

Apex International

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MVP Automated Filament Inspection System - Complete Solution Plan

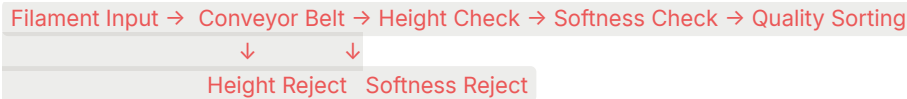
System Architecture and Flow Design

Production Line Flow Process

1. Item Feeding System

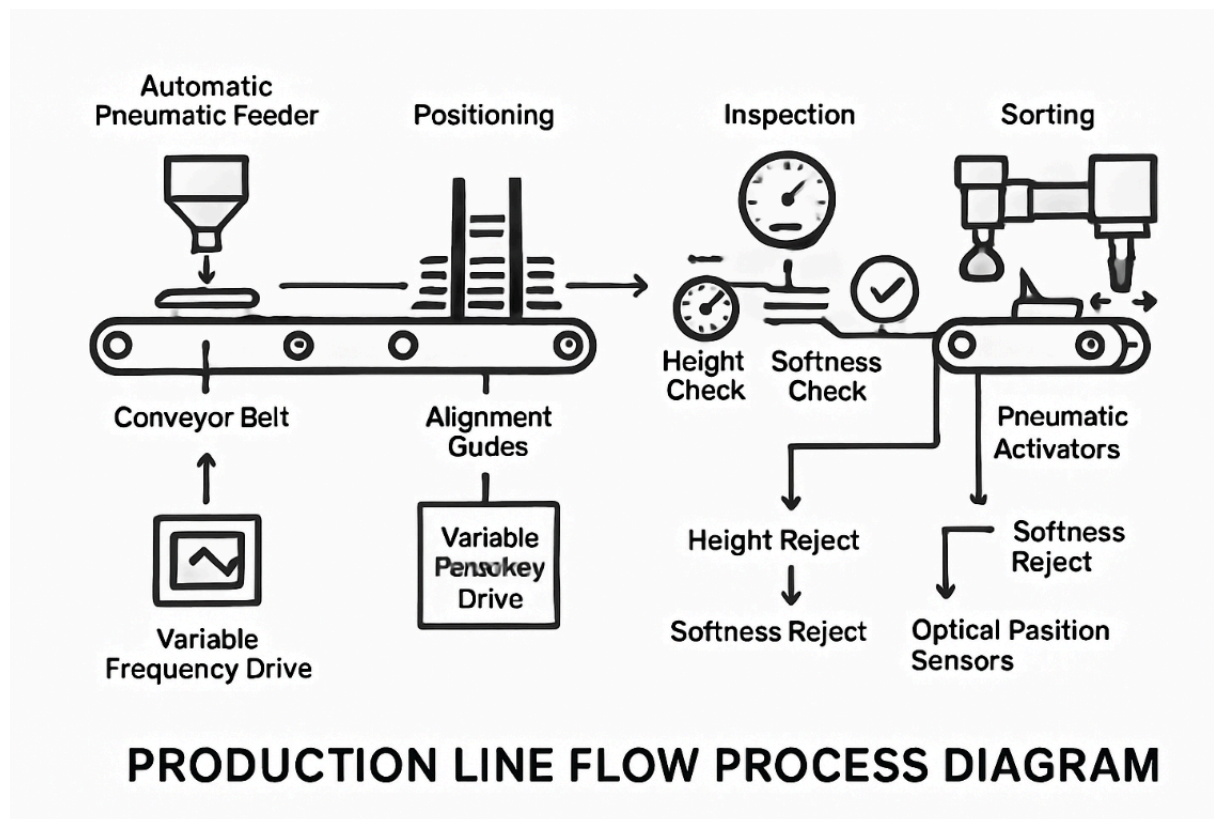
- **Automatic Feeder Unit:** Pneumatic actuator-based feeding system that picks filaments from bulk container and places them on conveyor belt at consistent intervals
- **Positioning System:** Alignment guides to ensure proper filament placement on conveyor
- **Speed Control:** Variable frequency drive (VFD) for conveyor speed adjustment

2. Inspection Sequence



3. Automated Sorting Mechanism

- **Pneumatic Actuators:** Air-powered arms to push rejected items into designated containers
- **Servo Motors:** For precise positioning and timing
- **Optical Position Sensors:** To confirm item placement before sorting action



Software Solution Architecture

Core Software Components

1. Real-Time Data Acquisition System

- **Sensor Interface Module:** Direct communication with height and softness sensors
- **PLC Integration:** Modbus/Ethernet IP communication with industrial controllers
- **Data Validation:** Real-time data filtering and validation algorithms

- **Buffer Management:** High-speed data buffering for continuous operation

2. Production Monitoring Engine

- **Live Status Tracking:** Real-time production line status monitoring
- **Throughput Calculator:** Automatic counting and rate calculation
- **Quality Classification:** Automatic categorization (Pass/Height Reject/Softness Reject)
- **Performance Metrics:** OEE (Overall Equipment Effectiveness) calculation

3. Time-Series Database System

- **InfluxDB Integration:** Optimized for sensor data storage and retrieval
- **Data Retention Policies:** Automatic data archiving and cleanup
- **High-Frequency Logging:** Millisecond-level data capture capability
- **Data Compression:** Efficient storage for long-term analytics

4. Configuration Management System

- **Sensor Calibration Interface:** Min/Max threshold settings for height and softness
- **Production Parameters:** Speed, timing, and quality tolerances
- **User Role Management:** Multi-level access control for operators and supervisors
- **Recipe Management:** Different product configurations and settings

5. Analytics and Dashboard Platform

- **Real-Time Dashboard:** Live production monitoring with key metrics
- **Historical Analytics:** Trend analysis for daily, weekly, monthly, yearly data
- **Quality Reports:** Detailed rejection analysis and root cause identification
- **Performance Optimization:** Recommendations based on data patterns

Software Technology Stack

Backend Development:

- **Programming Language:** Node js Express js
- **Database:** InfluxDB (time-series) + PostgreSQL (configuration)

- **Message Queue:** Redis for real-time data processing
- **API Gateway:** RESTful APIs for system integration

Frontend Development:

- **Dashboard Framework:** React.js with TypeScript
- **Visualization Library:** Chart.js and D3.js for advanced analytics
- **Real-time Updates:** WebSocket connections for live data
- **Responsive Design:** Mobile and tablet compatibility

Infrastructure:

- **Edge Computing:** Industrial PC with Linux/Windows IoT
- **Containerization:** Docker for application deployment
- **Data Synchronization:** Local processing with cloud backup
- **Security:** SSL encryption and user authentication

Hardware Requirements for Software Integration

Sensors and Measurement Devices

- **Height Measurement:** Laser displacement sensor ($\pm 0.1\text{mm}$ accuracy)
- **Softness Measurement:** Force/pressure sensor with calibrated probe
- **Position Detection:** Photoelectric sensors for item tracking
- **Speed Monitoring:** Encoder feedback from conveyor motor

Control and Automation Hardware

- **Industrial PLC:** Programmable Logic Controller (Siemens S7-1200 or equivalent)
- **HMI Panel:** 10-15 inch touchscreen for operator interface
- **I/O Modules:** Digital and analog input/output modules
- **Pneumatic Valves:** Solenoid-controlled actuators for sorting

Computing Infrastructure

- **Edge Computer:** Industrial PC (Intel i5, 8GB RAM, SSD storage)
- **Network Switch:** Managed Ethernet switch for device connectivity
- **UPS System:** Uninterruptible power supply for data protection
- **Wireless Access Point:** For mobile device connectivity

Communication Interfaces

- **Ethernet Network:** Gigabit connectivity for all smart devices
- **Serial Interfaces:** RS-485/RS-232 for legacy equipment integration
- **Wireless Protocols:** Wi-Fi and Bluetooth for mobile access
- **Cloud Gateway:** Secure internet connectivity for remote monitoring

Live Analytics and Dashboard Features

Real-Time Production Monitoring

- **Live Throughput Display:** Items per minute/hour with target comparison
- **Quality Status Indicators:** Pass rate, height rejection rate, softness rejection rate
- **Equipment Status:** Conveyor speed, sensor status, actuator health
- **Alarm Management:** Real-time alerts for system issues

Performance Analytics

- **Production Efficiency Metrics:**
 - Overall Equipment Effectiveness (OEE)
 - Availability, Performance, and Quality rates
 - Downtime analysis and categorization
 - Cycle time analysis
- **Quality Analytics:**
 - Rejection trend analysis
 - Pareto charts for defect categories

- Statistical process control charts
- Quality cost analysis

Financial and Business Intelligence

- **Cost Analysis Dashboard:**
 - Material waste cost calculation
 - ROI tracking and projections
- **Reporting Capabilities:**
 - Automated daily/weekly/monthly reports
 - Export functionality (PDF, Excel, CSV)
 - Email notifications for key metrics

Configuration Management Interface

Production Line Setup

- **Sensor Calibration Wizard:** Step-by-step calibration process
- **Quality Thresholds:** Min/Max values for height and softness parameters
- **Speed Configuration:** Conveyor speed and timing adjustments
- **Recipe Management:** Save/load different product configurations

User Management and Security

- **Role-Based Access Control:** Operator, Supervisor, Administrator levels
- **Audit Trail:** Complete log of configuration changes
- **Password Policies:** Secure authentication requirements
- **Session Management:** Automatic logout and session tracking