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N58 Open CPU-Based Milk Collection System

Dhwani A. Bambhaniya[1], Mayur M. Sevak[2,*], Arjan B. Bambhaniya[3]

Abstract

The N58 Open CPU-based milk collection system is designed to enhance the efficiency and transparency of milk collection processes in rural and urban dairy operations. By integrating a computerized platform with open-source technology (Open CPU), the system enables real-time monitoring, automatic data logging, and streamlined milk collection from multiple sources. The system allows farmers to register and track their milk deliveries, monitor milk parameters such as fat content and volume, and access instant payment reports. By automating various steps in the collection process, it reduces human error, prevents fraudulent activities, and ensures accurate measurements, which ultimately improves the overall transparency of the milk supply chain. The open-source nature of the platform ensures scalability and adaptability, making it suitable for diverse dairy operations while promoting sustainable practices and minimizing operational costs. This innovation aims to optimize milk collection, improve profitability for farmers, and deliver high quality milk to consumers.

Keywords: Open CPU, milk collection, cost, farmer, dairy

INTRODUCTION

History and Contribution of Milk Collection System

The history of the milk collection system reflects a fascinating evolution, transitioning from basic, manual techniques to advanced, technology-driven solutions designed for efficiency, quality control, and sustainability. In the early days of dairy farming, before industrial advancements, milk collection was a completely manual, labor-intensive task. Farmers milked cows by hand using pails or buckets, storing milk in basic containers, typically in cool, shaded areas to delay spoilage. Without refrigeration technology, milk needed to be consumed quickly or processed into dairy products like butter, cheese, or yogurt to extend its usability [1–3]. Selling milk was a hyper-local affair — farmers would distribute milk directly to nearby families or markets, and there was no organized infrastructure to manage transportation or ensure quality.

With the arrival of the Industrial Revolution in the 18th and 19th centuries, transformative changes began reshaping the dairy industry [4]. One of the first major innovations was the introduction of milk cans—metal containers that allowed farmers to store and transport milk in larger quantities more efficiently. This period also saw the rise of dairy cooperatives, where farmers pooled their milk, enabling centralized processing and distribution, which was critical to meeting the demands of growing urban populations. In cities, milkmen became a common sight, delivering milk door-to-door in large containers, though without refrigeration, milk still spoiled quickly, especially in warmer seasons.

***Author for Correspondence**
Mayur M. Sevak
E-mail: mayur.sevak@bvmengineering.ac.in

[1]Student, Department of Electronics & Communication Engineering, Birla Vishvakarma, Mahavidyalaya (Engineering College), Anand, Gujarat, India
[2,3]Assitant Professor, Department of Electronics & Communication Engineering, Birla Vishvakarma, Mahavidyalaya (Engineering College), Anand, Gujarat, India

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Early Milk Collection (Pre-Industrial Era)

In the early days of dairy farming, milk collection was a manual, labor-intensive process. Farmers would milk cows by hand, typically using pails or buckets. The milk was then stored in containers, often in cool, dry places to prevent spoilage. Since there were no refrigeration methods available, milk had to be consumed quickly or processed into dairy products such as butter, cheese, and yogurt to extend its shelf life [5–8].

Farmers would generally sell milk locally, with little to no system for organized transportation or quality control. The milk was usually collected in small quantities, and there was no standardized way of measuring quality or managing the supply chain. The practice was largely decentralized, with each household responsible for its own milk production and storage.

The Industrial Revolution (18th–19th Century)

With the advent of the Industrial Revolution in the 18th and 19th centuries, significant advancements were made in dairy farming and milk collection.

- *Introduction of Milk Cans:* One of the earliest innovations was the use of milk cans in the late 19th century. These were metal containers used to collect and store milk in larger quantities, which allowed farmers to deliver milk to centralized locations more efficiently.
- *Dairy Cooperatives:* In the late 19th century, dairy cooperatives began to form in response to growing urban populations and the need for more reliable milk distribution systems. These cooperatives allowed farmers to pool their milk together, which could then be processed more efficiently in centralized facilities [9–12].
- *First Milk Delivery:* In urban areas, milk was often delivered door-to-door by milkmen. The milk was typically carried in large containers and dispensed in smaller amounts for individual households. The transportation system was still rudimentary and lacked refrigeration, so milk often spoiled quickly in warm weather.

The Technological Advancements and Refrigeration (Early 20th Century)

The 20th century saw major changes in the milk collection system, thanks in large part to technological innovations like refrigeration and the rise of mechanized dairy farming.

- *Refrigerated Milk Tankers:* The introduction of refrigerated milk tankers in the early 20th century was a game-changer for the dairy industry. Milk could now be transported over long distances without the risk of spoilage, significantly expanding the milk market and allowing farmers to serve urban populations more effectively [12].
- *Milk Cooling:* The introduction of milk cooling systems, including bulk milk coolers, enabled farmers to store milk at low temperatures immediately after collection, preventing spoilage and maintaining quality. These systems also improved hygiene by reducing contamination risks [13–15].
- *Mechanical Milking Machines:* The development of mechanical milking machines in the early 20th century revolutionized milk collection on dairy farms. These machines allowed farmers to collect milk faster and more efficiently than manual hand-milking, especially on large farms with many cows.

The Post-World War II Developments (Mid-20th Century)

After World War II, milk collection systems became more sophisticated, with the widespread adoption of new technologies and processes aimed at improving efficiency and quality.

- *Bulk Milk Collection:* Large-scale bulk milk collection systems became common in the 1950s and 1960s, as farmers transitioned from delivering milk in small quantities to delivering it in larger volumes to centralized collection points. These bulk collection points were often equipped with refrigeration to keep the milk fresh during transport [15].
- *Standardization and Quality Control:* As the demand for milk increased, milk collection systems began to implement quality control measures. These included tests for fat content, bacterial count, and temperature checks, which ensured that the milk met certain standards before reaching consumers.

- *Automated Milk Collection:* During the mid-20th century, the introduction of automated systems for measuring and testing milk quality started to gain traction. This further streamlined the milk collection process and reduced the reliance on human labor.

The Modern Milk Collection Systems (Late 20th–21st Century)

The late 20th and early 21st centuries have seen the development of highly efficient and automated milk collection systems that integrate cutting-edge technology.

- *Automated Milking Systems:* The development of automated milking systems (AMS), also known as robotic milking, has transformed the way milk is collected on dairy farms. These systems allow cows to be milked automatically, without human intervention, while monitoring the cow's health and producing data on milk quality and quantity in real time [16].
- *Real-Time Data and Monitoring:* Modern milk collection systems are increasingly data-driven. Advanced sensor technology, IoT (internet of things) devices, and cloud-based systems enable real-time monitoring of milk quality (such as fat content, protein levels, and bacterial load) and the performance of the entire milk collection process. This allows for better quality control and data management throughout the supply chain [17–19].
- *Milk Collection Points and Logistics:* Today, milk collection points are highly automated, with sophisticated systems for monitoring milk storage, tracking deliveries, and ensuring the milk reaches processing plants efficiently.
- Refrigerated transport is now the norm, with temperature-controlled milk tankers and GPS (global positioning system) routing systems ensuring that milk is delivered quickly and at the right temperature.
- *Blockchain and Traceability:* In recent years, the implementation of blockchain technology in the dairy industry has further improved milk traceability, allowing consumers and stakeholders to track milk from the farm to the processing plant.

Need of Open CPU in Milk Collection

An Open CPU plays a crucial role in addressing these challenges by enabling a high level of automation and real-time data processing.

- *Automation of Milk Collection Processes:* Automation reduces human error and speeds up the collection process, leading to faster and more efficient operations (Figure 1).
- *Real-Time Monitoring:* Open CPU allows for real-time processing of data related to milk quality (e.g., fat content, SNF [solids not fat]) and quantity (e.g., weight of milk).
- *Integration with External Systems and Devices:* Milk collection systems often involve a variety of external devices such as milk weighing scales, quality analyzers, and payment terminals.

CHARACTERISTICS OF N58

- *Real-Time Processing:* Capable of handling time-sensitive tasks such as monitoring milk quality, calculating payment, and recording data in real-time.
- *Customizable:* Can be programmed to fit specific needs, making it adaptable for various applications like milk collection systems, industrial automation, or monitoring systems.
- *Interfacing with Sensors and Devices:* The CPU can interface with multiple sensors and devices such as weight sensors, quality analyzers, and payment terminals to automate tasks.
- *Data Handling:* It can store, process, and transmit data to centralized systems or databases for tracking and reporting purposes [20].
- *Scalable:* The Open CPU design allows for system expansion, making it suitable for applications that may grow in terms of data volume or functionality.

LITERATURE REVIEW

Agriculture is the strength of our country and the main joint business of Indian farmers is dairy farming. Dairies collect milk from farmer every day and payments are made on the basis of rate per liter. The rates depend on different parameter like weight, fat, adulteration, etc. The more the fat, more is the price. For this reason, there is a huge level of corruption in milk collection centers. Milk collection centers give daily receipt of milk information so there is wastage of paper also [21].

Figure 1. Automated milk bottling line.

In developing countries, production is dominated by small farmers with limited resources such as inadequate storage, transportation and finance. Furthermore, the presence of many intermediaries between farmers and final consumers reduce the margins realized by the small farmers and force them to sell their product at lower price. All the above factors lead to food loss waste (FLW) at the farm level [20].

First, existing machine learning (ML) models increasingly try to find specific labels for a larger number of activities. Their accuracy may become lower since it will be more challenging to distinguish between different but similar activities. Without understanding the correlation between the observed data, more data collection can be meaningless [11].

Besides, without understanding the fundamentals of the model (often referred to as the machine), it is hard to redesign the model structure. Given these issues, the explainable artificial intelligence (AI) approach aims to understand how the machine thinks while possibly using such understanding to improve prediction accuracy or usefulness in real-world scenarios with various constraints [4–6].

Deep-learning based computer vision models have proved themselves to be ground-breaking approaches to human activity recognition (HAR). However, most existing works are dedicated to improve the prediction accuracy through either creating new model architectures, increasing model complexity, or model parameters by training on larger datasets. Here, we propose an alternative idea, differing from existing work, to increase model accuracy and also to shape model predictions to align with human understandings through automatically creating higher-level summarizing labels for similar groups of human activities [7].

PARAMETERS IN MILK COLLECTION SYSTEM

Advantages

- Enhanced accuracy and efficiency
- Improved milk quality monitoring
- Reduced labor costs
- Real-time monitoring and control

Disadvantages
- Complexity in setup and integration
- Technology dependency

Input Parameters (Sensors and Devices):
- *Weight Measurement:* Weight of milk (from weight scale via RS232).
- *Milk Quality Parameters (from Analyzer via RS232):* Fat percentage, SNF (Solids-Not-Fat) percentage, density, water content/adulteration detection, etc.
- *User Input Parameters (via HID [Human Interface Device] Keyboard or Touchscreen):* Farmer ID or supplier code, quantity confirmation, rate per liter (based on fat/SNF values), payment mode selection.

Processing Parameters (Handled by N58 Open CPU)
- *Calculation of Payment:* Milk rate determination (based on fat/SNF content), total amount calculation (quantity × rate).
- *Data Logging and Storage (SD Card via SDIO):* Date and time of collection, farmer/supplier details, weight and quality parameters, payment records, etc.
- *Communication Protocols:* RS232 (weight scale, analyzer, printer), SPI (serial peripheral interface) (TFT [thin film technology] display, MAX3421 for keyboard), SDIO (storage in SD card).

Furthermore, Figure 2 illustrates the block diagram of the N58 Open CPU based milk collection system.

DISCUSSION

The N58 Open CPU-based milk collection system is an advanced solution designed to automate and streamline the process of milk procurement at dairy collection centers. This system integrates various peripherals such as a weight scale, milk analyzer, printer, TFT display, HID keyboard, and SD card storage, all connected through different communication protocols like RS232 driver, SPI, and SDIO [8–10].

The weight scale measures the quantity of milk and transmits the data via RS232 to the N58 CPU, while the milk analyzer provides essential quality parameters such as fat percentage, SNF content, pH, and temperature, which help determine the pricing of the milk.

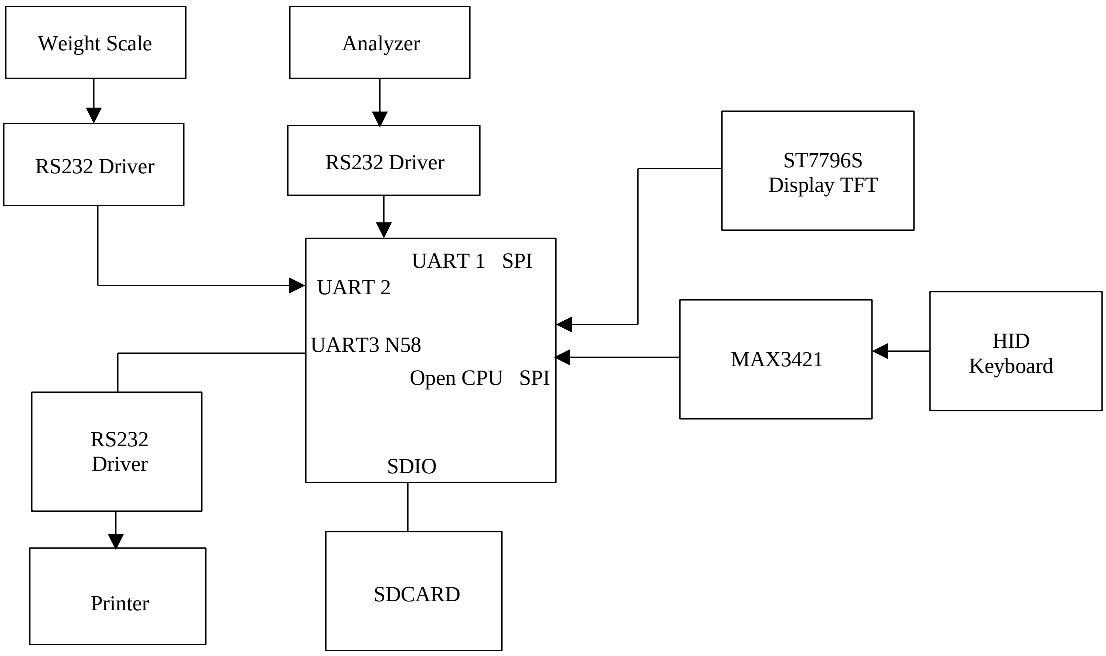

Figure 2. Block diagram of system.

A HID keyboard, connected via MAX3421 over SPI, allows operators to input supplier details, price rates, and other necessary information. The TFT display presents real-time information such as weight, quality parameters, and calculated pricing, ensuring transparency in transactions.

The N58 CPU processes the collected data to calculate the final price based on predefined rate charts. The transaction details, including supplier ID, milk weight, quality parameters, and payment details, are stored securely in an SD card via SDIO, ensuring data integrity and easy retrieval. Once the transaction is complete, a thermal printer generates a receipt containing all relevant details, providing proof of transaction for both the supplier and the collection center [9].

The N58 Open CPU is well-suited for this application due to its compact design, multiple communication interfaces, and efficient data processing capabilities. It eliminates the need for external microcontrollers, making the system more cost effective and easy to manage. By automating weight recording, quality assessment, and pricing calculations, the system reduces human errors, enhances transparency, and ensures accurate record-keeping. Furthermore, the ability to integrate with banking APIs (application programming interfaces) for direct farmer payments adds convenience and financial security to dairy suppliers. Future enhancements could include wireless connectivity, IoT-based real-time monitoring, and AI-driven milk quality analysis, further optimizing the efficiency of milk collection operations.

RESULTS

The N58 Open CPU-based milk collection system typically yields several positive outcomes for dairy farms. First and foremost, it enhances operational efficiency by automating the milk collection process, reducing the need for manual labor and minimizing human errors. With real-time data monitoring, the system tracks important metrics such as milk yield, quality (fat content, temperature), and time of collection, enabling farmers to make informed, data-driven decisions. This leads to better herd management and improved milk quality control, as the system ensures that milk is collected under optimal conditions, reducing the risk of contamination. Over time, this automation reduces labor costs and improves overall cost efficiency by minimizing waste and spoilage. Additionally, the system's open CPU architecture allows for easy customization and integration with other farm management systems, offering scalability and flexibility to meet the needs of farms of various sizes. Ultimately, the N58 system helps farmers streamline operations, maintain high-quality standards, and improve profitability.

CONCLUSION

In conclusion, The N58 Open CPU-based milk collection system is a highly efficient, automated solution that enhances the accuracy, transparency, and reliability of milk procurement at dairy collection centers. By integrating multiple peripherals such as weight scales, milk analyzers, printers, TFT displays, HID keyboards, and SD card storage, the system ensures seamless data acquisition, processing, and record-keeping. The use of RS232, SPI, and SDIO interfaces allows smooth communication between devices, eliminating manual errors and improving operational efficiency. With automated weight measurement, quality analysis, pricing calculations, and receipt generation, the system reduces dependency on manual interventions while ensuring fair and transparent transactions for dairy farmers. The SD card storage secures transaction records, and optional cloud integration with GPRS/4G modules further enhances data accessibility and real-time notifications. Additionally, potential integration with banking APIs for direct farmer payments increases financial security and convenience.

REFERNECES

1. Yadav SB, Dhavale KB, Kale SD, Kota PN. Automatic milk collection system. Asian J Converg Technol.2018; 4 (1): 1–4.
2. Benabdallah C, El Amraoui A, Frikha A, Delmotte F. Milk collection network design: location and configuration of small milk collection. In: 2022 5th International Conference on Advanced Systems and Emergent Technologies (IC_ASET), Hammamet, Tunisia, March 22–25, 2022. pp. 121–126.

3. Pearl J, Mackenzie D. The Book of Why: The New Science of Cause and Effect. New York, NY, USA: Basic Books; 2018.
4. Gunning D. Explainable artificial intelligence (XAI). Defense Advanced Research Projects Agency (DARPA). November 2017. Available at https://nsarchive.gwu.edu/sites/default/files/documents/5794867/National-Security-Archive-David-Gunning-DARPA.pdf
5. Adadi A, Berrada M. Peeking inside the black-box: a survey on explainable artificial intelligence (XAI). IEEE Access. 2018; 6: 52138–52160.
6. Holzinger A, Biemann C, Pattichis CS, Kell DB. What do we need to build explainable AI systems for the medical domain?. arXiv preprint. arXiv:1712.09923. December 28, 2017.
7. Altin M, Gürsoy F, Xu L. Machine-generated hierarchical structure of human activities to reveal how machines think. IEEE Access. 2021; 9: 18307–18317.
8. Xia K, Huang J, Wang H. LSTM-CNN architecture for human activity recognition. IEEE Access. 2020; 8: 56855–56866.
9. Yadav SN, Kulkarni VA, Gholap SG. Design of milk analysis embedded system for dairy farmers. In: 2013 International Conference on Advances in Technology and Engineering (ICATE), Mumbai, India, January 23–25, 2013. pp. 1-5.
10. Chakravarty R. IT at milk collection centers in cooperative dairies: The National Dairy Development Board experience. In: Bhatnagar S, Schware R, editors. Information and Communication Technology in Development: Cases from India. New Delhi, India: Sage Publications; 2000. pp. 37–47.
11. Ait-Saidi A, Caja G, Salama AA, Carné S. Implementing electronic identification for performance recording in sheep: I. Manual versus semiautomatic and automatic recording systems in dairy and meat farms. J Dairy Sci. 2014; 97 (12): 7505–7514.
12. Katheria AC, Truong G, Cousins L, Oshiro B, Finer NN. Umbilical cord milking versus delayed cord clamping in preterm infants. Pediatrics. 2015; 136 (1): 61–69.
13. Manjunath PK, Janani RS, Pillai AS. OpenCPU platform for IoT applications—a study. In: 2017 International Conference on Technological Advancements in Power and Energy (TAP Energy), Kollam, India, December 21–23, 2017. pp. 1–5.
14. Laguna JC, Higuera AG, Cantabrana RZ, de las Morenas J. Comprehensive traceability system of milk samples using RFID. In: Smart SysTech 2012: European Conference on Smart Objects, Systems and Technologies, Osnabrueck, Germany, June 12–13, 2012. pp. 1–8.
15. Durgun M. Real-time milk quality control using multi-spectral sensing and edge computing: advancing on-site detection of milk components with XGBoost. Appl Sci. 2024; 14 (23): 10916.
16. Faris ZM, Croock MS. Sensor network based animals feeding and milk production management system. Eng Technol J. 2018; 36 (2 Part A): 213–222.
17. Wolfert S, Ge L, Verdouw C, Bogaardt MJ. Big data in smart farming – a review. Agric Syst. 2017; 153: 69–80.
18. Jukan A, Carpio F, Masip X, Ferrer AJ, Kemper N, Stetina BU. Fog-to-cloud computing for farming: low-cost technologies, data exchange, and animal welfare. Computer. 2019; 52 (10): 41–51.
19. Melin M, Hermans GG, Pettersson G, Wiktorsson H. Cow traffic in relation to social rank and motivation of cows in an automatic milking system with control gates and an open waiting area. Appl Anim Behav Sci. 2006; 96 (3–4): 201–214.
20. Gruetzmacher TJ, Bradley Jr RL. Identification and control of processing variables that affect the quality and safety of fluid milk. J Food Protect. 1999; 62 (6): 625–631.
21. Sun L, Lundh Å, Höjer A, Bernes G, Nilsson D, Johansson M, Hetta M, Gustafsson AH, Saedén KH, Dicksved J. Milking system and premilking routines have a strong effect on the microbial community in bulk tank milk. J Dairy Sci. 2022; 105 (1): 123–139.

