RADAR DETECTION

WINTER INTERNSHIP PROJECT REPORT

submitted by

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SCoE-MIT Winter Internship – 2025

On

INDUSTRIAL AUTOMATION

SIEMENS CENTRE OF EXCELLENCE (SCoE)
MADRAS INSTITUTE OF TECHNOLOGY CAMPUS
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BONAFIDE CERTIFICATE

Certified that the SCoE-MIT Summer Internship Project Report entitled “RADAR DETECTION” is the bonafide work of

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who carried out the project work. Certified further that, to the best of my knowledge, the work reported here does not form part of any project on the basis of which degree or award was conferred on an earlier occasion on this or any other candidate.

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Rooban Kumar C M

ABSTRACT

Overview:

Industrial automation with Programmable Logic Controllers (PLCs) and Human-Machine Interfaces (HMIs) is a critical aspect of modern manufacturing and process control. This combination enhances operational efficiency, flexibility, and user interaction in industrial environments. PLCs serve as the backbone of automation systems, while HMIs provide a user-friendly interface for operators to monitor and control processes.

Key Components:

- **Programmable Logic Controllers (PLCs):** Functionality: PLCs are specialized digital computers designed for real-time control of industrial processes. They execute control instructions based on input signals from sensors and provide output signals to actuators and other devices. Programming: PLCs are programmed using languages such as Ladder Logic, Structured Text, or Function Block Diagram, allowing for easy customization of control processes. Reliability: Built to withstand harsh industrial environments, PLCs offer high reliability and robustness, making them suitable for continuous operation.
- **Human-Machine Interfaces (HMIs):** Functionality: HMIs are graphical user interfaces that allow operators to interact with the automation system. They display real-time data, system status, and alarms, enabling users to monitor and control processes effectively. User Interaction: HMIs provide touchscreens, buttons, and visual indicators, making it easy for operators to input commands, adjust settings, and respond to alerts. Data Visualization: HMIs can present complex data in an intuitive format, such as graphs and charts, facilitating better decision-making and operational oversight.

Benefits:

- **Enhanced Control:** The integration of PLCs and HMIs allows for precise control of machinery and processes, improving overall system performance.
- **Increased Efficiency:** Automation reduces manual intervention, streamlining operations and minimizing downtime.

- **Improved Safety:** HMIs provide operators with critical information and alerts, enabling them to respond quickly to potential issues, thereby enhancing workplace safety.
- **Flexibility and Scalability:** PLCs can be easily reprogrammed to accommodate changes in production processes, while HMIs can be updated to reflect new operational requirements.

Applications:

The combination of PLCs and HMIs is widely used in various industries, including manufacturing, food and beverage processing, water treatment, automotive assembly, and pharmaceuticals. Typical applications include conveyor systems, batch processing, and machine control.

Conclusion:

Industrial automation with PLCs and HMIs represents a powerful approach to modernizing manufacturing and process control. By leveraging the strengths of both technologies, industries can achieve greater efficiency, safety, and adaptability, ultimately leading to improved productivity and competitiveness in the market.

Para 2: Brief description of the project work

Title: Radar System for Airplane Distance and Direction Detection

Overview: This project focuses on the development of a radar system designed to detect the distance and direction of airplanes using two analog inputs. The system leverages the principles of radar technology, where radio waves are emitted, reflected off objects, and then received to determine their distance and position.

Key Components:

- **Radar Transmitter and Receiver:** The transmitter emits radio waves, while the receiver captures the reflected signals from airplanes.
- **Analog Sensors:** Two analog sensors (such as ultrasonic sensors or RF receivers) are employed to measure the distance and direction of the detected aircraft.
  Microcontroller: A microcontroller (e.g., Arduino, Raspberry Pi) processes the signals from the sensors, calculates the distance based on the time delay of the received signals, and determines the direction using the angle of reception.

- **Graphical Interface:** A display interface visualizes the distance data in real-time, allowing users to monitor the distance to the airplane dynamically.

Methodology: The radar system operates by emitting a signal that travels through the air and reflects off an airplane. The time taken for the signal to return is measured, allowing for the calculation of distance using the formula. The direction is determined by analyzing the signals received by the two sensors, which are positioned at a known distance apart. The microcontroller continuously reads the analog values from the sensors, processes the data, and updates the graphical display with the calculated distances.

Graphical Representation: The system includes a graphical representation of the distance data, which can be implemented using software tools like PLC and HMI . This visualization provides a clear and intuitive way to monitor the distance to the airplane over time.

Conclusion: This radar system represents a practical application of radar technology for aviation monitoring. By utilizing two analog inputs, it effectively measures and displays the distance and direction of airplanes, contributing to enhanced situational awareness in air traffic management and safety.

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CHAPTER 1 INTRODUCTION

Developing a radar system for detecting the distance and direction of airplanes is a significant advancement in aviation safety and air traffic management. This project utilizes the fundamental principles of radar technology, which involves the emission of radio waves that travel through the atmosphere, reflect off objects, and return to the radar system. By analyzing the time it takes for the radio waves to return, the system can accurately calculate the distance to an aircraft. Additionally, the direction of the incoming signals allows for precise positioning, enabling air traffic controllers to monitor multiple aircraft simultaneously and ensure safe distances between them.

The radar system is designed to process two analog inputs, which represent the received signals from the reflected radio waves. These inputs are crucial for determining both the range and bearing of the detected airplanes. Advanced signal processing techniques are employed to filter out noise and enhance the clarity of the received signals, ensuring that the system can operate effectively in various environmental conditions. The integration of digital signal processing algorithms allows for real-time data analysis, providing immediate feedback to air traffic controllers and enhancing situational awareness in busy airspace.

Furthermore, the implementation of this radar system has the potential to improve overall air traffic efficiency. By providing accurate and timely information about aircraft positions, the system can assist in optimizing flight paths, reducing delays, and minimizing the risk of mid-air collisions. As air travel continues to grow, the need for reliable and advanced radar systems becomes increasingly critical. This project not only aims to enhance safety but also to contribute to the development of smarter air traffic management solutions that can adapt to the evolving demands of the aviation industry.

CHAPTER 2

OBJECTIVE OF THE PROJECT

The primary objective of this project is to develop a radar system capable of accurately detecting and measuring the distance and direction of airplanes in real-time. By leveraging radar technology and utilizing two analog inputs, the system aims to enhance situational awareness for air traffic management and improve aviation safety. Specifically, the project seeks to achieve the following goals:

Distance Measurement: To implement a reliable method for calculating the distance to an aircraft by measuring the time delay of emitted radio waves that are reflected back to the radar system.

1. Direction Detection: To determine the direction of incoming aircraft by analyzing the signals received from two strategically positioned analog sensors, allowing for precise tracking of aircraft movements.
2. Real-Time Data Processing: To utilize a microcontroller for continuous processing of sensor data, ensuring that distance and direction information is updated in real-time for effective monitoring.
3. User -Friendly Visualization: To create a graphical interface that displays the distance and direction data in an intuitive manner, enabling users to easily interpret the information and make informed decisions.
4. Enhanced Air Traffic Management: To contribute to improved air traffic management by providing accurate and timely information about aircraft positions, thereby reducing the risk of collisions and optimizing flight paths.
5. Practical Application of Radar Technology: To demonstrate the practical application of radar principles in aviation, showcasing how technology can be harnessed to enhance safety and efficiency in air travel.

Through these objectives, the project aims to provide a comprehensive solution for monitoring aircraft in the airspace, ultimately contributing to safer and more efficient aviation operations.

CHAPTER 3

SOFTWARE TOOL

The software tool for this project is Siemens TIA Portal (Totally Integrated Automation Portal), used to program the Siemens S7-1200 Programmable Logic Controller (PLC) and design the Human-Machine Interface (HMI). TIA Portal is an advanced, user-friendly environment that integrates PLC programming, HMI design, and system diagnostics into a single platform, making it ideal for developing automation projects like the 3-way traffic signal control system.

Key Features and Benefits

1. Ladder Logic Programming (LAD):

TIA Portal supports ladder logic, a graphical programming language that is widely used for PLC programming due to its simplicity and visual clarity. In this project, ladder logic is used to design step-by-step sequences for traffic signal control, ensuring precise operation.

2. Norms_X and Scale_X:

The software includes a Norm function to get the analog inputs from the potentiometer, allowing easy definition and management of analog signals. In the system, there are two analog inputs: one is for the height of the airplane and another for the direction and scale_x function is used for conversion of analog data into readable numerical data.

3. HMI Integration:

The tool seamlessly integrates HMI design, enabling users to visualize real-time operations and interact with the system. Features like graphical displays for signal status, timer values, and manual overrides make system operation intuitive.

4. Diagnostic Tools:

TIA Portal offers extensive diagnostics capabilities for identifying and resolving faults quickly. It ensures reliability and efficient maintenance during development and operational phases.

5. Compatibility:

The software is compatible with Siemens S7-1200 PLC, a compact yet powerful controller that is well-suited for medium-scale automation projects like this traffic control system.

Tools Used

PLC Model: Siemens S7-1200

Programming Language: Ladder logic

Norms_X and Scale_X

HMI Design Tools: For monitoring the radar System for Airplane Distance and Direction Detection

CHAPTER 4 DESIGN STEPS

1. Logic definition: Define a level meter for the distance of the flight and a graph to monitor it. Also, define a map to showcase the direction of the flight.
2. Indication control: Assign each direction to an indication,
   Indication 1- North-east direction active
   Indication 2- South-east direction active
   Indication 3- South-west direction active
   Indication 4- North-west direction active

3. Level control: The level meter defines the distance of the airplane from the sea level and two indication symbols to monitor the flight accenting and decanting.
4. HMI design: Create a visual representation of flight status and allow operator overrides.

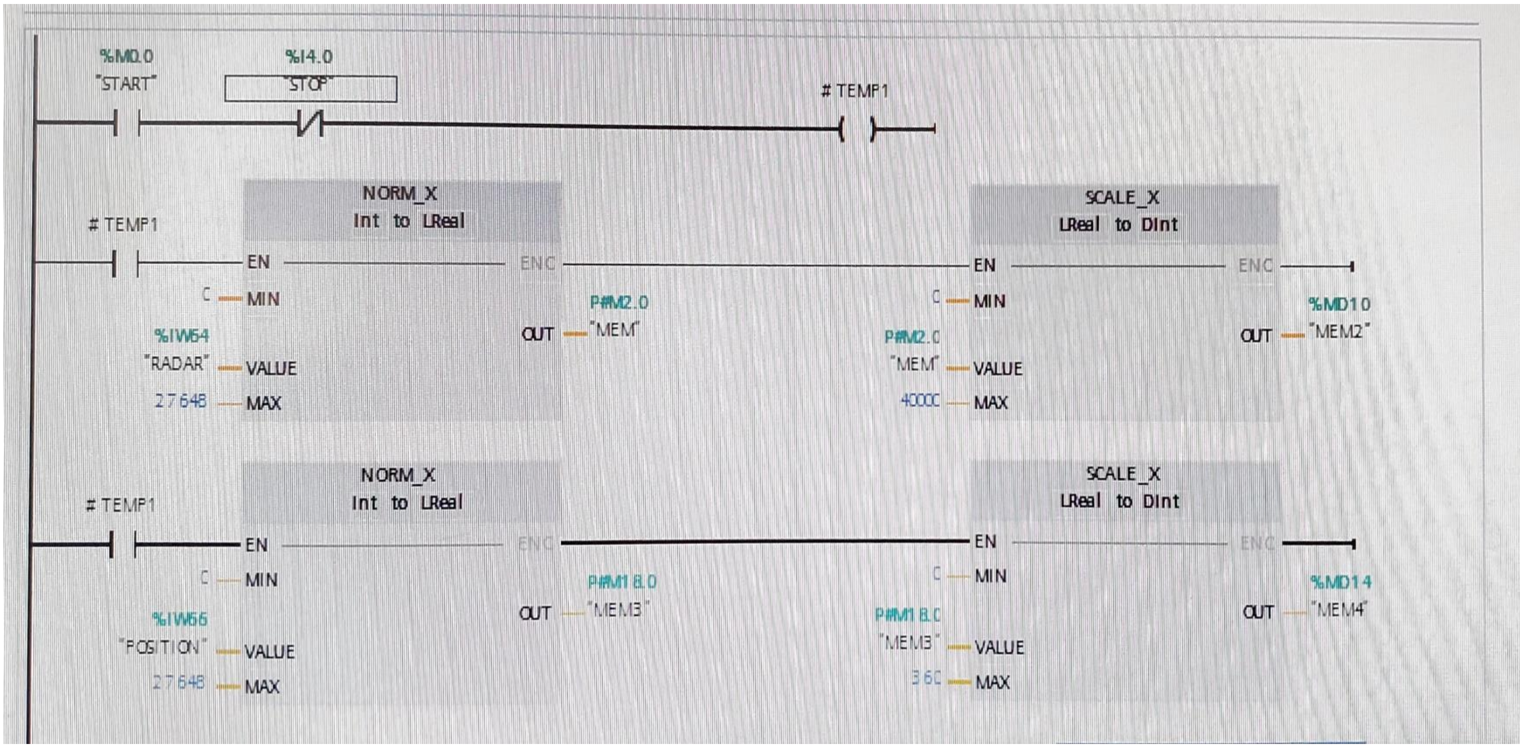
CHAPTER 5 IMPLEMENTATION

1. Start Logic:

When %M0.0 ("START") is activated (e.g., a button is pressed), it sends a signal to the S (Set) input of the SR block.

2. Stop Logic:

When %M0.1 ("STOP") is activated, it sends a signal to the R (Reset) input of the SR block.



3. Processing Method:

The process begins when #TEMP1 gets activated and shows true, and the two analog inputs are taken through a set of norm and scale function blocks.

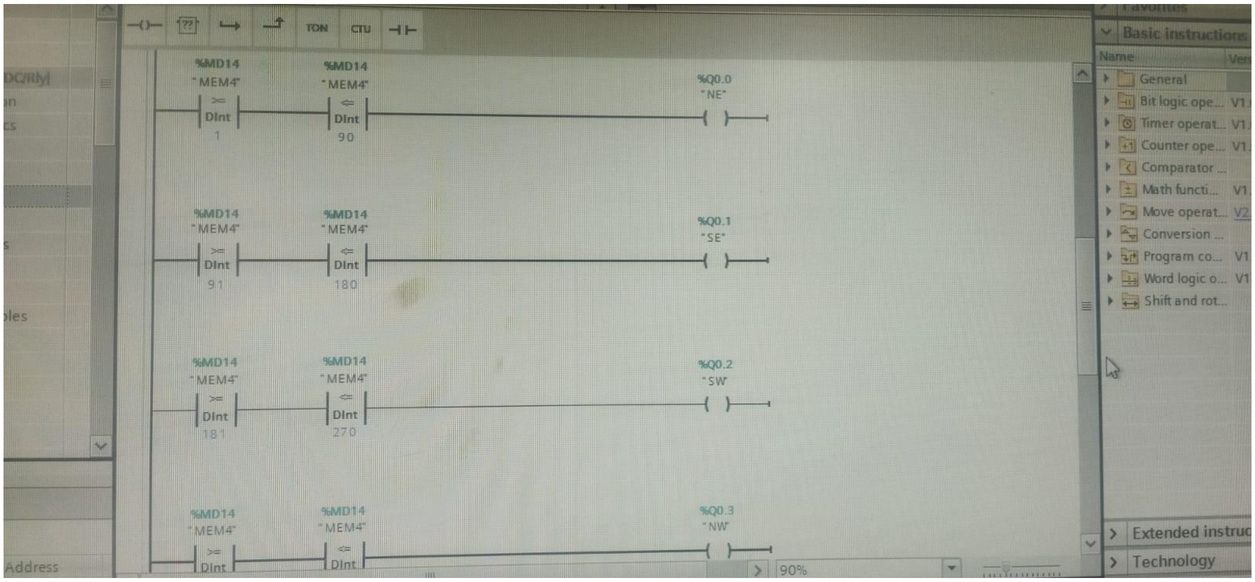
4. Control Methods for Direction:

Indication 1: Comparators in the range 1-90 are used to control the indication of the North East direction with an output of %Q0.0.

Indication 2: Comparators in the range from 91 to 180 are used to control the indication of the South East direction with an output of %Q0.1.

Indication 3: Comparators of range from 181-270 are used to control the indication of South West direction with an output %Q0.2.

Indication 4: Comparators of range from 271-360 are used to control the indication of North West direction with an output %Q0.3.

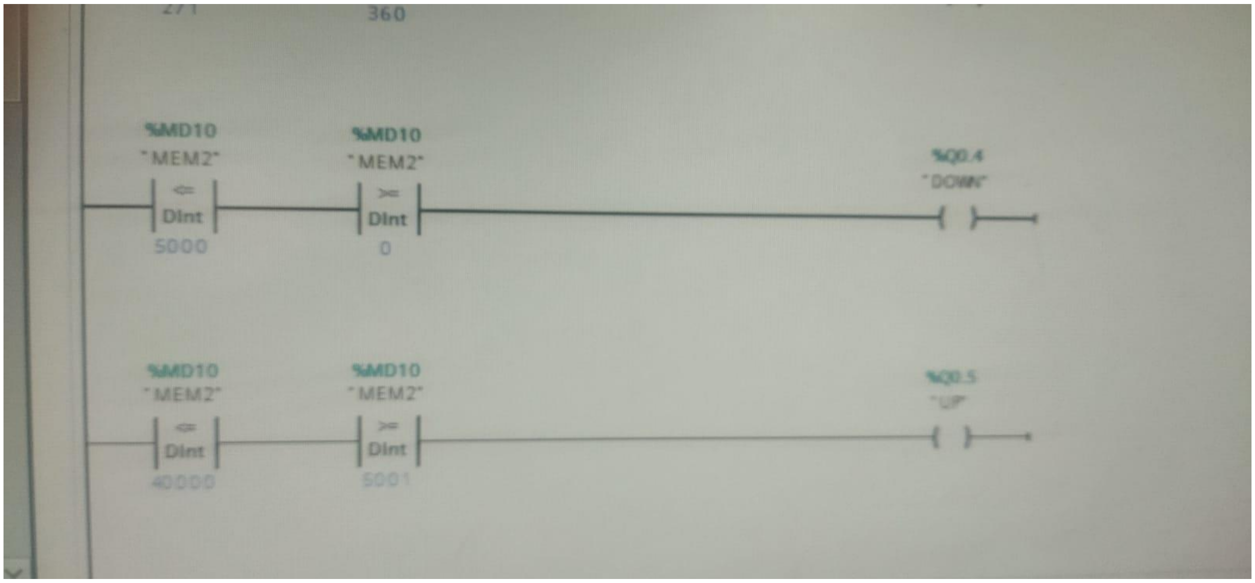


5. Control Methods for Distance from Sea Level:

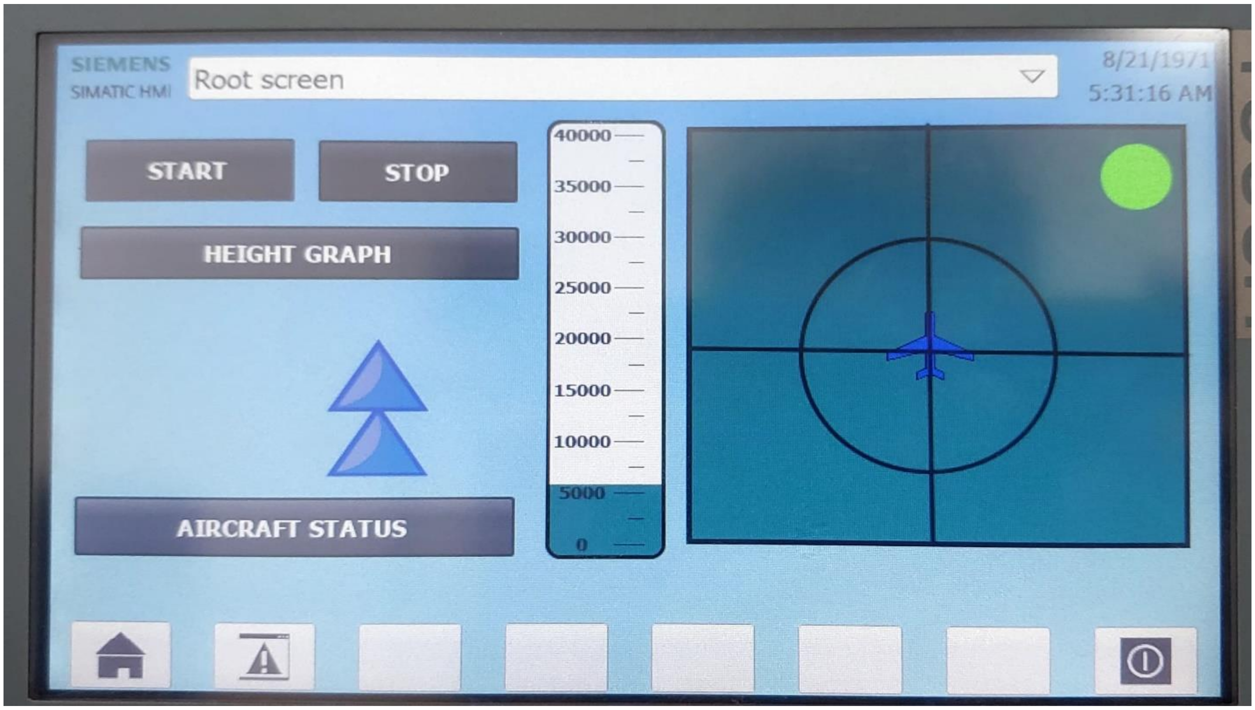
The analog input from the PLC kit is directly connected with the HMI scale to show the height of the flight.

Further, a graph has been added with an additional screen to monitor the altitudinal variations of the flight.

Two symbolic Indications are added to show the accent and decent of the flight and controlled by comparators showing decent when they reach below 5000 m.



To interface an HMI (Human Machine Interface) with Siemens S7-1200 using the TIA Portal.



Follow These Steps:

Hardware Setup:
Connect the Siemens S7-1200 PLC and the HMI panel to the network using the ethernet switch or directly through an Ethernet cable.
Assign proper IP addresses to avoid related errors.

2. Software Setup in TIA Portal

Step 1. Create a New Project

1. Open Siemens TIA Portal
2. Create a new project and name it appropriately

Step 2: Add Devices

1. Add the Siemens S7-1200 PLC to the project:
Go to “Add Device".
Select the specific S7-1200 model and firmware version. "

2. Add the HMI panel
Go to "Add Device"
Select your HMI model and firmware version,

Step 3: Configure PLC and HMI Network

1. Assign an IP address to the PLC
Navigate to "Properties” > "Ethernet Addresses", and set the IP.

2. Assign an IP address to the HMI:
Open the HMI in the project.
Navigate to "Properties" > "Ethernet Interface", and set the IP in the same subnet as the PLC.

Step 4: Define Tags

1. In the PLC, define memory addresses or variables (e.g., M bits, DBs) you want to monitor or control.

2. In the HMI, create tags linked to the PLC:
Go to "HMI Tags".
Create tags and link them to the PLC variables using symbolic or absolute addressing.

Step 5: Design HMI Screen
1. Design the HMI interface using the “Screens” editor.
2. Add objects like buttons, lamps, sliders, etc., and assign the HMI tags to these objects.

Step 6: Configure Communication

Set up communication between the PLC and HMI
Go to “Connections” under the HMI project
Add a new connection, select the PLC as the partner, and specify the network parameters.
Ensure the PLC’s IP address matches the HMI's communication settings.

Step 7: Compile and Download

1. Compile both the PLC and HMI configurations to check for errors.
2. Download the configurations to the PLC and HMI.

Use the "Online" menu in TIA Portal.
Select the device and transfer the project.
3. Testing the Interface
Start the PLC in RUN mode.

Test the HMI functionalities by interacting with the designed interface Verify that the HMI properly reads and writes to the PLC.This process ensures seamless integration of an HMI with an S7-1200 PLC.

CHAPTER 6 RESULTS

Thus, a PLC-based Radar System demonstrates a reliable and efficient method of control monitoring of variable inputs.

CHAPTER 7 CONCLUSION AND FUTURE WORK

Future Work:

- Integrating more precise sensors to determine the exact location of the flight.
- Expanding the system to support higher range of distances
- Adding flight movement projections by mathematical means to support predictive maintenance.

CHAPTER 8 REFERENCES

1. Chen, Zhi (2020), et al. "Concept Whitening for Interpretable Image Recognition." Nature Machine Intelligence Vol. 2, pp.772 to 782.

2. Snchez-Silva Mauricio, Frangopol Dan M, Padgett Jamie, Soliman Mohamed (2016), ‘Maintenance and operation of infrastructure systems’, Vol. 142, No. 9, pp. 534 to 569.

3. Wang K, Wang Y (2018), ‘How AI affects the future predictive maintenance: a primer of deep learning’, Vol.10, No.5, pp. 978 to 981.