IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.471 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 12, December 2025

DOI: 10.17148/IJARCCE.2025.141207

IOT-BASED AUTOMATIC BILLING AND MILK QUALITY MANAGEMENT SYSTEM

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Abstract: The dairy industry faces persistent challenges in ensuring milk quality, transparency in transactions, and operational efficiency. This project proposes an IoT-based system that automates milk collection, quality assessment, and billing processes to address these issues. The system integrates sensors to measure key milk parameters such as fat content, SNF (SolidsNot-Fat), temperature, and volume in real-time. These readings are transmitted to a central microcontroller, which processes the data and calculates the payment based on predefined quality and quantity metrics. The results are displayed instantly and stored in a cloud database for transparency and traceability.

Keywords: IoT, Milk quality management, Billing automation, Auto-filling, Dairy industry.

I. INTRODUCTION

The dairy sector plays an important role in supporting the livelihood of millions of farmers, especially in rural areas. However, the traditional method of milk collection still depends heavily on manual checking, handwritten records, and human judgment. This often leads to mistakes, delays, unfair pricing, and misunderstandings between farmers and milk collection centres. Many farmers feel unsure whether their milk is being tested correctly or whether they are being paid the right amount. At the same time, dairy centres struggle to maintain consistency, transparency, and proper quality control.

To overcome these challenges, this project introduces an IoT-based automatic billing and milk quality management system. The idea is to bring accuracy, fairness, and simplicity to the milk collection process. Sensors are used to measure essential parameters such as pH, temperature, fat content, and weight, giving real-time and unbiased results. The system automatically calculates the payment based on quality and quantity, reducing human errors. With IoT features, the data is uploaded online so that both farmers and dairy managers can access clear records anytime.

Overall, this project aims to modernize dairy collection by combining technology with practical needs, ensuring trust, efficiency, and better outcomes for everyone involved.

II. LITERATURE SURVEY

The literature survey for this project shows how different researchers have tried to improve milk quality testing and automate the dairy collection process using sensors and simple electronic systems. Earlier works mostly focused on detecting adulteration using pH, temperature, and conductivity sensors. These studies highlight that milk spoils quickly and can easily be mixed with water, soda, or other chemicals, making sensor-based testing an essential requirement. Some researchers built low-cost Arduino systems to help rural farmers check milk freshness without laboratory equipment, proving that simple technology can make a big difference in small villages.

Other studies explored advanced methods like spectroscopy and machine learning to identify adulteration more accurately. A few projects also introduced automatic billing systems where milk weight and quality were combined to generate a transparent payment slip. This idea inspired the need for fair and unbiased billing at collection centres. Research on IoT-based systems showed how uploading data to the cloud improves record-keeping and ensures transparency between farmers and dairy managers.

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Overall, the literature highlights a clear problem: farmers need honest testing and fair pricing, while dairy centres need accuracy and efficiency. These findings support the need for a combined system that uses sensors, automation, and IoT to manage milk quality and billing together.

III. METHODOLOGY

The methodology of this IoT-based automatic billing and milk quality management system begins with collecting milk from the farmer and placing it on a load cell. The load cell accurately measures the weight of the milk, ensuring the quantity is recorded without any manual errors. After this, the milk sample is tested using sensors such as pH, temperature, and fat sensors. These sensors instantly check how fresh the milk is, whether it has been adulterated, and what fat percentage it contains. All these readings are sent to the Arduino, which acts as the main controller.

The Arduino processes the sensor data and compares the values with standard quality levels. Based on these readings, the system calculates the price of the milk automatically, combining both the weight and the fat percentage. The results are displayed on the LCD screen so that the operator and farmer can clearly see the values and payment.

At the same time, the NodeMCU module sends all the processed information to a cloud platform using Wi-Fi. This creates a digital record of quality, quantity, and billing for future reference. The pump and relay unit help in handling and transferring the milk safely. Through this automated process, the system ensures fairness, accuracy, and transparency for both farmers and dairy centres.

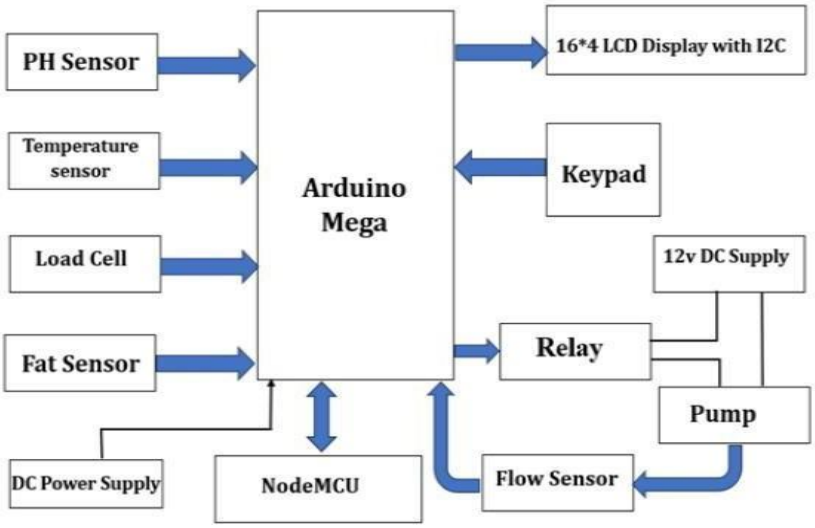

Figure 1: Block Diagram of Proposed System

The Arduino Mega is the main controller of the system, and all sensors are connected directly to it. The pH sensor, temperature sensor, load cell, and fat sensor send their readings to the input pins of the Arduino. These sensors allow the system to check milk freshness, temperature, weight, and fat content. The Arduino reads these values and prepares them for processing. A DC power supply provides the required 5V power to the Arduino and all sensors.

On the output side, the Arduino is connected to a 16×4 LCD display through an I2C module, which reduces wiring to just two lines. A keypad is also connected so the operator can enter details such as farmer ID. A relay module is connected to the Arduino, and it controls the milk pump, which runs on a separate 12V power supply

The NodeMCU is connected to the Arduino using serial communication pins. It receives the processed sensor data from the Arduino and uploads it to the cloud through Wi-Fi. This allows all milk readings and billing information to be stored online and viewed remotely. Together, these connections allow the system to test milk quality.

The diagram shows how all components of the automatic billing and milk quality management system are connected. At the centre is the Arduino Mega, which acts as the main controller. The pH sensor, temperature sensor, load cell, and fat sensor are connected to the input pins of the Arduino so it can read milk quality and quantity in real time. The readings are processed inside the controller.
On the output side, the Arduino sends the results to a 16×4 LCD display using an I2C interface, which reduces wiring.

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A keypad is also connected to allow the operator to enter farmer details or give commands. The relay module is connected to the Arduino and controls the milk pump using a 12V power supply. The flow sensor attached to the pipe sends data back to the Arduino to monitor milk movement.

A NodeMCU module is connected for Wi-Fi communication. It uploads all processed data to the cloud, allowing remote monitoring and digital record keeping.

IV. RESULTS

The proposed system was implemented and tested under various real milk collection conditions. Milk quality monitoring accurately measured pH, temperature, and fat levels using the connected sensors. The load cell recorded milk weight with high precision, enabling correct quantity calculation. The IoT module successfully uploaded all readings to the cloud for remote monitoring. The automatic billing feature generated accurate payment based on both milk quality and quantity. The pump and flow-control mechanism operated smoothly during milk transfer, ensuring stable and hygienic handling throughout testing.

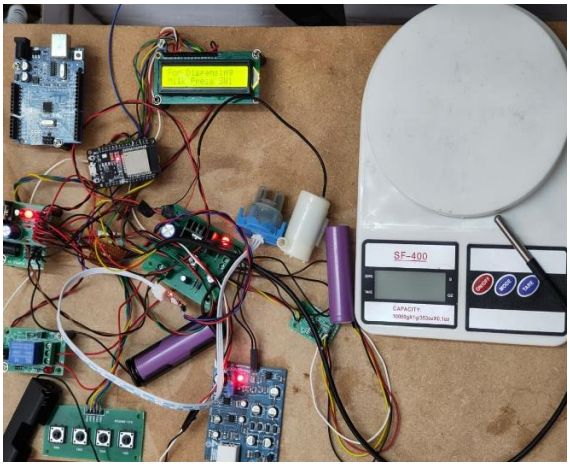

Fig 5.1: Prototype of Proposed System

This prototype is designed to monitor Milk Quality and Despensing the milk the milk quality is measured using Ph sensor, Tubidity sensor, Ldr sensor, Temperature sensor, Smell sensor, And for dispensing milk uses pump, and weighing scale to despense the milk.

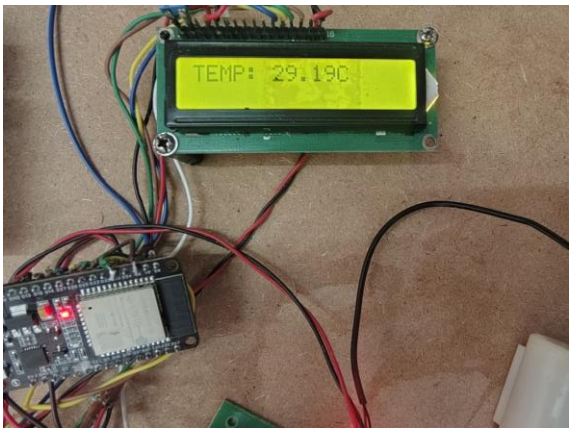

Fig 5.2 Work of Temperature sensor

The temperature sensor is a key component in an IoT-based automatic billing and milk quality monitoring system. Its primary function is to continuously measure the temperature of the milk stored in the dispensing tank to ensure freshness and safety. Because milk is highly perishable, maintaining it within the recommended range (typically **2–6°C**) is essential to prevent bacterial. growth and spoilage.

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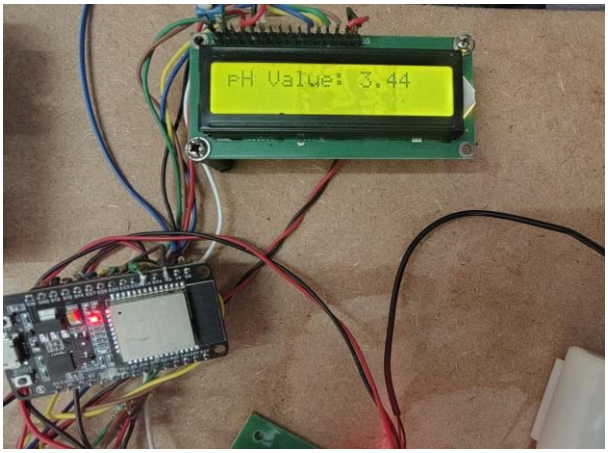

Fig 5.3 PH Value of milk for quality.

The **pH sensor** is an essential component used to assess the **freshness, purity, and spoilage level** of milk in an IoT-based automatic billing and milk quality monitoring system. Since milk is highly sensitive to bacterial activity, its pH value changes noticeably as it spoils. Fresh milk typically has a slightly acidic pH of **6.6 to 6.8**, and when bacterial growth increases, the pH drops, indicating souring and poor quality.

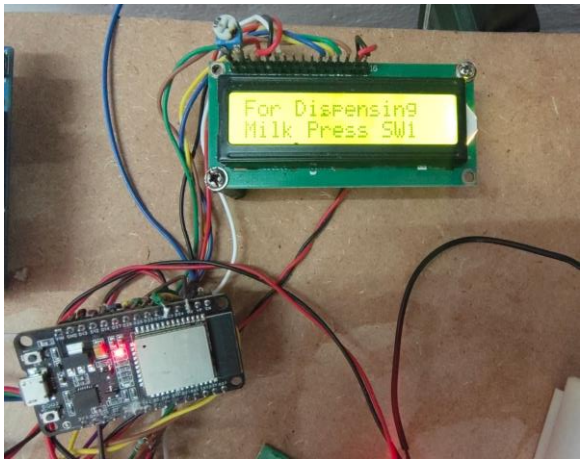

Fig 5.4 Despensing of milk

A milk dispenser that uses a pump to automatically deliver preset quantities of **0.25 L, 0.5 L, and 1 L** by running the pump for calibrated durations for accuracy.

Fig 5.5 LDR sensor for quality

An **LDR sensor** is used to detect milk flow or level changes, enabling an IoT-based system to automatically measure quantity, check quality indicators, and generate real-time billing.

V. CONCLUSION AND FUTURE SCOPE

This project successfully demonstrates how IoT and sensor-based automation can bring fairness, accuracy, and trust to milk collection centres. By measuring pH, temperature, fat percentage, and weight automatically, the system reduces

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manual errors and ensures that farmers receive honest payment based on real data. The cloud storage feature keeps records safe and accessible, improving communication between farmers and dairy managers. Overall, the system proves that simple technology can make a meaningful difference in improving transparency and efficiency in dairy operations.

In the future, the system can be expanded by adding mobile app support so farmers can view their records instantly. Machine learning can be used to predict milk quality trends and detect adulteration more accurately. Automatic cleaning mechanisms and advanced sensors can be introduced for better hygiene and safety. The system can also be connected to large dairy software platforms, making it suitable for bigger industries and cooperative networks.

ACKNOWLEDGMENT

I would like to express my heartfelt gratitude to my project guide and faculty members for their continuous support, guidance, and encouragement throughout the development of this project. Their valuable suggestions, patient explanations, and constant motivation helped me understand each step clearly and complete this work with confidence.

I am also deeply thankful to my department and the laboratory staff for providing the necessary facilities, tools, and a comfortable working environment. Their cooperation made it easier for me to test, analyse, and improve the system during each stage of development. I truly appreciate their time and willingness to help whenever needed.

Lastly, I want to thank my friends and family for their encouragement, understanding, and emotional support throughout this journey. Their constant belief in me kept me motivated, even during difficult moments. I am grateful to everyone who directly or indirectly contributed to this project and helped me grow both technically and personally.

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