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## SOLAR POWERED MILK QUALITY MONITORING SYSTEM USING WSN

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**Abstract:** The current generation has seen a significant rise in milk demand, which has increased the number of milk centers in various regions. Milk is the most important source of nutrition for children, pregnant women, and adults. Milk of the highest quality is dense and free of contaminants. A few adulterants are added to milk to sustain milk income and increase yield. Since farmers supply so much of the milk, there's a fair chance they'll get the information wrong if they don't know what they're doing. The consistency of milk can be harmed by these adulterants. Adulteration of milk has been a major social problem in recent years. Consumption of tainted milk can result in serious health problems. Milk adulteration must be detected, and milk consistency must be ensured. Various types of sensors, such as pH sensors, gas sensors, and temperature sensors, may be used to detect milk adulteration. This implementation is designed to make the process more apparent to all people who deposit milk. The Arduino controller is used in this framework. The entire milk analyser system is regulated by this Arduino. Controllers are connected to a variety of sensors. This is an easy-to-use method.

### Highlights

- Arduino-Uno used in this system which provide a faster and reliable result than previously implemented milk analyzer system.
- Four different types of milk samples from different dairies are used in this milk quality analysis system. m Study indicated that this system is more efficient than the previous study. This system is user-friendly and easy to use.

**Keywords:** Arduino, LCD, Solar panel, turbidity sensor, gas sensor, pH sensor, temperature sensor, ultrasonic sensor, ESP8266.

### I. INTRODUCTION

Milk is one of the staple foods which is consumed all around the world for its nutritional value. Humans consume milk and milk products as their primary wellsprings of sustenance. As a rule, dairy items are high in starches, sugar, protein, nutrients, catalysts and minerals. Milk contains 3.3% protein, 5% lactose, 87% water and 3.9% fats. Nonetheless, the nature of supplements can contrast according to the type of cow, feed, season, lactation stage, and different variables. The expression "defilement" alludes to the expansion of different substances in milk to build how much crude milk accessible. Also, pollution of milk may happen during unsanitary handling, bundling, furthermore, circulation. The unapproved expansion of cow milk to milk from different animals is one of the most widely recognized adulterations in the dairy industry. This isn't simply an issue of food quality and realness, yet in addition of consumer security for the individuals who are allergic to cow milk. Food defilement is what is happening among shops today to create all the more speedy compensation. Defilement is utilized in dinners for instance, adding chalk powder to turmeric, starch to curry powder, mixing papaya seeds with dull pepper, developing mangoes and so on. On a long reason, this contaminated attempt has unfavorable outcomes for individuals. India finishes commonly 77.68 million metric gigantic heaps of fluid cow milk.

## II. MATERIALS AND METHODS

The Arduino-based milk quality and amount assessment is introduced in this review. Clients will utilize their phones to get to drain boundary information in this proposed structure. Utilizing an Android cell phone application, for example, a sequential Bluetooth terminal, information can be saved in their versatile memory as a Milk Log. The continuous clock module records ongoing milk boundaries like pH, temperature, saltiness, and other milk debasement. The pH level of milk, not set in stone by a pH sensor, is essentially used to decide the consistency of milk.

The sum and sorts of defilements added to drain are distinguished by this technique, which examinations the milk content. Electronic gadgets interacted with various sorts of sensors are utilized to recognize defilements.

## III. MAIN COMPONENTS OF THE SYSTEM

The key components of this proposed Arduino Uno system are as follows:

The UNO version is included in this proposed scheme. A microcontroller is the Arduino Uno. It's an open-source electronics platform board that's a hybrid of hardware and software. It can be directly pre-programmed via USB. It is based on the **ATmega328P microcontroller**. Digital I/P and O/P pins, Analog I/P pins, 16 MHz ceramic resonators, USB link, a power jack, and a reset button are all included. It's simple to connect to other electronics modules and sensors. It has a 5 volt DC operating voltage. It is a low-cost microcontroller board that regulates the entire device and provides quicker and more reliable results.

Solar Panel is used as a supply source to the proposed system and **ESP8266 WiFi module** is used as cloud protocol in which transfers data to the cloud through internet.

**pH Sensor:** A pH sensor tests the concentration of hydrogen ions in water or liquid. The pH scale is a numerical scale that is used to assess the acidity or baseness of a substance.

**Temperature Sensor:** A thermometer is used to determine the temperature. Milk has its own set of temperature requirements. That temperature must be maintained during milk storage for an extended period. Milk is typically healthy at temperatures between 35 and 40 degrees Fahrenheit.

**Gas Sensor:** New milk has a different odor than adulterated milk. When milk is stored for a long time with the aid of any external contamination and the adulteration and toxicity levels are high, toxic gases are produced. This preserved milk produces gas, which emits a foul odor. This milk can cause several health problems. It is not appropriate for human consumption. Gas sensors or Air Quality Sensors are used to identify poisonous gases in the form of foul odors (MQ135).

**Turbidity sensor** is a logical sensor that actions turbidity. They are exceptionally valuable and viable instruments to recognize the clearness and molecule content in an answer, similar to water. Turbidity sensors are utilized to diminish squander, further develop yields, and break down water quality in a great many enterprises.

**Ultrasonic Sensor:** Its Vcc is connected to 5V of positive voltage for power. Trigger pulse is send here for the sensor to go into ranging more for object detection. Echo sends a signal that if an object has been detected or not. If a signal is returned an object has been detected.

**LCD Display:** A liquid crystal display (LCD) is an optical system with a flat-screen. The LCD monitor is used to show the various milk parameters as well as the system's performance.

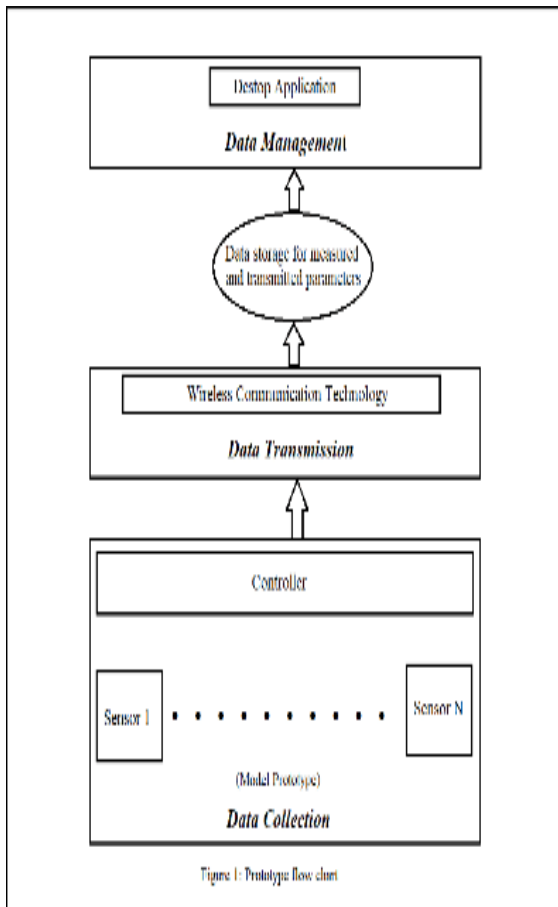
**ESP8266 WiFi Module** is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all WiFi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much WiFi-ability as a WiFi Shield offers (and that's just out of the box)! The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community.

## IV. OBJECTIVE

To design a prototype of milk quality monitoring system, this venture investigates the nature of milk and communicates the data

utilizing Remote Sensor Organization. Defilement in milk can be recognized by electronic gadget and sensors. The progression of rapid, delicate, dependable, and clever strategies and sensor structures for food quality noticing and early disclosure/ID of microorganisms is fundamental. Microbe recognizing confirmation has emerged as the dairy business' top specific need. Buyers and administrative associations can apply AI calculations to the examine phantom information.

## V. METHODOLOGY



**Data Management:** A wireless sensor network is a wireless infrastructure that transmits data through thousands of sensors that are deployed across the area. Sensor nodes are onboard processor that monitors the environment based on the specific parameter. They read environment variables that would be used for data acquisition. Sensors are an integral part of any IoT-based smart system with the data collection process. The sensors used in our projects are temperature sensors and pH sensors. These sensors sense the milk's temperature and pH values in real-time. This data is stored in the sensor till it is transmitted to the base station. This process of capturing data through sensor nodes in a network in real-time and storing it for further process is data collection. It is the first and most important step.

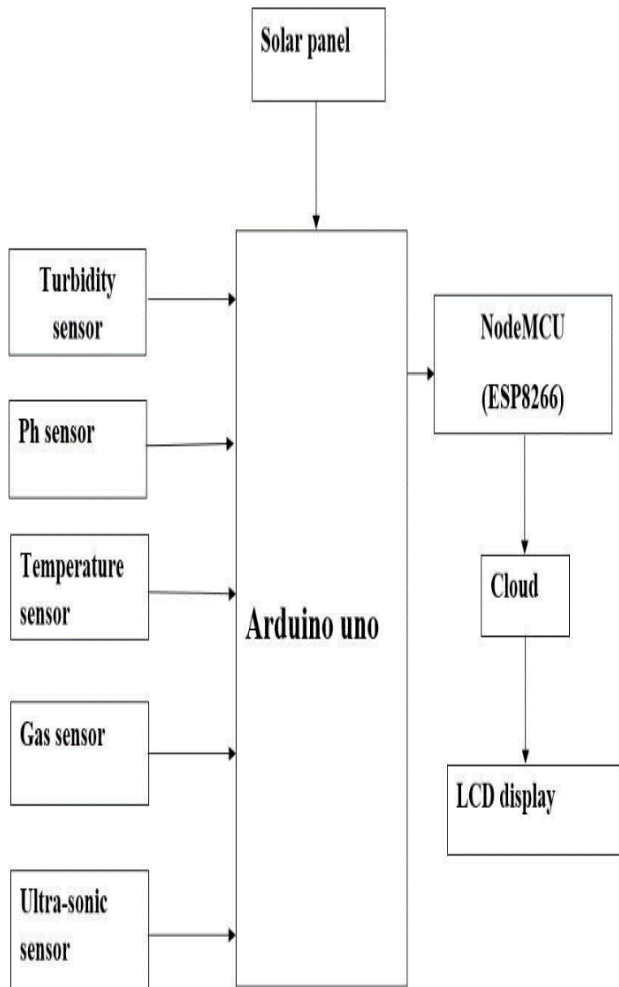
**Data transmission:** It is impractical to plug in to every sensor node in a communication system to transmit data continuously, especially when a huge number of sensors are positioned in a network that is spread across the location. Hence wireless communication is used for the transmission of data. Smart sensors transmit data wirelessly. They will be connected using WiFi

modules and system controllers. There will be cooperative communication between all the nodes for systematic transmission of data. Different protocols can be used to decide the transmission path for the data. Each protocol vary based on network structure, network lifetime, delay, range, and many other factors.

**Data Collection:** Once the data is transmitted wirelessly, it has to be collected and stored in a module. Data Management deals with efficient organisation and usage of sensor-originated data. The three main things in data management are it should deal with the data that is being received, handle the communication errors and manage it in real time. The data is delivered in a stream and is important to receive it accurately in predefined time intervals. Due to multiple hops between nodes in the network, errors maybe induced. This can be found out with extremely variable delay. And since the energy is spent continuously during every round, repetitions of the same data is a waste of time and energy. Hence the data is transmitted once and the energy is saved. Thus giving real-time values as well.

Consumer Price Index (CPI) is used as a proxy in this study for inflation rate. CPI is a wide basic measure to compute usual variation in prices of goods and services throughout a particular time period. It is assumed that arise in inflation is inversely associated to security prices because Inflation is at last turned into nominal interest rate and change in nominal interest rates caused change in discount rate so discount rate increase due to increase in inflation rate and increase in discount rate leads to decrease the cash flow's present value (Jecheche, 2010). The purchasing power of money decreased due to inflation, and due to which the investors demand high rate of return, and the prices decreased with increase in required rate of return (Iqbal et al, 2010).

## VI. BLOCK DIAGRAM



This paper proposes a prototype to monitor milk quality using smart sensors. The prototype uses different sensors like temperature, pH, turbidity, Ultrasonic and gas sensor. The block diagram of the proposed WSN prototype using solar is shown above. It is observed that most of this system use a controller with external NodeMCU(ESP8266). It is a low-power consumer and close proximity wireless ad hoc network. It enables transmission of data within the area of 10m-100m. Milk parameter sensing sensors are interfaced with the controller. Parameters such as temperature and pH are measured by inserting sensors in the milk. Every substance has an optimal temperature. Similarly, milk has a normal temperature range which can result in spoilage. When the temperature varies it results in microbial activities in milk. This microbial activity causes a change in the pH value of milk causing change in color and bad odor. With the change in standard range of temperature and pH value indicating milk contaminant when the sensors are arranged in a sample of milk. The parameter a are measured

by the sensors and will be displayed on lcd and also will be stored in cloud by Wi-Fi module for future references.

As the model is solar powered it can be run on both the supplies.

This prototype device can be used by both the milk quality monitoring authorities as well as consumers.

### VII. i) ADVANTAGES

- When the milk is adulterated with the sugar and water in exact proportions the lactometer test fails, such case this project can be used.
- Similarly, the soap or salt added with the water in exact proportions the lactometer test fails, even in such situations this model can be used.
- Ease of handling.
- Output will be obtained within less response time.
- Low maintenance cost.

### ii) DISADVANTAGES

- It is not universal that is, it can be used only for the detection of milk quality.
- Calibration is required for at least every 50 tests.
- Depends on requirements of accuracy cost of the sensors will be varied.

### iii) APPLICATIONS

- The project proposed is beneficial to the society by giving measure to reduce the adulteration practice in milk.
- This device is used in small dairies for the quality analysis of milk.
- It provides quality assurance for farmers and consumers.
- It can also be used by the normal people, where an individual should know about the Quality of milk that he consumes in his daily life.
- It can be used by Milk Traders for Computerized Milk Analysis.

**VIII. RESULTS AND ANALYSIS**

The Ph value of the milk ranges from 6.4 to 6.8, if any other substance is added to the milk its ph value varies accordingly.

Normally there is no gas content presence in pure milk but with time when the milk starts spoiling foul smell comes out from the milk and can be detected by gas sensor. In normal air condition the gas sensor gives the value of 350 to 420. When tested with milk and if there is any gas it will go beyond 420 depending upon gas content. Every substance has its own temperature range and for the milk it is about 45-degree Fahrenheit to 80 degree Fahrenheit. Beyond this temperature microbial activity starts in the milk.

SAMPLES	pH	TEMPERATURE (in Celsius)	TURBIDITY	QUALITY
1	6.51-6.72	30.31	3000	High
2	6.66-6.87	31.25	3200	Normal
3	7.03-7.23	31.38	Beyond 3600	Low
4	6.89-7.21	32.43	Beyond 3600	Low

Table 1.1

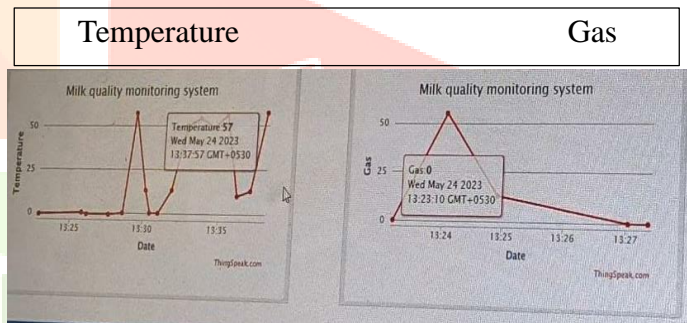
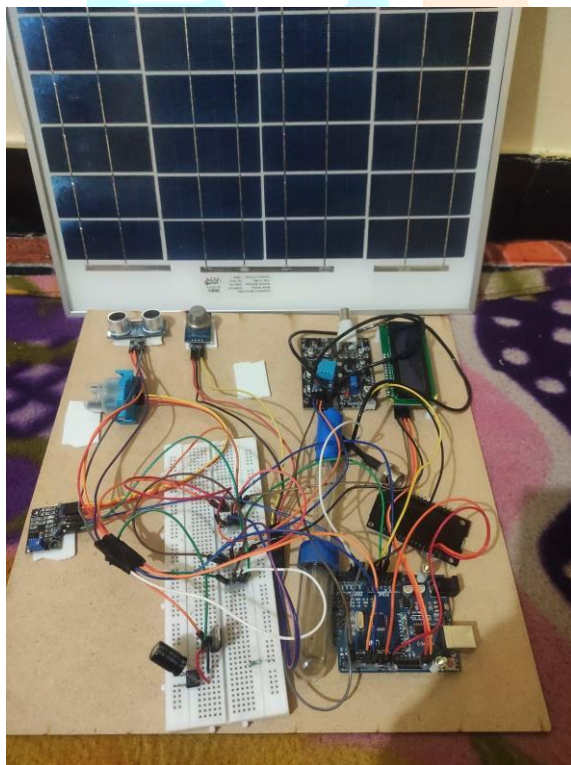


Fig 1.2

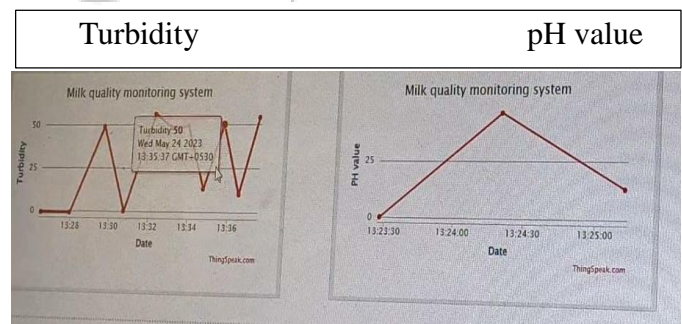


Fig 1.3

## IX. CONCLUSION

Every consumer should be aware of the quality of milk that they consume. This system can significantly reduce the milk spoilage and milk adulteration across the world. If used worldwide then the device would generate loads of data that will give real data for future analysis and studies. This can improve milk quality by studying unpredicted factors that are involved. The focus is to help the milk industries and its customers to get good milk.

We designed a wireless network prototype that measure milk parameters to give quicker and more reliable result. The machine can be used by farmers, small milk booths, milk industries and consumers. The device can also be modified by adding a Bluetooth and sending an alert to a mobile whenever the milk quality is low. The system can also be mounted on the containers. Hence, through this the milk can be monitor 24 hours and time duration for safe milk consumption before spoilage can be known. This will also reduce milk wastage for the producers and also help their business. They can keep track of milk quality for entire month and watch out for milk with the changing seasons. Since the model gives exact quantitative values for all the parameters, it is easier to analyse the behaviour of milk. The ranges of pH, temperature and other parameters can be studied based on the location, season in the year and many other factors. The further study can also give the different categories in milk types for consumption of different categories of people. The system is simple to understand the working and easy to use. It also gives real time reliable data about the milk parameters. Also, the values are matched against the prescribed neutral safe ranges by World Health Organization. The Data can be extended in future to store in SQL and do further analysis. This gives standard methods and practices concerning about milk safety

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