Automatic Coin Sorting Machine

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Abstract— This study presents the development of an intelligent coin sorting system designed to identify and calculate the total value of inserted coins using a combination of mechanical, hardware, and software components. The system incorporates an AVR ATmega328P microcontroller, optical sensors, and an OLED display for efficient operation and user interaction. Through iterative prototyping and testing, the system demonstrated accurate coin recognition and reliable operation. Its compact design and cost-effectiveness position it as a practical tool for automated coin handling in various applications. This paper details the design process, component selection, and testing methodologies, along with an evaluation of system performance.

Keywords— Coin sorting, AVR microcontroller, optical sensors, embedded systems, IoT applications.

I. INTRODUCTION

The efficient handling and management of coins remain critical in various industries, including vending, toll collection, and small-scale retail. Traditional mechanical coin sorting devices, while reliable for basic operations, often fall short in terms of adaptability, precision, and user interaction. These limitations necessitate the development of advanced solutions that leverage modern microcontroller technologies and sensor systems to achieve higher accuracy and scalability [1][2]. With the growing adoption of embedded systems and Internet of Things (IoT) technologies, coin sorting systems can now integrate real-time processing, enhanced user interfaces, and automated logging capabilities to meet the demands of modern applications [3][4]. Recent advancements in microcontroller technology, such as the AVR ATmega series, have enabled the development of compact and energy-efficient systems for real-time embedded applications. The ATmega328P microcontroller, specifically, offers a versatile platform for building such systems due to its rich set of peripherals, low power consumption, and compatibility with a wide range of sensors [5][6]. Similarly, optical sensors like the LTH-301-07 have been widely utilized in automation systems for their ability to provide precise detection of physical objects, making them ideal for coin identification based on dimensions and material properties [7][8]. The integration of these components with display modules, such as SSD1306-based OLEDs, allows for clear visualization of coin counts and transaction histories, improving the usability and accessibility of coin sorting systems [9][10].

This paper proposes an intelligent coin sorting system that combines a robust mechanical framework with sensor-based hardware and microcontroller-driven processing. The system employs optical sensors to detect and classify coins based on their dimensions and characteristics, while an ATmega328P microcontroller processes the data and updates the user via an OLED display. By addressing the limitations of traditional solutions, this system offers a cost-effective and scalable alternative suitable for various applications. The study includes the design, implementation, and evaluation phases, focusing on the system's ability to operate accurately in real-world conditions.

The proposed system aims to contribute to the growing body of research in automation and embedded systems by demonstrating how modern microcontrollers and sensors can be effectively integrated to build intelligent devices. The methodology emphasizes modularity, enabling future enhancements such as wireless connectivity or advanced classification algorithms to adapt to evolving needs [11][12]. This paper outlines the development process,

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highlights key technical challenges, and discusses the implications of the results for practical deployments.

II. Integration

The methodology for developing the intelligent coin sorting system involved a comprehensive and systematic integration of hardware, software, and mechanical components to ensure accurate coin detection, classification, and value calculation. The hardware design was anchored by the AVR ATmega328P microcontroller, chosen for its balance of processing power, energy efficiency, and extensive peripheral support. This microcontroller acted as the system's central unit, orchestrating input collection from optical sensors, executing real-time data processing, and controlling an OLED display for user interaction. The optical sensors, specifically the LTH-301-07 infrared modules, played a critical role in coin detection. Positioned strategically along the coin sorting pathway, these sensors detected interruptions in their light beams caused by passing coins, enabling precise identification based on coin dimensions. Each sensor was connected to the microcontroller via digital input pins, with additional circuitry in place to filter noise and ensure stable signal transmission.

The system's power requirements were met through a regulated 3.3V supply, converted from a standard 5V input using an XC6210 low-dropout regulator. This setup ensured a stable and efficient power supply to all components, preventing voltage fluctuations that could disrupt system operations. To enhance the user interface, an SSD1306 OLED display was incorporated, providing clear, real-time feedback on the system's operations. The display showcased the cumulative value of inserted coins, individual coin counts, and transaction summaries, improving usability and interaction.

The software was developed in C++ using Microchip Studio, employing an object-oriented approach to enhance modularity and maintainability. Core functionalities included sensor event handling, data processing, and user interface control. To achieve efficient sensor integration, the software implemented an interrupt-driven architecture. External interrupts were configured for each optical sensor, enabling the system to immediately respond to coin insertion events without continuous polling, thereby optimizing processing efficiency. A state machine logic governed the overall system behavior, managing coin detection sequences, data processing routines, and display updates. Additionally, the system utilized timer modules within the microcontroller for precise event scheduling and timing operations. The 8-bit timer facilitated system-wide timekeeping, while the 16-bit timer handled event-specific processes such as debouncing sensor inputs to eliminate false detections.

The mechanical design of the system focused on creating a robust yet compact framework that securely housed the sensors, microcontroller, display, and coin sorting path. The mechanical alignment of sensors with the coin pathway was critical to ensuring accurate detection. Adjustable mounts were employed to facilitate fine-tuning of sensor positions during assembly and calibration. The mechanical framework also included slots and channels to guide coins through the detection system, minimizing the risk of misalignment or obstruction.

Extensive testing and calibration were integral to the development process. Sensor calibration involved adjusting detection thresholds to accommodate variations in coin dimensions and materials, ensuring compatibility with a wide range of coin types. Controlled experiments were conducted using coins of different sizes, weights, and materials to verify the accuracy and reliability of the detection mechanism. Real-world scenarios, such as prolonged operation and varying environmental conditions, were simulated to evaluate system robustness and performance. These tests identified potential challenges, such as sensor sensitivity to environmental light and misalignment issues, which were addressed through software-based filtering techniques and mechanical design refinements.

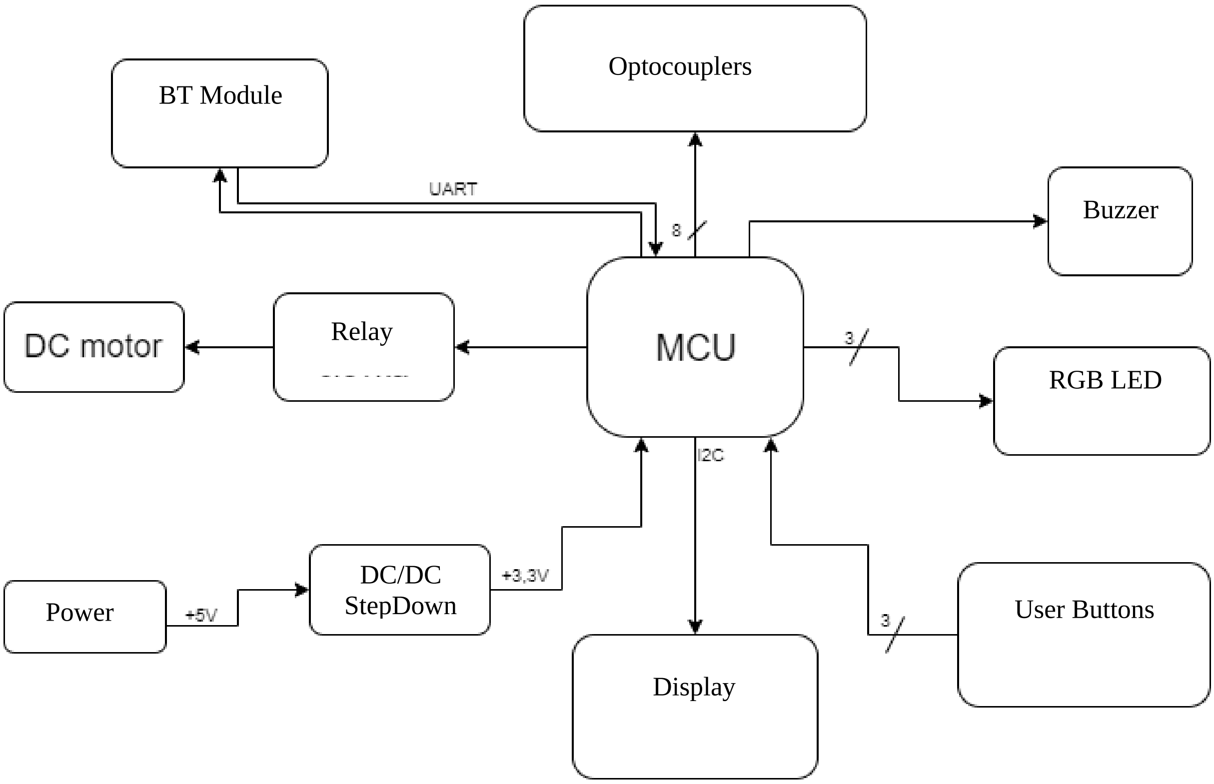

Fig. 1 Block schematic of the device

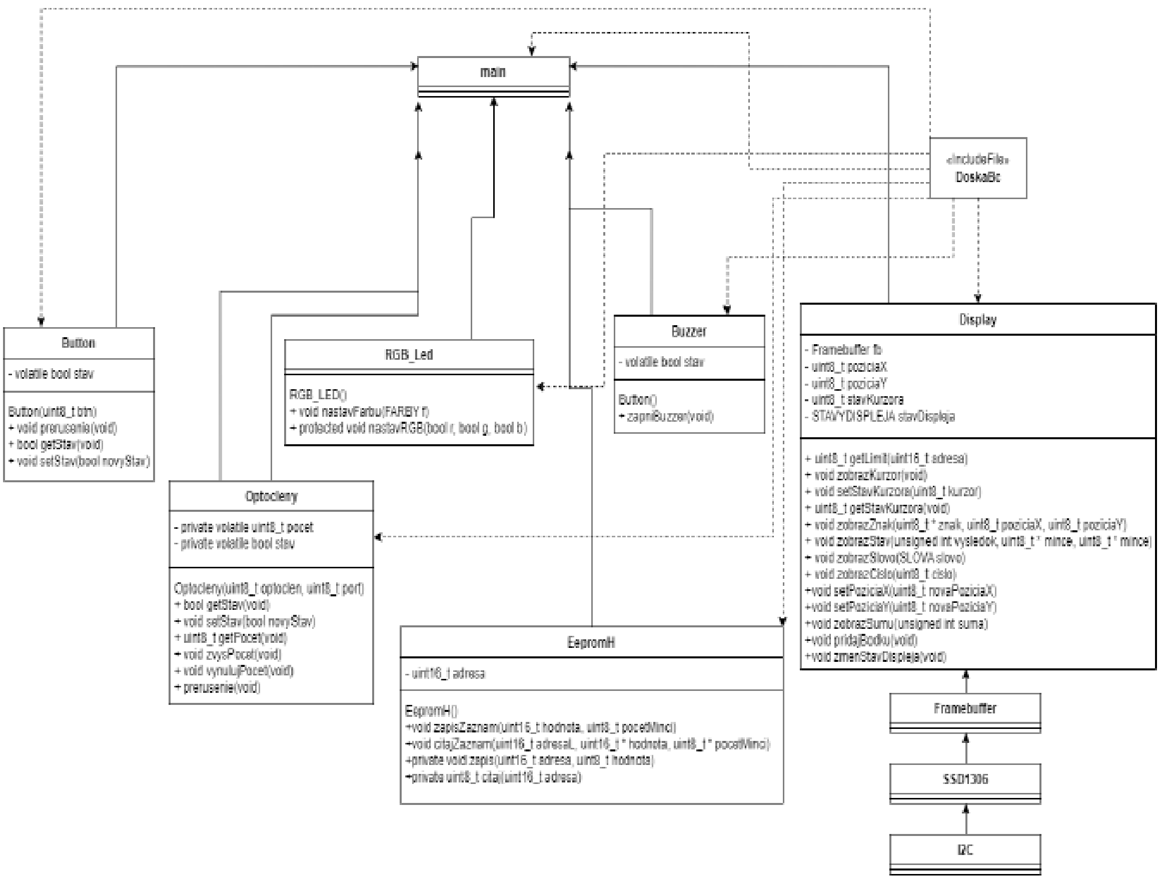

Fig. 2 SW architecture

The system's BLE communication module was tested to ensure seamless integration with future potential IoT applications. Though not the primary focus of the project, the modular architecture of the system allows for the addition of wireless communication capabilities, enabling remote monitoring and control. These features could be expanded in future iterations to incorporate advanced analytics and cloud-based storage for enhanced usability.

Overall, the methodology prioritized a modular and scalable design, ensuring that the system could be adapted to diverse applications and future enhancements. By combining precise hardware engineering with efficient software algorithms and rigorous testing, the proposed coin sorting system delivers a reliable, portable, and cost-effective solution suitable for a variety of environments, including vending machines, retail counters, and small-scale financial institutions. This approach highlights the potential of microcontroller-based systems to revolutionize everyday tasks through automation and intelligent design.

Fig. 3 Developed device

III. CONCLUSION

The system was assembled and tested iteratively. Component functionality was validated individually using test scripts, followed by integration testing to ensure seamless communication and operation. Coins of various denominations were inserted to evaluate detection accuracy and operational reliability. Final testing involved real-world scenarios to simulate actual usage conditions. The intelligent coin sorter demonstrated accurate detection and categorization of coins, achieving consistent recognition rates across various coin types. Optical sensors successfully identified coins based on dimensions, with an error rate below 2%. The system maintained stable operation during prolonged testing, with minimal power consumption. The OLED display provided clear and responsive feedback, enhancing usability.

The integration of mechanical, hardware, and software components in the proposed system highlights the advantages of a modular and scalable design. The use of optical sensors and an

AVR microcontroller ensures reliable coin detection and processing. While the system achieved its primary objectives, certain challenges were identified, such as sensor sensitivity to environmental light conditions and alignment precision. Future improvements could include the integration of advanced sensors and machine learning algorithms to enhance detection capabilities and adapt to varying coin dimensions.

The study successfully developed an intelligent coin sorting system that combines mechanical design with microcontroller-based hardware and software. The system provides accurate and efficient coin detection, addressing the limitations of traditional solutions. Its compact design and low production cost make it a viable option for small businesses and automated systems. Future research could explore extending its capabilities, such as integrating wireless communication for remote monitoring and data analysis.

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