.

When it comes to implementing new technologies like AI, Data Analytics, and Vision Systems, SMEs often face several dilemmas

- Cost and Financial Constraints
- Lack of Expertise and Skilled Workforce
- Uncertainty About ROI
- Integration with Existing Systems
- Resistance to Change

EMPOWERING SMES WITH AI, DATA ANALYTICS, AND VISION SYSTEMS

Implementing new technologies like AI, Data Analytics, and Vision Systems is crucial for SMEs to stay competitive in today's rapidly evolving market

- Enhance Efficiency - AI automates routine tasks, optimizing processes and reducing manual effort.
- Cost Reduction - New technologies streamline operations, lowering operational costs.
- Improve Product Quality - Vision systems ensure precise quality control, increasing customer satisfaction.
- Data-Driven Decision Making - Data analytics provides valuable insights, enabling informed decisions.
- Innovation and Growth - Adopting these technologies allows SMEs to innovate and stay competitive in a digital economy.
- Long-Term Success - Implementing AI, Data Analytics, and Vision Systems positions SMEs for sustainable growth and success.

AS RESEARCHERS, LET'S ENGAGE DIRECTLY WITH SME’S, LISTEN TO THEIR CHALLENGES, AND PROVIDE TAILORED SOLUTIONS. WE HAVE GOVERNMENT SUPPORT AVAILABLE TO FUND PROJECTS THAT ADDRESS THESE NEEDS.

Enhancing Operational Efficiency for SMEs through IoT, ML, and Data Analytics

This proposal aims to enhance the operational efficiency of four SME companies—GD AgroTrade, T Mobility, E-Circuitech, and Waterland Aquaculture—by integrating sensors, machine learning (ML), and data analytics. The project will leverage MIMOS's cloud and dashboard infrastructure to optimize processes, improve product quality, and reduce operational inefficiencies.

GD AgroTrade
Process: Fish pallet production (mixing, extruding, drying, packaging).
Challenges: Inconsistent drying quality, production downtime.
Focus: Optimize drying process via temperature control, real-time monitoring, and ML for anomaly detection.

TS Mobility
Process: Managing and renting buggies.
Challenges: Inefficient booking, vehicle breakdowns, poor service tracking.
Focus: Automate booking, track buggy usage, predictive maintenance via IoT and ML.

E-Circuitech
Process: PCB production (designing, printing, etching, drilling, assembling).
Challenges: Production errors, high waste rates.
Focus: Real-time defect detection with cameras, data collection, and ML for quality control.

Waterland Aquaculture`
Process: Fish fry production (breeding, hatching, rearing, harvesting).
Challenges: Inconsistent fry quality, high mortality rates.
Focus: Monitor water quality (pH, DO, temperature), real-time data collection, ML for optimal conditions.

Proposed Solution

IoT Integration:
- Install sensors for real-time monitoring (temperature, GPS, water quality).
- Implement automated booking and monitoring systems.

Data Analytics:
- Collect and analyze data to identify optimal conditions, predict trends, and detect anomalies.

Machine Learning:
- Develop predictive models for optimal settings, anomaly detection, and process optimization.

Budget Allocation

Infrastructure Design and Development (Sensors): RM30,000
IoT, MQTT, Dashboard, and Cloud (MIMOS Facilities): RM20,000
ML and Data Analytics: RM50,000
Total for Each SME: RM100,000

Benefits of Integrating AI, IoT, and Data Analytics

- Real-Time Decision Making: AI-enabled insights for instant adjustments.
- Efficiency and Cost Reduction: Automated processes reduce labor and operational costs.
- Data-Driven Insights: Continuous data collection for optimizing and refining processes.

THANK YOU