<u>Annexure3b- Complete filing</u>

<u>INVENTION DISCLOSURE FORM</u>

Details of Invention for better understanding:

1. TITLE: ThermalEye.

INTERNAL INVENTOR(S)/ STUDENT(S):

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3. DESCRIPTION OF THE INVENTION:

The invention, tentatively titled "ThermalSense IoT," integrates the advanced MLX90640 infrared thermal sensor into an Internet of Things (IoT) framework, revolutionizing how we perceive and interact with our surroundings. This innovative project harnesses the power of IoT technology to provide real-time thermal imaging data for various applications.

At its core, ThermalSense IoT utilizes the MLX90640 sensor's high resolution and accuracy to capture detailed thermal images of objects and environments. These images are then processed and transmitted via IoT connectivity, allowing users to remotely monitor and analyze temperature variations in different scenarios.

One key aspect of this invention is its versatility. Whether deployed in industrial settings for predictive maintenance, in healthcare for monitoring body temperature, or in smart homes for energy efficiency, ThermalSense IoT offers a customizable solution to suit diverse needs.

Moreover, the project emphasizes user-friendliness and accessibility. Through intuitive interfaces and cloud-based platforms, individuals and businesses can easily access and interpret thermal data, enabling informed decision-making and enhancing operational efficiency.

Overall, ThermalSense IoT represents a significant leap forward in thermal imaging technology, offering a scalable and adaptable solution for a wide range of industries and applications.

A. PROBLEM ADDRESSED BY THE INVENTION:

Limited Accessibility to Thermal Imaging Technology: Traditional thermal imaging systems are often expensive and require specialized equipment and expertise, limiting their accessibility to certain industries or applications. By integrating the MLX90640 sensor into an IoT framework, the invention makes thermal imaging technology more accessible to a wider range of users.

Sr. No.	Patent I'd	Abstract	Research Gap	Novelty
1	[10.1049/cp.2010.0521](10.1049/cp.2010.0521)	Measuring room occupancy has always been a desirable endeavour. This could be for security reasons, to save energy or simply for	Despite the widespread adoption of the MLX90640 sensor for thermal imaging applications, there remains a research gap in understanding its performance and	The novelty of this research lies in the development of a novel algorithm for enhancing the performance and accuracy of the MLX90640 sensor in dynamic environmental conditions. Unlike existing studies that primarily focus on controlled laboratory settings or

		statistical reasons. Recently the use of thermal imaging systems in this area has increased as these systems became cheaper and therefore more attractive. This paper investigates room occupancy measurement using a low resolution (16×16 pixel) infrared camera. After giving a short overview of application areas, the chosen people detection algorithm is outlined. This includes the introduction of a novel method for blob classification, using morphological area adjustment.	accuracy in dynamic and uncontrolled environmental conditions, particularly in scenarios with rapid temperature changes or varying ambient conditions.	stable environmental conditions, this research addresses the critical need for reliable thermal imaging in real-world scenarios with rapid temperature changes, varying ambient conditions, and dynamic events.
2	10.1109/SmartTechCon57526.2023.10391373	Leaf temperature provides valuable information about the water status of the plant. A leaf temperature monitoring system will offer potential benefits in precision agriculture. This paper presents an implementation of low-cost cameras, namely MLX90640 and AMG8833, for monitoring the leaf	Despite the widespread adoption of the MLX90640 sensor for thermal imaging applications, there remains a research gap in understanding its performance and accuracy in dynamic and uncontrolled environmental conditions, particularly in scenarios with rapid temperature changes or varying ambient conditions.	The novelty of this research lies in the development of a novel algorithm for enhancing the performance and accuracy of the MLX90640 sensor in dynamic environmental conditions. Unlike existing studies that primarily focus on controlled laboratory settings or stable environmental conditions, this research addresses the critical need for reliable thermal imaging in real-world scenarios with rapid temperature changes, varying ambient conditions, and dynamic events.

		temperature. The low-cost camera is connected to a Raspberry Pi Zero W, a tiny single-board computer that performs the data processing and interfacing to the ThingSpeak IoT platform. The experimental results show that even though the AMG8833 has a low resolution of 8×8 pixels, it can be used to measure the leaf temperature, similar to the MLX90640, whose resolution is 32×24 pixels. The AMG8833 achieves a refresh rate of 26.57 fps, very fast than the MLX90640, which achieves 2.10 fps. Moreover, three thresholding algorithms, Otsu, Yen, and Mean thresholding work properly to separate the leaf from the background. Thus the leaf and background temperature can be defined easily.		
3	[10.23919/CCC50068.2020.9188721](10.23919/CCC50068.2020.9188721)	This project is based on DSPTMS320C6748 as the core control of the intelligent air cooling radiator	Despite the widespread adoption of the MLX90640 sensor for thermal imaging applications, there remains a research gap	The novelty of this research lies in the development of a novel algorithm for enhancing the performance and accuracy of the MLX90640 sensor in dynamic environmental conditions. Unlike

		system. The purpose is to solve the problem of high energy consumption, non-intelligence and uneven heat dissipation in the traditional way of heat dissipation. For this reason, we proposed to take DSP as the control core. The main reason for choosing DSP chip is its fast processing speed and the physical property of multi-stage pipeline, so that the system can respond more quickly and accurately. The sensor is MLX90640 pyroelectric infrared temperature sensor. The sensor can obtain the temperature of 32x24 points, thus forming a lattice temperature distribution image. When the environment is abnormal, the processor makes corresponding response and controls the speed of the dc motor and the moving direction of the steering gear by controlling the duty cycle of PWM square wave output.	in understanding its performance and accuracy in dynamic and uncontrolled environmental conditions, particularly in scenarios with rapid temperature changes or varying ambient conditions.	existing studies that primarily focus on controlled laboratory settings or stable environmental conditions, this research addresses the critical need for reliable thermal imaging in real-world scenarios with rapid temperature changes, varying ambient conditions, and dynamic events.

Remote Monitoring and Analysis: Many industries require real-time monitoring and analysis of temperature variations across different environments. Conventional methods may involve manual measurements or periodic inspections, which are time-consuming and less efficient. The invention enables remote monitoring and analysis of thermal data, allowing for proactive decision-making and predictive maintenance strategies.

Data Interpretation Complexity: Interpreting thermal imaging data can be complex and require specialized knowledge. The invention addresses this challenge by providing user-friendly interfaces and cloud-based platforms that facilitate data visualization and analysis, making thermal information more understandable and actionable for users across various industries.

Integration with IoT Ecosystems: Incorporating thermal imaging technology into existing IoT ecosystems can be challenging due to compatibility issues and integration complexities. The invention offers seamless integration with IoT frameworks, ensuring interoperability and scalability for diverse applications and use cases.

Overall, the invention addresses the need for affordable, accessible, and user-friendly thermal imaging solutions that can empower industries to enhance efficiency, safety, and decision-making processes.

B. OBJECTIVE OF THE INVENTION :

Enhanced Monitoring Capabilities: The primary objective of the invention is to enable enhanced monitoring capabilities through real-time thermal imaging. By integrating the MLX90640 sensor into an IoT framework, the invention aims to provide users with a reliable and scalable solution for monitoring temperature variations across diverse environments. This includes applications such as industrial equipment monitoring, building energy management, and healthcare monitoring.

Facilitating Predictive Maintenance: Another key objective is to facilitate predictive maintenance strategies by leveraging the capabilities of thermal imaging technology. By continuously monitoring temperature variations and identifying potential issues before they escalate, the invention aims to help industries reduce downtime, minimize maintenance costs, and prolong the lifespan of critical equipment. This objective aligns with the growing demand for predictive maintenance solutions in various sectors, including manufacturing, utilities, and transportation.

C. STATE OF THE ART/ RESEARCH GAP/NOVELTY:

C. DETAILED DESCRIPTION:

A detailed description in a patent serves as a comprehensive guide to the invention's technical aspects, providing clarity and specificity to patent examiners and potential users or investors. Here's what it typically includes:

Technical Components: The detailed description outlines the technical components of the invention, including the MLX90640 sensor, IoT connectivity modules, and any additional hardware or software components necessary for its operation. It explains how these components interact with each other to achieve the desired functionality.

Operating Principle: It elucidates the operating principle of the invention, detailing how the MLX90640 sensor captures thermal images, how the data is processed, and how it is transmitted via IoT connectivity. This section may include flow diagrams, block diagrams, or other visual aids to illustrate the process.

Integration with IoT Framework: The description explains how the invention integrates with IoT frameworks, highlighting any protocols, communication standards, or compatibility requirements. It may also discuss how the invention interacts with existing IoT ecosystems and devices.

Data Processing and Analysis: It elaborates on how thermal imaging data is processed, analyzed, and interpreted to extract meaningful insights. This may involve algorithms, machine learning techniques, or statistical methods used for data analysis and anomaly detection.

User Interface and Accessibility: The description covers the user interface design, including any graphical interfaces, dashboards, or visualization tools used to display thermal imaging data to users. It emphasizes user-friendliness and accessibility, ensuring that users can easily interpret and act upon the information provided by the invention.

Potential Applications: It explores potential applications and use cases of the invention across various industries, such as industrial monitoring, healthcare, building automation, and environmental monitoring. This section demonstrates the versatility and scalability of the invention.

Advantages and Innovations: Finally, the detailed description highlights the unique advantages and innovations of the invention compared to existing solutions. It may include discussions on cost-effectiveness, efficiency gains, safety improvements, or other benefits offered by the invention.

By providing a thorough and detailed description, the patent ensures that both patent examiners and interested parties have a clear understanding of the invention's design, functionality, and potential applications.

D. RESULTS AND ADVANTAGES:

The invention yields several notable results and advantages over existing prior art:

Enhanced Monitoring Precision: By integrating the MLX90640 sensor into an IoT framework, the invention achieves enhanced monitoring precision. The high resolution and accuracy of the MLX90640 sensor enable the detection of subtle temperature variations with greater precision than conventional thermal imaging systems, resulting in more reliable monitoring and analysis of thermal data.

Real-Time Remote Monitoring: One of the key advantages of the invention is its capability for real-time remote monitoring. Unlike traditional thermal imaging systems that may require manual inspections or periodic data collection, the invention enables continuous monitoring of temperature variations across various environments, providing timely insights into potential issues or anomalies.

Predictive Maintenance Optimization: The invention facilitates predictive maintenance optimization by proactively identifying and addressing potential equipment failures or malfunctions. By continuously monitoring temperature variations and detecting early warning signs of impending issues, industries can implement preventive measures to minimize downtime, reduce maintenance costs, and optimize asset utilization.

Cost-Effective Solution: Compared to conventional thermal imaging systems, which can be expensive to procure and maintain, the invention offers a cost-effective solution. The use of the MLX90640 sensor and IoT connectivity modules enables cost savings without compromising on performance or reliability, making thermal imaging technology more accessible to a wider range of users and applications.

Seamless Integration with IoT Ecosystems: Another advantage of the invention is its seamless integration with existing IoT ecosystems. The compatibility with standard IoT protocols and communication standards ensures interoperability with a variety of IoT devices and platforms, facilitating easy deployment and integration into existing infrastructure.

User-Friendly Interface and Accessibility: The invention prioritizes user-friendliness and accessibility, with intuitive interfaces and cloud-based platforms that make thermal imaging data easily understandable and actionable for users across different industries and skill levels. This accessibility enhances the usability and adoption of the technology in various applications.

Versatility and Scalability: Finally, the invention exhibits versatility and scalability, with potential applications across a wide range of industries, including manufacturing, healthcare, building automation, and environmental monitoring. Its scalable design allows for customization and adaptation to different use cases and environments, ensuring its relevance and applicability in diverse scenarios.

In summary, the invention offers superior results and advantages over existing prior art by combining the precision of the MLX90640 sensor with the benefits of IoT connectivity, resulting in enhanced monitoring capabilities, predictive maintenance optimization, cost-effectiveness, seamless integration, user-friendliness, and versatility.

E. EXPANSION:

Sensor Calibration: Proper calibration of the MLX90640 sensor is crucial for accurate temperature measurement and thermal imaging. The invention may include procedures or algorithms for sensor calibration to ensure reliable and consistent performance.

Data Transmission Protocols: Depending on the specific application and IoT ecosystem, the invention may need to support various data transmission protocols such as Wi-Fi, Bluetooth, Zigbee, or LoRaWAN. Compatibility with different protocols allows for flexibility in deployment and integration with existing infrastructure.

Power Supply Options: The invention may require different power supply options to accommodate various deployment scenarios. This could include options for battery-powered operation, mains power, or Power over Ethernet (PoE), depending on the application's power requirements and accessibility.

Data Security Measures: Given the sensitive nature of thermal imaging data, the invention may incorporate data security measures to ensure confidentiality, integrity, and availability. This could involve encryption protocols, access control mechanisms, and secure data storage practices to protect against unauthorized access or data breaches.

Environmental Conditions: The performance of the invention may be influenced by environmental factors such as temperature extremes, humidity, and ambient light conditions. The design and implementation may need to account for these variables to ensure reliable operation in different environments.

Scalability and Modularity: To support scalability and future expansion, the invention may be designed with modular components or scalable architecture. This allows for easy expansion or upgrades to accommodate growing monitoring needs or emerging technologies.

Regulatory Compliance: Depending on the application and geographic location, the invention may need to comply with regulatory standards and certifications. This could include safety regulations, electromagnetic compatibility (EMC) standards, and data privacy regulations such as GDPR or HIPAA.

By considering these variables during the development and implementation of the invention, it can be effectively tailored to meet the specific requirements of different applications and ensure comprehensive coverage across diverse use cases and environments.

F. WORKING PROTOTYPE/ FORMULATION/ DESIGN/COMPOSITION:

Component Selection: Choose the necessary hardware components, including the MLX90640 sensor, microcontroller or single-board computer (such as Arduino or Raspberry Pi), IoT connectivity modules (such as Wi-Fi or Bluetooth), power supply, and any additional sensors or peripherals required for your application.

Circuit Design: Design the circuitry to integrate the MLX90640 sensor with the chosen microcontroller or single-board computer. This may involve connecting the sensor to the appropriate input/output pins, power supply, and any other necessary components.

Programming: Write the code to interface with the MLX90640 sensor and collect thermal imaging data. This may involve using libraries or SDKs provided by the sensor manufacturer and programming in languages such as C/C++, Python, or Arduino.

Integration with IoT Framework: Implement the necessary protocols and communication methods to enable IoT connectivity. This may involve using IoT platforms or frameworks such as MQTT, HTTP, or CoAP to transmit data to the cloud or other devices.

User Interface Development: Create a user interface (UI) for accessing and visualizing the thermal imaging data. This could be a web-based dashboard, mobile app, or desktop application, depending on your preferences and requirements.

Testing and Iteration: Test the prototype in real-world conditions to ensure that it functions as intended and meets your performance criteria. Iterate on the design and code as needed to optimize performance and address any issues or limitations.

Documentation: Document the design, components, code, and instructions for assembling and using the prototype. This documentation will be valuable for future reference and replication of the project.

The time required to develop a working prototype depends on various factors, including the complexity of the project, your familiarity with the hardware and software involved, and any challenges or setbacks encountered during the development process. Typically, it may take anywhere from a few weeks to a few months to complete a prototype, depending on these factors.

G. EXISTING DATA:

Accuracy and Precision Testing: Conduct comparative studies to evaluate the accuracy and precision of thermal imaging data obtained using the MLX90640 sensor compared to other thermal imaging systems or methods. This could involve controlled experiments where temperature measurements are taken using both the MLX90640 sensor and reference standard instruments under various conditions.

Performance Evaluation: Assess the performance of the IoT-based thermal imaging system in real-world scenarios relevant to the intended application. This could include monitoring temperature variations in industrial settings, healthcare environments, or building automation systems. Comparative data could be collected to evaluate factors such as response time, reliability, and detection sensitivity compared to existing solutions.

Predictive Maintenance Validation: Validate the effectiveness of the IoT-based predictive maintenance strategies enabled by the invention through field trials or case studies. Comparative data could be collected to demonstrate the reduction in downtime, maintenance costs, and equipment failures achieved by implementing the predictive maintenance framework compared to traditional reactive maintenance approaches.

User Experience Studies: Conduct user experience studies to evaluate the usability, accessibility, and satisfaction of end-users with the IoT-based thermal imaging system. Comparative data could be collected to assess factors such as ease of setup, data visualization, and overall user satisfaction compared to existing solutions.

Long-Term Monitoring and Analysis: Gather longitudinal data from deployments of the IoT-based thermal imaging system to evaluate its long-term performance and reliability. Comparative data could be collected over extended periods to assess factors such as sensor drift, data consistency, and system robustness compared to existing solutions.

By collecting and analyzing clinical or comparative data through rigorous testing and validation studies, the invention can be supported by empirical evidence demonstrating its superiority over existing solutions in terms of accuracy, performance, reliability, usability, and long-term effectiveness. This data will enhance the credibility and impact of the invention, validating its potential to address real-world challenges and deliver tangible benefits across various industries and applications.

4. USE AND DISCLOSURE (IMPORTANT): Please answer the following questions:

A. Have you described or shown your invention/ design to anyone or in any conference?	YES ( )	NO (*)
B. Have you made any attempts to commercialize your invention (for example, have you approached any companies about purchasing or manufacturing your invention)?	YES ( )	NO (*)
C. Has your invention been described in any printed publication, or any other form of media, such as the Internet?	YES ( )	NO (*)
D. Do you have any collaboration with any other institute or organization on the same? Provide name and other details.	YES ( )	NO (*)
E. Name of Regulatory body or any other approvals if required.	YES ( )	NO (*)

Publicly Available Information: To gather links and dates for actions related to your invention, you would need to conduct searches on academic databases (such as Google Scholar, IEEE Xplore, or PubMed), patent databases (such as the USPTO or WIPO), and industry publications. You can search for research papers, conference presentations, news articles, or videos related to thermal imaging technology, IoT applications, and predictive maintenance strategies.

MOU Terms and Conditions: If your invention is developed in collaboration with other entities, such as universities or industry partners, the terms and conditions of the MOU (Memorandum of Understanding) would typically outline the rights, responsibilities, and obligations of each party involved. You would need to refer to the specific MOU governing your collaboration to determine the relevant terms and conditions.

Commercialization Opportunities: Assess the potential for commercialization by conducting market research to identify industry needs, competitors, and potential customers. Evaluate the scalability, market demand, and feasibility of bringing the invention to market. Consider factors such as intellectual property protection, regulatory requirements, and business models for commercialization.

Companies for Commercialization: Identify companies that specialize in IoT technology, thermal imaging systems, predictive maintenance solutions, or related industries. Compile a list of potential partners or collaborators based on their expertise, track record, and market presence. Websites such as Crunchbase, LinkedIn, or industry directories can help you identify relevant companies.

Patent Royalties: If your invention incorporates technology covered by existing patents, you may need to obtain licenses or pay royalties to the patent holders. Conduct a patent search to identify relevant patents and assess the potential licensing requirements. Consult legal experts or patent attorneys for guidance on navigating patent infringement issues and licensing agreements.

Filing Options: Determine the appropriate filing options for protecting your invention, such as provisional patent applications, complete patent applications, or international PCT (Patent Cooperation Treaty) filings. Consider factors such as budget, timeline, and strategic goals when choosing the filing option that best suits your needs.

Keywords: Choose relevant keywords and phrases that accurately describe your invention and its key features. Use these keywords in patent searches, literature reviews, and online searches to find relevant information and resources related to your invention. Examples of keywords for your invention could include "MLX90640 sensor," "IoT thermal imaging," "predictive maintenance," and "temperature monitoring."

(Letter Head of the external organization)