School of Engineering
Department of Electrical and Electronics Engineering

OPTIMIZING SOLAR SYSTEMS USING SCADA

Presented by: Mohammad Shraif

Supervisor: Dr. Ibrahim SERHAN

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Outline

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• Maintenance and optimization
• Problem Statement
• Challenges
• Available Techniques
• Proposed Solution
• Comparison
• Cost Analysis
• Conclusion and future work
Introduction

• Photovoltaic is becoming essential.

• Photovoltaic is the direct conversion of sunlight into electricity.
Maintenance and Optimization

• Improving performance of PV systems.
• Analyzing and optimizing the functionality and performance of PV systems.
• Enhancing the control and the monitoring of the solar system inputs (Feedback) and outputs (alarms).
• Extending the life time and the efficiency of the system due to proper precise monitoring.
Problem Statement

- Monitoring, sorting, and detecting PV faults
- Detecting degradation in real time
- Locating the faults
- Archiving and analyzing the faults for statistics purposes
Challenges

• Type of solar panels

• Area of the solar system

• Feedback status (diagnostics, error, etc.) of every solar panel

• Network length
Available Techniques

• Visual inspection

• Thermography

• Wireless sensor based network
Proposed Solution

• Motivation
  • Limitations of current methods

• SCADA System based on PLC and industrial network
  • Supervisory Control and Data Acquisition
  • A system of hardware and software elements that allows to monitor, gather, record information and control outputs.
Equipment Used

- AKT-180-M Solar Panel
- Sensors
- Chassis
- DeviceNet Scanner
- DeviceNet Cable
  - 24 Vdc
  - 500 m thick cable length
  - 6 m drop line length
Equipment Used Cont’d

- I/O communication devices:
  - Armorblock
  - ArmorPOInt
  - Flex
    - 30 meter signal cabling length

- PLC

- HMI
Design

• DeviceNet based system

• PV farm with 93 KWp

• Three different scenarios
  1. ArmorBlock
  2. Flex
  3. ArmorPoint
Scenario I: Using ArmorBlock

- Area = 3162 m²
- 516 PV panels
- 43 Strings
- 12 PV panels per string
- 16 points per ArmorBLOCK
- 1 complete row per ArmorBlock for T
- 2 complete rows for I and V readings
- 22 ArmorBlocks
Scenario I Redistributed

A total of 43 strings of PV Panels

String of 12 PV Panels

PLC Chassis
Scenario II: ArmorPoint

- Area: 3162 m²
- 516 PV panels
- 43 string of PV panels
- 12 PV panels per string
- 63 I/O modules per ArmorPoint
- 5 complete rows per ArmorPoint
- Five ArmorPoints
Scenario III: Flex I/O

- Area = 2090 m²
- 516 PV panels
- 33 string of PV panels
- 16 PV panels per string
- 17 Flex I/O
- 1 complete row per Flex I/O
- 96 analog inputs
### SCADA V.S. Thermography V.S. W.S.N.

<table>
<thead>
<tr>
<th>Thermography</th>
<th>WSN</th>
<th>SCADA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly affected by weather</td>
<td>Affected by weather</td>
<td>Independent of weather</td>
</tr>
<tr>
<td>Limited number of controlled sensors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No readings</td>
<td>Non-precise feedbacks</td>
<td>Higher precision of feedbacks</td>
</tr>
<tr>
<td>Master-slave protocol only</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wireless communication only</td>
<td>Wireless communication only</td>
<td>In addition to cabling, wireless is available</td>
</tr>
<tr>
<td>Non-secured transfer of data</td>
<td>Non-secured transfer of data</td>
<td>More secured transfer of data</td>
</tr>
<tr>
<td>Simple</td>
<td>Complex configuration</td>
<td>Simple configuration</td>
</tr>
<tr>
<td>High power consumption</td>
<td>High lifetime cost</td>
<td>Moderate power consumption</td>
</tr>
<tr>
<td>High lifetime cost</td>
<td>High lifetime cost</td>
<td>Low lifetime cost</td>
</tr>
</tbody>
</table>
## Cost Analysis

<table>
<thead>
<tr>
<th>System</th>
<th>Cost ($)</th>
<th>Operation &amp; Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermography</td>
<td>29895</td>
<td>High</td>
</tr>
<tr>
<td>W.S.N.</td>
<td>14478</td>
<td>Very High</td>
</tr>
<tr>
<td>SCADA (ArmorBlock)</td>
<td>4501.39</td>
<td>Medium</td>
</tr>
<tr>
<td>SCADA (ArmorPoint)</td>
<td>17504.46</td>
<td>Medium</td>
</tr>
<tr>
<td>SCADA(Flex)</td>
<td>13749.09</td>
<td>Medium</td>
</tr>
</tbody>
</table>

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Conclusion and Future Work

• Maintenance and optimization of PV systems are essential needs.
• The proposed SCADA is more reliable than current systems.
• The proposed SCADA is expandable and can handle several scenarios and situations.
• The proposed SCADA is characterized by cost effectiveness.
• It has the capability to handle inputs, outputs, and power.
• New horizons to get more precise feedbacks to be considered.
• Increasing efficiency by controlling outputs (Rotary axes).
Thank You

Q & A