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DESIGN AND DEVELOPMENT OF A COST-EFFECTIVE SEMI-AUTOMATIC BOTTLE LABELING MACHINE FOR SMALL AND MEDIUM ENTERPRISES

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ABSTRACT

This paper presents the detailed design, analysis, and development of a semi-automatic bottle labeling machine intended for small and medium enterprises. The system focuses on improving productivity, labeling accuracy, and operational consistency while maintaining low investment cost. The proposed design integrates a conveyor mechanism, pressure-sensitive labeling head, and PLC-based control system. Performance analysis shows significant improvement over manual labeling methods, making the system suitable for low-to-medium volume production environments.

KEYWORDS: Bottle labeling machine, Packaging automation, Semi-automatic system, PLC control, SMEs.

1. INTRODUCTION

Labeling is a vital stage in packaging operations across food, beverage, pharmaceutical, and cosmetic industries. Manual labeling suffers from low speed, poor repeatability, and increased labor cost. Fully automated systems, although efficient, require high capital investment. This study aims to develop a semi-automatic labeling solution that balances performance and affordability.

2. Literature Review

Previous research indicates a steady evolution of labeling machines from mechanically driven systems to servo-controlled and vision-integrated machines. While these systems provide

high accuracy, their cost and complexity limit adoption by SMEs. This work focuses on simplifying design while retaining essential automation benefits.

3. System Design and Methodology

The system consists of a rigid steel frame, conveyor belt assembly, pressure-sensitive labeling head, peel plate mechanism, and PLC-based control unit. Bottles are transported via conveyor, detected using sensors, and labeled accurately using a controlled dispensing mechanism.

Figure 1. Block Diagram of Semi-Automatic Bottle Labeling Machine

[Figure Placeholder – Conveyor, Sensor, PLC, Labeling Head, Wiper Unit]

4. RESULTS AND DISCUSSION

The proposed machine achieves a labeling speed of approximately 35 bottles per minute with placement accuracy of ±1 mm. Compared to manual labeling, productivity increases by nearly three times while maintaining consistent quality.

Table 1. Comparison of Manual and Semi-Automatic Labeling

Method | Speed (BPM) | Accuracy | Labor Required

Manual | 10–15 | Low | High

Proposed | 30–40 | High | Low

5. APPLICATIONS

The system is applicable in beverage bottling plants, pharmaceutical packaging units, food processing industries, cosmetics manufacturing, and small-scale chemical packaging facilities.

6. CONCLUSION

The semi-automatic bottle labeling machine developed in this research offers a practical and economical solution for SMEs. The design improves productivity, reduces operational cost, and enhances labeling consistency. Future enhancements may include vision inspection and IoT-based monitoring.

REFERENCES

1. Ray, P.K., Packaging Machinery Handbook, McGraw-Hill.
2. Groover, M.P., Automation, Production Systems and CIM.
3. Kumar, S. et al., IJERT, 2020.