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## Technical Analysis of Automatic Paper Feeding Systems in Newspaper Printing: Postprint

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### Abstract

This paper, based on the development practice of innovative automatic paper feeding technology for newspaper printing, analyzes and elaborates the problems and solutions that newspaper enterprises need to address when implementing heavy-duty robot-based automatic paper conveying technology in high-speed rotary printing. It specifically presents the system architecture design and implementation pathway for newspaper printing automatic paper feeding systems; clarifies that the process design of such systems should emphasize alignment with actual production requirements and realistic conditions; proposes a modular design and implementation solution for cluster control technology of automatic paper conveying heavy-duty robots; and provides practical reference for realizing intelligent control of complete closed-loop newsprint logistics handling in newspaper printing.

### Full Text

#### Preamble

**Abstract:** Based on the development and implementation of innovative automatic paper feeding technology for newspaper printing, this paper analyzes and elaborates on the problems and solutions required for newspaper enterprises to achieve automatic paper feeding using heavy-load robots in high-speed rotary printing. It specifically introduces the system architecture design and implementation roadmap for the newspaper printing automatic paper feeding system; clarifies that process design must emphasize matching actual production requirements and existing conditions; proposes a modular design and implementation scheme for cluster control technology of automatic paper feeding heavy-load robots; and provides a practical reference for realizing intelligent control of complete newsprint logistics loop processing in newspaper printing.

**Keywords:** automatic paper feeding system; wireless cluster control

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## 1. System Architecture Design

The newspaper printing automatic paper feeding system integrates wireless communication technology, ARM embedded computer technology, system control technology, drive control technology, magnetic navigation technology, safety control technology, and battery power technology. Through configuration software, it monitors the entire paper feeding system's operation. Based on paper demands from each paper stand of the printing press, the industrial fieldbus controller processes and transmits signals to the central control system, which then dispatches transport robots via wireless LAN to complete tasks including automatic paper roll loading, transport, weighing, mounting/dismounting, core recovery, and automatic charging, while monitoring equipment status, performing self-diagnostics, and indicating faults. The system can connect to the company's ERP system to collect, record, and statistically process paper consumption information.

[Figure 1: see original paper] System Design and Implementation Roadmap

As shown above, system technical design is based on actual requirements. After determining the overall objectives, these are decomposed into several sub-objectives to construct and finalize the overall technical design scheme, enabling categorized design, implementation, optimization during installation and commissioning, and final deployment.

## 2. System Process Design

The production process design for the wireless cluster-controlled robot automatic paper feeding system operates as follows: Upon receiving a paper demand signal from a paper stand, the system identifies the requesting stand, paper type, and unwinding direction, automatically generating a corresponding paper delivery task. This task is transmitted via wireless network to an automatic robot—an AGV transport vehicle—waiting at the parking area's dispatch position. The AGV receiving the task automatically proceeds to the loading platform at the tail of the corresponding shelf conveyor to load the paper roll (with paper type and unwinding direction preset in the system). After the AGV arrives at the loading platform, the shelf conveyor initiates loading. Upon successful loading, the AGV transports the paper roll to the requesting stand under guidance from a weak magnetic guidance line (with intermediate paper roll weighing), and after completing automatic mounting/dismounting, returns the paper core for centralized recovery by the core recovery device (with simultaneous core weighing). Finally, the AGV returns to the parking area to queue for the next task.

### 3. Cluster Control Technology

The wireless cluster control network primarily introduces multi-layer network control technology into the newsprint automatic transport system, including industrial Ethernet technology (both wireless and wired) and industrial field-bus technology (PROFIBUS-DP), applied in zones and layers according to the newsprint transport system's control tasks, optimizing the overall control system design.

The system specifically establishes a paper roll preprocessing zone and a paper roll transport zone, each with a Siemens S7-300 PLC as the master station and several S7-200 PLCs as slave stations. The slave stations exchange information with the master station via PROFIBUS industrial bus, while the S7-300 PLC master station exchanges information with the system master control computer via industrial Ethernet. Simultaneously, the master control computer exchanges information with automatic transport robots (AGVs) via wireless Ethernet, following the TCP/IP protocol, covering a factory radius of over 150 meters to achieve networked wireless cluster control of 18 low-pallet transport robots (AGVs).

[Figure 2: see original paper] System Layout Schematic Diagram

[Figure 3: see original paper] Production Process Layout Schematic Diagram

This approach modularizes the complex newsprint transport system, decomposing complex functions and making system organization more orderly, efficient, and reliable.

Communication between the master control computer and AGVs occurs through a wireless Ethernet network. On the master control computer side, this wireless network is built based on a set of IEEE 802.11g standard wireless routers. The system employs carrier-grade high-power wireless APs with adjustable 1W output power, frequency range of 2400-2484 MHz, and transmission rates up to 54 Mbps. On the AGV side, wireless network transceivers (wireless network cards) also compliant with IEEE 802.11g standards are used. The master control computer's high-power broadband wireless AP and 18 MOXA wireless network cards corresponding to the 18 AGVs form a wireless LAN. After installing the driver, configuring virtual port parameters, correctly setting communication parameters and IP addresses for the wireless AP and built-in AGV wireless network cards, and performing corresponding interface programming on the AGV's main CPU, real-time communication between the master control computer and AGVs is achieved.

Through wireless network communication and data exchange, the master control computer can monitor each AGV's current spatial position, task progress, control system operation status, and power conditions, and issue new task instructions to corresponding AGVs based on feedback information to facilitate task completion.

With both master control computer and AGVs set to automatic mode, data

transmission occurs at a frequency of 2-3 times per second, enabling real-time data exchange.

#### 4. Software, Hardware, and Control Flow

Due to different equipment selections across system components, control system software development varies accordingly. For the Shenzhen Press Group's automatic paper feeding system, the master control computer program was primarily developed based on Microsoft's Windows XP Professional, SQL Server 2000, VB, VC, and Wellintech's KingView technology platform. The master controller and paper stand control sections were developed using Siemens S7-300 and S7-200 PLC series development software and Siemens bus technology SIMATIC NET. The AGV main controller program was primarily developed using C/C++ language. Each control system component operates relatively independently while sharing data in real-time through wired or wireless communication.

[Figure 4: see original paper] Wireless Network Communication Schematic Diagram

The master control computer exchanges data and information with the S7-300 PLC master station via industrial Ethernet. Monitoring software, through human-machine interface configuration, provides real-time graphical simulation of the site environment and dynamically monitors all equipment operation status. It schedules AGV operation via wireless network and enables remote operation control, fault diagnosis, and recording of system equipment for intelligent online equipment management.

By connecting to enterprise ERP software, the system can process paper roll weighing and core weighing information, record paper consumption for each paper stand, and statistically generate detailed newsprint consumption reports and shift reports.

[Figure 5: see original paper] Control System Flowchart

#### System Configuration: Shenzhen Press Group Wireless Cluster-Controlled Robot Automatic Paper Feeding System

- **1 unit:** Monitoring and management (main control computer)
- **Main controller:** Siemens S7-300 PLC
- **Sub-controller:** Siemens S7-200 PLC
- **Model:** OPTIPLEX 330
- **Wireless equipment:** WiFly-City ODU-8300-PG
- **5 transport robots (AGVs):** (outsourced processing)
- **18 units:** Automatic paper roll transport
- **AGV manual control**
- **7 guidance and landmark magnetic strips**
- **Optical landmark reflector plates**
- **Infrared light emitters**

- **4 wireless routers (APs)**
- **Handheld remote control**

The newspaper printing automatic newsprint transport system fully utilizes various mature new technologies and processes, featuring high automation, high integration, stable operation, simple maintenance, and economic practicality. The system improves the enterprise' s production environment quality and management level, enhancing the competitiveness of newspaper printing enterprises.

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*Note: Figure translations are in progress. See original paper for figures.*

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