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# The ARC Journal

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## Research Projects

### . AI-Based SMT Line Pick & Place Robot Optimization

*Narbeh Nahapetyan (ARC Smart Manufacturing Lab Coordinator)*

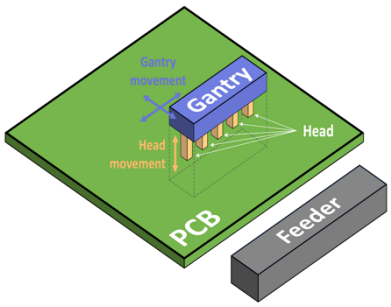
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## LAB: Smart Manufacturing

| **Research Topic** | AI-Based SMT Line Pick and Place Robot Optimization |
|---|---|
| Submitted By: Narbeh Nahapetian | Submitted Date: January 23, 2025 |

**Purpose**
The purpose of this research is to investigate on AI-driven strategies to optimize pick-and-place robot operations within Surface Mount Technology (SMT) production lines. By leveraging operational metrics and machine learning techniques, this research aims to reduce overall production cycle and switching time.








**The Past and Current States**
Historically, setting up P&P machines involved manual or semi-automated processes, relying on operator experience and extensive trial and error. While newer machines used tools offer basic optimization, they still demand significant human input, leading to longer setup times which cause production demands grow.

**The Innovation**
This research proposes a data driven, AI-based configuration by automatically analyzing product data files and machine constraints.

**The Economic Effect**
The system aims to reduce setup time, minimize operator intervention, and adapt quickly to changing production needs. Which will also lead to decrease in failing rates and increase of production capacity.

**Research Justification**
This research investigates how artificial intelligence can optimize the setup of P&P machines in Surface Mount Technology (SMT) production. By analyzing each product's specific data file along with available machine-specific constraints, such as supported feeder banks, available feeders, number of gantries and supported heads, an AI-based framework will generate an optimized setup file specified to minimize machine overall cycle times and reduce manual configuration efforts. This research-based innovation is expected to improve P&P process time efficiency, enhance producing quality, and reduce setup time (setup can be done in parallel of production), making it a valuable for smart SMT production lines.

**Project Scope**
This project will use AI-driven methods to generate optimal setup for SMT P&P machines. The scope includes:

1. **Data Analysis:** This stage focuses on parsing product data files (like pick-and-place and BOM files) to extract critical parameters such as component types, placement location while considering specific machine constraints like available feeders, feeder banks, gantry and nozzles number and configurations.
2. **AI Model Development:** Based on the insights from the first stage, an AI-driven approach will be designed to generate optimized setup files, including feeder assignments and placement sequences that minimize cycle times and overall production time.

**Challenges**
Conducting thorough testing and simulations without disrupting active production lines can be difficult, especially when replicating real-world manufacturing conditions at a research scale. Reaching to a solution which can be adapted to different machine models will be an issue too. The limitation of P&P currently in hand can affect validation process too.

**Project Deliverables**
The project deliverables should reflect the research and planning aspects. Here's the deliverable items:

1- **Feasibility Study:** Analysis of current methods and identification of AI integration opportunities in scenarios of SMT P&P robot optimization.
2- **Proof of Concept Plan:** Such a system which will demonstrate how the research insights will be tested in a controlled environment, specifying the methodologies, overall performance and validation criteria.

**Commercial Potential**
We expect that the outcome of the research could be used for the developing of the following commercial product:
"AI Based SMT Line Mounting (Pick and Place) Machines Optimizer"

## . AI-Based Optimization of SMT Reflow Oven Heating Profile

*Narbeh Nahapetyan (ARC Smart Manufacturing Lab Coordinator)*

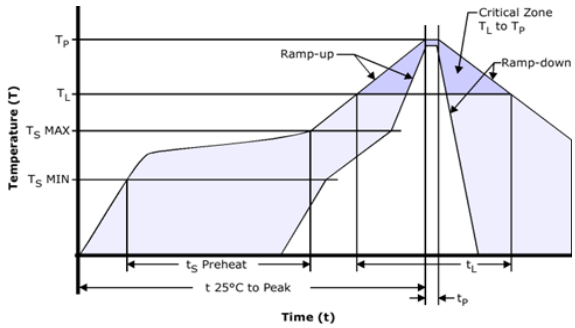
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# LAB: Smart Manufacturing

| **Research Topic** | AI-Based Optimization of SMT Reflow Oven Heating Profiles |
|---|---|
| Submitted By: Narbeh Nahapetian | Submitted Date: December 18, 2024 |

**Purpose**
The purpose of this research is to explore the feasibility of using AI based Assist System that can be used in the optimization process of reflow oven temperature profile setup, aiming to enhance efficiency, reduce setup time, and improve soldering quality in SMT production lines.







**Research Justification**

The increasing complexity of Surface Mount Technology (SMT) manufacturing demands precise control over reflow oven temperature profiles to ensure optimal soldering quality and product reliability. Manual trial-and-error methods are often time-consuming and prone to errors, leading to increased production costs and potential defects. This project aims to research an AI-based assistant that can integrates hardware sensors and intelligent software to automate the setup of reflow oven heating profiles. By leveraging real-time data and advanced machine learning algorithms, we expect to propose a solution that will guide users in configuring optimal temperature profiles compatible with PCB designs, component types, and solder paste properties. This research-based innovation is expected to improve process efficiency, enhance producing quality, and reduce setup time, making it a valuable for modern SMT production lines.

**Project Scope**

This project focuses on researching an AI-based solution to assist in configuring optimal heating profiles for SMT line reflow ovens. The scope includes:

1. Integrating hardware sensors to monitor real-time temperature and heat distribution.
2. Simulating AI algorithms to recommend temperature profiles based on PCB designs, component specifications, and solder paste recommended profile by producer.
3. Iterative monitoring based on results to improve accuracy and reliability.

**Challenges**

The challenges include hardware integration challenges with existing reflow ovens in POC phase, data quality issues affecting AI model accuracy, and challenges in training the AI model to handle different PCB designs. Also, the limitation of Reflow Ovens types currently in hand can affect validation process too.

**Project Deliverables**

The project deliverables should reflect the research and planning aspects. Here's the deliverable items:

1- **Feasibility Study**: Analysis of current methods and identification of AI integration opportunities in reflow oven temperature profiling. Specifications for the proposed AI-based system, including hardware, software, and integration requirements.

2- **Proof of Concept Plan**: Initial concept and methodology for integrating sensors and AI algorithms into the reflow oven process, outlining the expected outcomes in system simulation.

**Commercial Potential**

We expect that the outcome of the research could be used for the developing of the following commercial product:
“AI Based SMT Line Reflow Oven Heating Profiler”

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