Milk Quality Checker

Aryan Rahul patkar[1], Omkar Machindra Adak[2], Shreyash Gajanan kharade[3]. Guide: - Adinath Shankar Satpute[4]

[1,2,3,4]*Department of Electronics and Telecommunication,*
Samarth polytechnic belhe, pune.

***Abstract*—Milk is a widely consumed food product, but due to its perishable nature, it is highly susceptible to spoilage and adulteration. Traditional methods for testing milk quality are time consuming, require laboratory facilities, and are not feasible for real-time or on-site use. This project aims to develop a low-cost, portable Milk Quality Checker that uses sensors to monitor key parameters such as pH level, temperature, and Total Dissolved Solids (TDS) to determine milk freshness and detect possible adulteration.**

***Index Terms*—Milk Quality, pH Sensor, Temperature Sensor, TDS Sensor, ESP 32, Food Safety, Real-time Monitoring, Milk Adulteration Detection, IoT based System, Embedded System, Sensor Technology, Dairy Industry, Microcontroller Milk Spoilage Detection, Low-Cost Solution**

I. INTRODUCTION

Milk is a vital part of the human diet, but it is highly perishable and prone to spoilage and adulteration. Traditional testing methods are time consuming and require lab facilities. A Milk Quality Checker offers a smart, sensor-based solution to quickly assess milk quality by measuring parameters like pH, temperature, and conductivity. This system enables real-time, onsite monitoring, ensuring safety and reducing health risks associated with spoiled or adulterated milk.

II. LITERATURE SURVEY

Rapid sensor- and biosensor-based methods have been developed to detect milk spoilage using key indicators such as pH, conductivity/impedance, dissolved oxygen, ATP, CO_2, etc. These methods offer fast response times, high sensitivity, and potential for real-time monitoring.

Electronic noses ("E-nose") made of metal oxide semiconductor sensors have been used to classify milk quality, as well as identify milk source (farm origin) by analyzing odor and chemical composition, along with machine learning for classification.

Bioelectrochemical sensors combined with signal processing and machine learning enable detection of specific adulterants (e.g. antibiotics) in milk with high accuracy.

Impedance-based methods (e.g. using four-electrode / van der Pauw configurations) have been explored to detect water addition and adulterants in milk, providing cheaper alternatives to conventional lab-techniques.

Multispectral / color sensor approaches have been used in portable systems paired with lightweight machine learning models (e.g. logistic regression) for real-time adulteration detection. These shows promise for affordability and field deployment.

III. PROBLEM STATEMENT

Traditional methods for assessing milk quality are time-consuming, costly, and require laboratory infrastructure, making them unsuitable for Realtime or on-site testing. There is a need for a low cost, portable, and sensor-based system that can accurately and quickly detect milk spoilage and adulteration to ensure safety and quality throughout the supply chain.

IV. AIM AND OBJECTIVES

Aim: To design and develop a low-cost, sensor-based system for real-time detection of milk quality and adulteration.

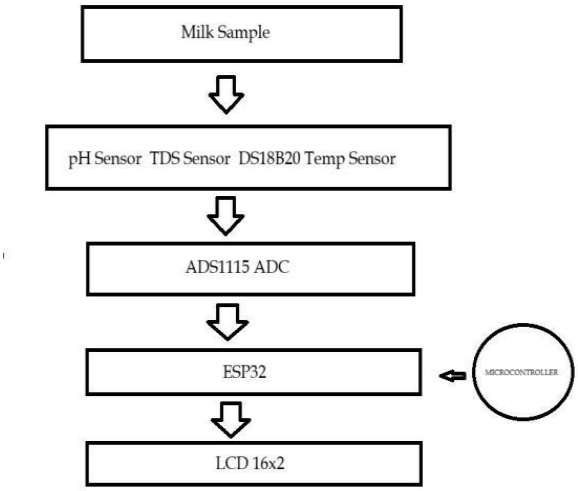
Objectives:

- To measure key milk parameters such as pH, temperature, and conductivity.
- To detect spoilage or adulteration using sensor data.

- To enable real-time monitoring through a microcontroller-based system.
- To provide quick, accurate, and user-friendly results on-site.

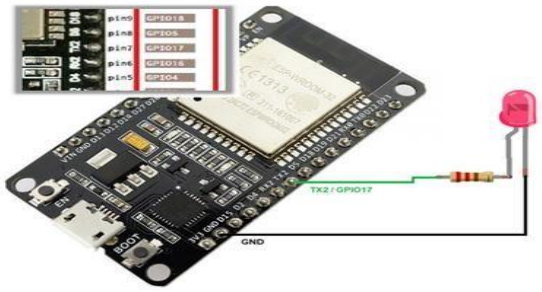
V. SYSTEM ARCHITECTURE

The system comprises sensors (pH, temperature, conductivity) interfaced with a microcontroller (e.g., Arduino or Raspberry Pi) for data acquisition. Sensor readings are processed and analyzed to determine milk quality. Results are displayed on an LCD or transmitted to a mobile app via Bluetooth/Wi-Fi for real-time monitoring.



VI. COMPONENTS

- Esp32



The ESP32 is a low-cost, low-power microcontroller with integrated Wi-Fi and Bluetooth capabilities, developed by Espressif Systems. It features a dual-core Tensilica LX6 processor, operates at up to 240 MHz, and supports a wide range of peripherals including ADC, DAC, SPI, I²C, UART, and PWM. Its built-in wireless modules make it ideal for IoT applications, including smart sensing, real-time data transmission, and remote monitoring.

- Gravity pH sensor

The Gravity pH Sensor is an easy-to-use sensor module designed to measure the pH level (acidity or alkalinity) of liquids. It typically consists of a pH probe connected to an interface board that converts the analog signal into a readable output for microcontrollers like Arduino or ESP32. Widely used in water quality monitoring, agriculture, and food industry applications, it provides accurate real-time pH measurement

- Gravity TDS sensor

The Gravity TDS (Total Dissolved Solids) Sensor measures the concentration of dissolved solids in water or liquid solutions by detecting the electrical conductivity. It provides an analog output proportional to the TDS level, which helps assess water or liquid purity. Commonly used in water quality monitoring, agriculture, and food industry, it's compatible with

microcontrollers like Arduino and ESP32 for real-time measurement.

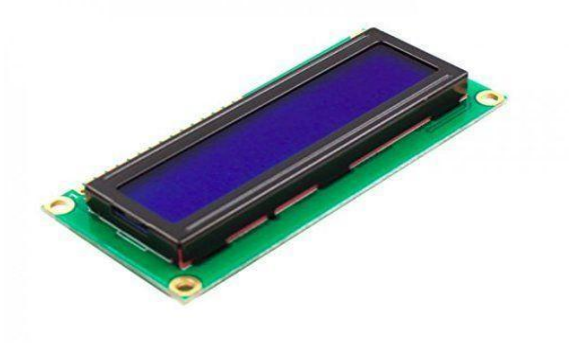
- Water Proof Temperature DS18B20

The DS18B20 is a digital temperature sensor with a waterproof stainless-steel probe, ideal for measuring temperature in liquids. It uses the 1Wire communication protocol, allowing multiple sensors to connect on a single data line. Known for its accuracy (±0.5°C) and ease of use with microcontrollers like Arduino and ESP32, it's widely used in environmental monitoring and food safety applications

- ADC ADS1115

The ADS1115 is a 16-bit analog-to-digital converter (ADC) with an I²C interface. It offers high-resolution, low-noise measurements and includes four input channels, programmable gain amplifier (PGA), and a sample rate up to 860 samples per second. Widely used to enhance microcontroller ADC capabilities, it's ideal for precise sensor readings in applications like environmental monitoring and instrumentation.

- LCD Display 16X2



The 16x2 LCD is a commonly used alphanumeric display module that can show 16 characters per line on 2 lines. It uses the HD44780 controller and communicates via parallel or I²C interface. It's widely used in microcontroller projects for displaying data such as sensor readings, status messages, and user prompts.

VII. WORKING

The system uses sensors to measure key milk parameters like pH, temperature, and conductivity. These sensors send analog signals to a microcontroller, which processes and analyzes the data to detect spoilage or adulteration. The results are displayed on an LCD or sent wirelessly to a mobile device, enabling real-time monitoring of milk quality.

VIII. RESULTS

The system successfully detected variations in milk quality based on sensor readings. Spoiled milk showed decreased pH, increased conductivity, and abnormal temperature levels. The real-time output matched expected spoilage patterns, confirming the system's reliability and effectiveness in identifying poor-quality milk.

IX. ADVANTAGES & APPLICATIONS

Advantages

1. Provides quick, real-time assessment of milk quality.

2. Portable and easy to use on-site without lab facilities.
3. Reduces risk of consuming spoiled or adulterated milk.

Applications

1. Used by dairy farmers for monitoring milk freshness.
2. Quality control in milk processing and packaging units.
3. Distribution centers to ensure milk safety during transit.

X. FUTURE SCOPE

Improving sensor accuracy, adding more contaminant detection, and using IoT for remote monitoring will enhance the Milk Quality Checker. Machine learning can boost prediction, and making the device smaller and cheaper will increase accessibility.

XI. CONCLUSION

The Milk Quality Checker offers a quick and affordable way to ensure milk safety and quality, helping prevent spoilage and adulteration for healthier consumption.

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