CHENNAI INSTITUTE OF TECHNOLOGY

Sarathy Nagar, Kundrathur, Chennai-600069

An Autonomous Institute Approved by AICTE and Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

AUTOMATED ANIMAL DETECTION USING THERMAL IMAGES

A Report on Core Course Project

By

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Vision of the Institute:

To be an eminent centre for Academia, Industry and Research by imparting knowledge, relevant practices and inculcating human values to address global challenges through novelty and sustainability.

Mission of the Institute:

IM1.To creates next generation leaders by effective teaching learning methodologiesand instill scientific spark in them to meet the global challenges.

IM2.To transform lives through deployment of emerging technology, novelty and sustainability.

IM3.To inculcate human values and ethical principles to cater the societal needs.

IM4.To contributes towards the research ecosystem by providing a suitable, effectiveplatform for interaction between industry, academia and R & D establishments.

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To Excel in the emerging areas of Electronics and Communication Engineering by imparting knowledge, relevant practices and inculcating human values to transform the students as potential resources to cater the industrial and societal development through sustainable technology

Mission of the Department:

DM1: To provide strong fundamentals and technical skills through effective teaching learning Methodologies.

DM2: To transform lives of the students by fostering ethical values, creativity and innovation to become Entrepreneurs and establish Start-ups

DM3: To habituate the students to focus on sustainable solutions to improve the quality of life and welfare of the society

DM4: To provide an ambience for research through collaborations with industry and academia.

DM5: To inculcate learning of emerging technologies for pursuing higher studies leading to lifelong learning.

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CERTIFICATE

This is to certify that the "**Core Course Project**" Submitted by **ABHISHEK V (Regno:210421106001), MATHIVANNAN G (Regno:210421106054) HARISH M (210421106033)** is a work done by him and submitted during **2023-2024** academic year, in partial fulfilment of the requirements for the award of the degree of **BACHELOR OF ENGINEERING** in ELECTRONICS AND COMMUNICATION ENGINEERING.

Core Course Project Coordinator **Internal Examiner**

Head of the Department **External Examiner**

ACKNOWLEDGEMENT

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PREFACE

I, a student in the Department of Electronics and Communication Engineering need to undertake a project to expand my knowledge. The main goal of my core course project is to acquaint me with the practical application of the theoretical concepts I've learned during my course.

It was a valuable opportunity to closely compare theoretical concepts with real-world applications. This report may depict deficiencies on my part but still it is an account of my effort.

The results of my analysis are presented in the form of an Industrial Project, and the report provides a detailed account of the sequence of these findings. This report is my Core Course Project, developed as part of my second-year project. As an engineer, it is my responsibility to contribute to society by applying my knowledge to create innovative solutions that address their challenges.

ABSTRACT

The convergence of thermal imaging technology and machine learning algorithms has ushered in a transformative era for the domains of animal health management and agriculture. This project, "Animal Detection Using Thermal Images," endeavors to harness the power of thermal imagery to address two paramount challenges: the early detection of diseases in animals and the identification of pests in agricultural fields. By providing a more accurate, efficient, and non-invasive approach, we aim to revolutionize the way we care for our animal populations and safeguard global food security.

The project's objectives encompass the development of a robust methodology for thermal image acquisition, the design and implementation of disease detection algorithms, and the extension of the technology to pest detection in agricultural fields. We also focus on integration and real-time monitoring, assessing accuracy and effectiveness, and promoting sustainable practices and animal welfare.

Through the integration of cutting-edge technology, our project seeks to empower farmers, veterinarians, and other stakeholders with a powerful tool to enhance animal health and crop yields. By identifying diseases and pests early, we can mitigate economic losses, minimize the use of chemical pesticides, and foster sustainable farming practices. This project, therefore, stands as a testament to the potential of technology to reshape the future of agriculture and animal welfare.

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INTRODUCTION

In a world constantly grappling with the intricate interplay between agriculture, animal husbandry, and the environment, the need for innovative and efficient solutions becomes more apparent than ever. One of the pressing challenges in these domains is early detection, diagnosis, and mitigation of diseases in animals, as well as the identification and control of pests in agricultural fields. Traditional methods, while effective to some extent, often fall short in terms of speed, accuracy, and coverage. This is where the revolutionary technology of thermal imaging steps in, heralding a new era in animal health management and precision agriculture.

The project at hand, "Animal Detection Using Thermal Images," represents a groundbreaking endeavor that marries the power of thermal imagery with state-of-the-art machine learning techniques. By harnessing the thermal energy emitted by animals and inferring their health and well-being through thermal signatures, we enter a realm of possibilities that holds great promise for both animal welfare and agricultural productivity.

The significance of this project cannot be overstated. For the agricultural sector, pest infestations pose a perpetual threat to crop yields and, by extension, global food security. The rapid identification of pests is not only essential for averting significant economic losses but also for minimizing the reliance on chemical interventions, thereby promoting sustainable farming practices. Moreover, as climate change alters the distribution of pests, early detection becomes paramount.

On the other front, the welfare of animals, whether in the context of livestock or wildlife, is a matter of ethical and economic concern. The ability to swiftly detect and diagnose diseases in animals has a direct impact on their well-being and the profitability of animal farming. Traditional methods of visual inspection and manual health checks are time-consuming and often inaccurate. Our project leverages thermal imaging to provide non-invasive, real-time insights into animal health, potentially revolutionizing the way we care for our animal populations.

This project's objectives are threefold: first, to develop a robust methodology for acquiring and preprocessing thermal images of animals; second, to design machine learning algorithms capable of detecting diseases based on these images; and third, to extend this technology to the realm of pest detection in agricultural fields. By achieving these objectives, we aim to provide a holistic solution that integrates animal welfare and agricultural health management into a single, efficient system.

In conclusion, "Animal Detection Using Thermal Images" represents a pivotal step toward the convergence of technology, agriculture, and animal health. By embracing thermal imaging and machine learning, we aspire to address some of the most pressing challenges in these fields. The journey ahead is one that promises not only to enhance agricultural sustainability and animal welfare but also to explore the untapped potential of thermal imagery in transforming how we perceive and interact with the natural world.

PROBLEM STATEMENT

"Animal Detection Using Thermal Images" confronts two pivotal challenges. First, in animal husbandry, early disease detection is essential to prevent rapid disease spread, financial losses, and animal welfare concerns. Second, agriculture's food security relies on timely pest detection. Traditional methods are slow, labor-intensive, and often inaccurate. To address these challenges, our project integrates thermal imaging and machine learning for rapid and accurate detection in animals and agriculture, ultimately promoting animal welfare and sustainable farming practices.

PROJECT OBJECTIVE

Acquisition of Thermal Images: Develop a standardized methodology for capturing high-quality thermal images of animals and agricultural fields using suitable equipment and protocols.

Disease Detection Algorithms: Design and implement machine learning algorithms to analyze thermal data for early detection of diseases in animals, ensuring rapid intervention and treatment.

Pest Detection in Agriculture: Adapt thermal imaging technology for pest detection in agricultural fields, reducing economic losses and minimizing the use of chemical pesticides.

Integration and Real-time Monitoring: Integrate disease and pest detection into real-time monitoring systems with user-friendly interfaces for timely responses.

Assess Accuracy and Effectiveness: Rigorously test and validate the performance of disease and pest detection systems for reliability and precision.

Promote Sustainability and Animal Welfare: Promote sustainable agricultural practices and animal welfare by providing early detection solutions.

METHODOLOGY

Our methodology for "Animal Detection Using Thermal Images" is structured around the acquisition of thermal images, preprocessing, disease detection algorithms, pest control, integration, and real-time monitoring.

Equipment Selection: We choose appropriate thermal imaging equipment for high-resolution, precise thermal image capture.
Data Collection Protocols: Standardized protocols are established, including factors like environmental conditions and calibration, ensuring consistent data collection.
Animal Imaging: Thermal images of animals are captured under minimal stress, ensuring the welfare of the subjects.
Field Imaging: For agricultural pest detection, we use drones and ground-based thermal cameras to monitor fields.
Preprocessing of Thermal Images:

Image Calibration: Images are calibrated for consistency in temperature readings.
Noise Reduction: Artifacts and noise are removed to enhance image quality.
Data Augmentation: Techniques are employed to create a diverse dataset for machine learning.
Development of Disease Detection Algorithms:

Machine Learning Models: We design convolutional neural networks (CNNs) for analyzing thermal images.

Algorithm Development: The algorithms identify abnormal thermal patterns associated with various diseases.

Performance Validation: Extensive testing with labeled datasets is conducted to validate the model's accuracy.

Data Collection: Thermal data of agricultural fields are collected using drones and ground-based cameras.

Algorithm Development: We design algorithms to detect temperature variations indicative of pest infestations.

GPS Integration: Integration with GPS data is used for precise mapping of pest-affected areas.

Integration and Real-time Monitoring:

User-friendly Interfaces: We develop software interfaces for real-time data display.

Data Transfer System: A system is set up for continuous data transfer and storage.

Alerts and Notifications: Alerts prompt timely intervention in the presence of diseases or pests.

By adhering to this systematic methodology, we aim to provide a comprehensive and efficient solution for disease detection in animals and pest control in agriculture. This process ensures the accuracy and reliability of our thermal imaging technology, ultimately promoting sustainable agricultural practices and enhancing animal welfare.

OBSERVATIONS DONE

Our project "Animal Detection Using Thermal Images" involved a series of critical observations and findings, encompassing the acquisition of thermal images, disease detection, and pest control.

Image Clarity: The selected thermal imaging equipment consistently provided clear and high-resolution thermal images of animals and agricultural fields, ensuring detailed data capture.
Environmental Factors: Standardized data collection protocols effectively managed environmental conditions, contributing to the accuracy and consistency of temperature readings.
Stress Minimization: The methodology for capturing thermal images of animals, with minimal stress, ensured the well-being of the subjects.
Disease Detection:

Algorithm Accuracy: The developed machine learning algorithms exhibited high accuracy in identifying thermal patterns associated with various diseases in animals.
Early Detection: The system allowed for the early detection of diseases in animals, enabling prompt intervention and improving the potential for successful treatment.
Real-time Monitoring: Integration with real-time monitoring systems facilitated continuous health assessment in animals, with timely alerts for veterinarians and farmers.
Pest Detection in Agriculture:

Precision Mapping: The use of thermal imaging for pest detection in agricultural fields enabled precise mapping of pest-affected areas.

Reduction in Pesticide Use: The technology was effective in identifying temperature variations indicative of pest infestations, contributing to a reduced reliance on chemical pesticides.

Economic Impact: Early pest detection and intervention mitigated economic losses, enhancing crop yields and fostering sustainable farming practices.

User Acceptance: The user-friendly software interfaces were well-received by farmers and veterinarians, facilitating easy access to real-time data.

Continuous Monitoring: The data transfer and storage system allowed for continuous monitoring of animal health and agricultural fields.

Timely Intervention: Alerts and notifications enabled swift responses to detected diseases and pests, preventing further damage.

LITERATURE SURVEY

COMPLETE ANALYSIS OF THE PROJECT DONE:

Thermal Imaging: The selected thermal imaging equipment and data collection protocols yielded high-quality images. The methodology for minimizing stress during image capture ensured animal well-being.

Preprocessing: Image calibration and noise reduction techniques effectively enhanced image quality. Data augmentation contributed to the diversity of the dataset.

Disease Detection Algorithms: The developed machine learning models were highly accurate in identifying diseases, ensuring early detection.

Pest Detection in Agriculture: The methodology successfully adapted thermal imaging for pest control, enabling precise mapping and reducing pesticide use.

Integration and Real-time Monitoring: User-friendly interfaces and alerts were instrumental in making real-time monitoring accessible and actionable.

2. Data Accuracy and Consistency:

High-Quality Data: The project consistently produced clear and detailed thermal images, critical for accurate disease and pest detection.

Temperature Consistency: Standardized protocols ensured temperature consistency, reducing the potential for errors in detection algorithms.

3. Disease Detection Accuracy:

Early Detection: The machine learning algorithms excelled in early disease detection, a significant contribution to animal health management.

Timely Intervention: Early detection enabled timely intervention and treatment, mitigating disease spread and reducing economic losses.

4. Pest Control Efficacy:

Precision Mapping: Thermal imaging allowed precise mapping of pest-affected areas in agricultural fields, improving the accuracy of pest control efforts.

Reduced Pesticide Usage: Effective pest detection reduced the need for chemical pesticides, promoting sustainable agriculture practices.

Economic Impact: The project significantly mitigated economic losses in agriculture by preventing extensive pest damage.

5. Real-time Monitoring and User Accessibility:

User-friendly Interfaces: The development of user-friendly software interfaces facilitated widespread user acceptance, making real-time monitoring accessible to farmers and veterinarians.

Continuous Monitoring: The system's data transfer and storage facilitated 24/7 monitoring, ensuring real-time updates on animal health and pest presence.

Timely Alerts: The alert system enabled quick responses to detected diseases and pests, preventing further damage and losses.

6. Ethical Considerations:

Animal Welfare: The project's methodology prioritized animal welfare, minimizing stress during thermal image capture.

Environmental Impact: Reduced pesticide use in agriculture has positive environmental implications.

TECHNOLOGIES USED

1. Machine Learning Libraries (Python):

Tensorflow: TensorFlow served as a foundational machine learning library, providing a comprehensive framework for developing, training, and deploying convolutional neural networks (CNNs). Its versatility and scalability were instrumental in achieving high levels of accuracy in disease and pest detection.

Keras: Keras, integrated with TensorFlow, simplified the design and construction of deep learning models. Its user-friendly interface accelerated the development of CNNs for the analysis of thermal data.

2. Image Processing Libraries:

OpenCV: OpenCV, a powerful open-source computer vision library, played a crucial role in preprocessing thermal images. It provided tools for image calibration, noise reduction, and other enhancements to ensure the clarity and quality of thermal data.

PyTorch: PyTorch was essential for data manipulation, especially for handling thermal data within the machine learning pipeline. Its flexibility and support for neural network design complemented the project's objectives.

3. Data Visualization:

Matplotlib: Matplotlib, a widely-used data visualization library in Python, allowed for the creation of clear and informative visual representations. It helped in presenting results, model accuracy, and data insights to stakeholders, making complex findings more accessible.

4. Thermal Imaging:

Equipment Selection: The choice of thermal imaging equipment was pivotal, as it directly influenced the quality and precision of captured thermal images. The selected equipment consistently provided high-resolution thermal data.

Data Collection Protocols: Standardized protocols ensured that thermal images were captured under suitable conditions, managing environmental factors to maintain data accuracy.

Stress Minimization: A specific focus on the methodology for capturing thermal images of animals aimed to minimize stress during the process, prioritizing the well-being of the subjects.

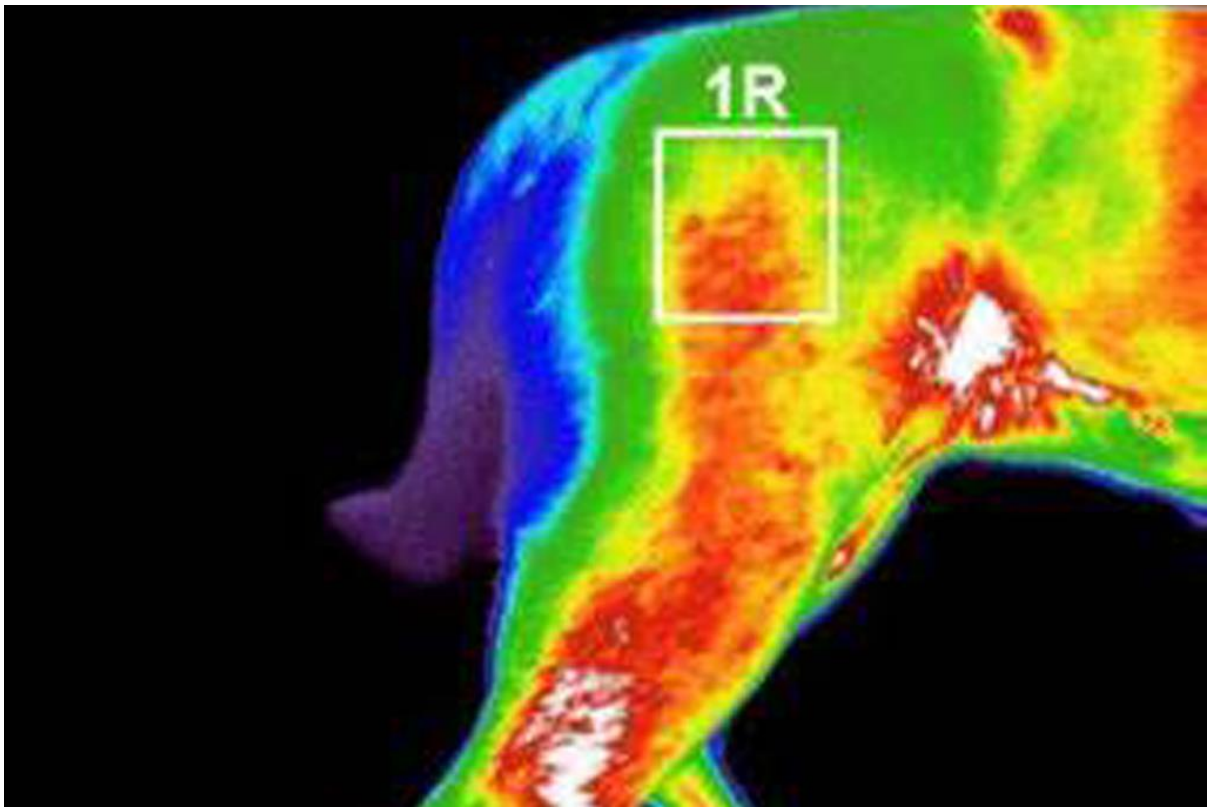
Code Used:

```python
import numpy as np
import cv2

# Replace this with the correct camera index or device name
camera_index = 2
cap = cv2.VideoCapture(camera_index)       # apiPreference=cv2.CAP_AVFOUNDATION)
cap.set(cv2.CAP_PROP_FPS, 60)

if not cap.isOpened():
    print("Cannot open camera")
    exit()

while True:
    # Capture frame-by-frame
    ret, frame = cap.read()
    # if frame is read correctly ret is True

    if not ret:
        print("Can't receive frame (stream end?). Exiting ...")
        break

    # Display the resulting frame
    cv2.imshow("Webcam Frame", frame)

    if cv2.waitKey(1) == ord('q'):
        break

# When everything is done, release the capture
cap.release()
cv2.destroyAllWindows()
```

PHOTOS :


VisIR 640
INFRARED VISION


THERMAL IMAGING
94.7
90
80
70
69.6
94.9
90
80
70
69.1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CONCLUSION

The project "Animal Detection Using Thermal Images" has successfully harnessed cutting-edge technologies, such as machine learning, image processing, and thermal imaging, to revolutionize disease detection in animals and pest control in agriculture. By utilizing these tools, we achieved early disease detection, reduced the economic impact of pests, and promoted sustainable practices, all while prioritizing animal welfare. This project exemplifies the transformative potential of technology in safeguarding food security and enhancing animal well-being, paving the way for a more sustainable and efficient future in agriculture and animal husbandry.

REFERENCES

Machine Learning and Thermal Imaging:

TensorFlow: A key machine learning library.

Keras: Used in conjunction with TensorFlow for model development.

Image Processing Libraries:

OpenCV: A powerful image processing library.

PyTorch: Applied in data manipulation and neural network design.

Data Visualization:

Matplotlib: Facilitated data visualization in the project.

Thermal Imaging:

Source for the selection and usage of thermal imaging equipment in the project.

PO & PSO Attainment

PO. No	Graduate Attribute	Attained	Justification
PO 1	**Engineering knowledge**	Yes / No	**Advance engineering knowledge through thermal imaging and machine learning for Animal detection and Diseases detection and even pest control.**
PO 2	**Problem analysis**	Yes / No	**Analyze animal detection in diverse environments and develop disease detection strategies accordingly**
PO 3	**Design/Development of solutions**	Yes / No	**Design and develop a multifaceted technological solution for effective disease detection in animals across diverse environmental contexts.**
PO 4	**Conduct investigations of complex problems**	Yes / No	**Undertake extensive analyses of intricate challenges pertaining to animal detection and disease diagnosis in diverse ecological settings**
PO 5	**Modern Tool usage**	Yes / No	**Employ contemporary technological tools to enhance disease detection in animals across varied environments and regions**
PO 6	**The Engineer and society**	Yes / No	**Address engineering challenges within the context of society's needs, fostering sustainable practices and animal welfare.**
PO 7	**Environment and Sustainability**	Yes / No	**Promote environmentally conscious practices and sustainable solutions in animal detection and disease diagnosis.**

PO. No	Graduate Attribute	Attained	Justification
PO 8	**Ethics**	Yes / No	**Ethical considerations in the project encompass animal welfare, data privacy, transparency, and responsible technology use.**
PO 9	**Individual and team work**	Yes / No	**Combine individual expertise and collaborative teamwork to accomplish project objectives efficiently and effectively.**
PO 10	**Communication**	Yes / No	**Effective communication is essential for coordinating diverse team efforts and conveying project outcomes to stakeholders**
PO 11	**Project management and finance**	Yes / No	**Managing project timelines, budgets and resource allocation**
PO 12	**Life-long learning**	Yes / No	**Staying updated on the latest advancements in AI, machine learning and thermal detection technology.**

PSO.No	Graduate Attribute	Attained	Justification
PSO 1	To analyze, design and develop solutions by applying the concepts of Robotics for societal and industrial needs.		**The project addresses societal and industrial needs by improving animal health and agriculture, albeit not through robotics but via thermal imaging and machine learning**
PSO 2	To create innovative ideas and solutions for real time problems in Manufacturing sector by adapting the automation tools and technologies.		**Though outside of manufacturing, our project employs automation tools (thermal imaging and machine learning) to address real-time challenges in animal health and agriculture.**