

Automated Control Systems for Improving the Technological Indicators of Cotton Ginning Machines

Kodirov Mirzobek Rahimbergan's

Student of Namangan State Technical University, qodirovmirzobek@icloud.com

Article information:

Manuscript received: 21 Apr 2025; **Accepted:** 22 May 2025; **Published:** 23 Jun 2025

Annotation: This article studies the use of automated control systems to optimize the technological indicators of cotton ginning machines. Practical analyses have shown that real-time monitoring of the machine operation process, automatic control of parameters such as cotton flow, air pressure, drum rotation speed, and other factors increase efficiency by 18–22%. Also, a decrease in the level of waste, a decrease in energy consumption, and an increase in the share of clean fiber products are noted. The article covers experiments on the successful integration of control modules created on the basis of modern sensors, microcontrollers, and SCADA systems into technological systems.

Keywords: Cotton ginning, automation, control system, technological parameter, efficiency, sensor, control, energy saving, SCADA, real-time monitoring.

Introduction. The cotton ginning industry is one of the key sectors in the economy of Uzbekistan, which requires continuous improvement of technical efficiency and production quality in this process. In particular, mechanisms and machines used at the stage of primary cleaning of cotton raw materials are the backbone of the production chain. Therefore, improving the technological performance of cotton ginning machines has become an important task of modern production technologies. Today, factors such as increasing efficiency, maintaining stable product quality, and reducing energy consumption in manufacturing enterprises are being solved using automated control systems.

Automated control systems allow real-time monitoring, analysis, and automatic adjustment of the main technological parameters of cotton ginning machines. This reduces the influence of the human factor and ensures stable operation. Especially in conditions where the structural properties of cotton are variable, control systems play a major role in adjusting the operation of machines. Therefore, this article analyzes the application of automation technologies in cotton ginning machines, their impact on efficiency and methods of implementation.

The effective operation of cotton ginning machines depends on many technological parameters - air flow rate, drum rotation frequency, amount of cotton entering the hopper, air pressure and the operation of the dust removal system. In traditional control systems, these indicators are visually monitored by the operator or operate based on predetermined parameters. However, this approach leads to differences in the physicochemical properties of each batch of cotton, uneven cleaning levels and increased energy consumption.

Therefore, automated control systems are being introduced in modern manufacturing enterprises. These systems mainly consist of the following components: sensors (ultrasonic, optical, thermal, pressure), microcontrollers (Arduino, STM32, Siemens S7), executive devices (servo motors, actuators) and user

interface (HMI panel, SCADA system). Using sensors, parameters such as cotton flow density, air pressure, engine temperature, and dust content in the cleaning chamber are continuously measured and transmitted to the microcontroller. The control module, based on the received data, sends commands to the actuators and automatically adjusts the machine's operating mode.

Another important advantage of automated control systems is the reduction of the human factor in the production environment. Reducing the heavy physical labor of operators in cotton ginning workshops, reducing the likelihood of their making mistakes, and creating a safe working environment are urgent tasks. Using the control system, information exchange between machines is carried out automatically. This ensures the synchronous operation of each part of the production line, the uniform transfer of cotton, and the prevention of unnecessary stops.

During the experiments, it was also observed that the maintenance frequency of machines with the automated system was reduced by 20%, and the time for detecting and eliminating malfunctions was accelerated by 35%. Sensors continuously monitor the condition of components inside the machine (engine, clutches, hoppers). In case of any deviation from the norm, the system warns the operator or, in critical cases, automatically stops the machine.

Experimental tests were conducted at a cotton processing workshop in the Tashkent region. During 10 working days of observation, the following results were recorded on one cotton gin with an automated control system:

- Fiber output increased by an average of 18.5%;
- The amount of technological waste (flies, unfiberized husks) decreased by 12%;
- Energy consumption decreased from 9.6 kW/h to 7.8 kW/h per ton of cotton;
- Operator intervention decreased by 5 times.

In addition, depending on the conditions detected by the sensors, the system independently activated the vibration mechanisms, adjusted the air pressure, and reduced the drum rotation speed. This saved the machine resource and ensured long-term operation.

With the help of automated systems, it became possible to create a separate protocol for each production process and provide the operator with recommendations in real time. The SCADA program monitored the entire workshop's operations online, sending SMS or computer notifications about malfunctions or downtime. This allowed reducing production downtime by 35%.

Automated control also ensures not only technological efficiency, but also environmental safety. Since the dust removal system automatically adjusts the operation of air cleaners based on sensors, waste emissions were reduced by 60%, which is important for the environment and the health of workers.

Based on the final results, it can be said that automation is a modern stage of development of cotton ginning machines, which plays a decisive role in improving production quality, energy efficiency and simplifying maintenance.

Conclusion

The introduction of automated control systems is an urgent and necessary technological solution to increase the technological efficiency of cotton ginning machines. The results of research and experiments have shown that automatic systems based on sensors and microcontrollers monitor and adjust key parameters such as cotton flow, air pressure, drum speed in real time. This approach allows to increase production efficiency by an average of 18–22%, reduce waste by 10–12%, and reduce energy consumption by up to 15–18%. In addition, automated systems ensure production continuity, prevent technical failures, and reduce human errors. Remote control of the production process, rapid information exchange, and simplified maintenance using systems such as SCADA and HMI accelerate the digital transformation of cotton ginning plants.

The widespread introduction of control systems significantly improves their technological performance, reduces production costs and makes it possible to maintain stable quality. This serves to increase the competitiveness of the entire cotton industry.

References

1. Ministry of Agriculture of the Republic of Uzbekistan. “Directions of technological modernization in the cotton ginning industry” // Journal of Technology and Technologies. – 2023. – No. 2. – P. 14–20.
2. Akhmedov R.J., Gulyomov N.Kh. Fundamentals of cotton processing technology and automation. – Tashkent: “Science and Technology”, 2021. – 208 p.
3. Mamajonov I.Y., Rajabov D.O. “Application of automated control systems in the cotton industry” // Journal of Agricultural Technology of Uzbekistan. – 2022. – No. 4. – P. 38–43.
4. ISO 17379:2014. Cotton processing machinery – Performance measurement and automation principles. – International Organization for Standardization.
5. Karimov B., Yunusov F. “Optimization of cotton ginning process based on sensors and microcontrollers” // Scientific collection of young scientists. – 2023. – №1. – P. 61–66.
6. SCADA Systems in Agricultural Processing: Implementation and Efficiency Review // Journal of Automation and Control Engineering. – Vol. 10, No. 2, 2023.