A holistic IoT based monitoring platform for smart BMC centers

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Abstract : India is considered as the largest producer of milk with a production of 150 million tones every year. The harvested milk is collected at the Bulk Milk Cooler (BMC) Center situated in every village. These centers have bulk milk coolers with varied capacities that hold and cool the milk until it is collected by milk hauler. Currently this process of milk collection and transportation involves a lot of human mediation that leads to compromise in milk quality and also limits the exporting of milk. Internet of Things can play an important role in overcoming these limitations. This paper proposes a system which automates the Bulk Milk Cooler Centre using Internet of Things. This system allows automating the quality testing and quantity monitoring of milk collected at Bulk Milk Cooler center. It also monitors diesel consumption which is used for power backup at the Bulk Milk Cooler Centre. This system collects the data and actuates actions based on the values of the data collected such as if the milk in the bulk cooler is adulterated or occurrence of diesel theft at the centre. The collected data is used to perform analysis and identify the solutions that can be used to increase the milk production.

IndexTerms **- BMC (Bulk Milk Cooler), SNF (Solids-Not-Fat), Milk, IoT (Internet of Things), Android, Arduino, CLR (Calibrated Lactometer Reading), pH (pouvoir hydrogene).**

I. INTRODUCTION:

The dairy industry in India is the largest contributor to the countries agricultural GDP & at international level too India generates 16% of world's total milk production. [1] Internet has become a crucial part of today's world and using IoT domain can support this growth of milk production industry in India. Internet of Things allows connecting every physical object around using internet and sensing the surrounding data using various sensors.

Even though dairy industry is a major contributor to the country's GDP, lack of technology is observed at the root of this industry. This root is the BMC centers where the milk is collected every day. The quality testing of milk in BMC involves human intervention which can sometimes adulterate the milk. A generator set is used as power backup at BMC center and the diesel for it is provided by the associated mother plants. The diesel in the tank needs continuous human surveillance as it is prone to theft. Due to such drawbacks the country lacks in achieving the required standard of milk.

The BMC center is an important part of the dairy industry cycle in India. Innovating the BMC center with the help of booming IoT technology to overcome the current drawbacks and improve the quality of milk is the basic idea behind this paper. This paper presents a system that monitors the BMC center and actuates the android application based on the sensed data values.

II. LITERATURE REVIEW:

Milk is composed of water: 87.3% (85.5 to 88.7%), milk fat: 3.9 % (2.4 to 5.5%), proteins: 3.25% (2.3 to 4.4%), casein: 2.6% (1.7% to 3.5%), serum proteins, minor proteins, carbohydrates (lactose): 4.6% (3.8 to 5.3%), minerals: 0.65% (0.53 to 0.80%), cationic: K, Ca, Mg, K, anionic: chloride, phosphate, citrate, carbonate. [2]Here the quality of milk is determined by measuring the following parameters:

Solids-Not-Fat (SNF) is substances in milk that are not butterfat and water. These are basically proteins, lactose, minerals, acids, enzymes, vitamins contents of the milk. It is the total solid content in the milk minus its fat content. The total milk solid is the sum of fat and SNF. The SNF can be calculated using following formula:

$$SNF = (CLR\ reading/4) + (Fat \times 0.21) + 0.36.$$

The CLR is the calibrated lactometer reading based on which the SNF is calculated [3]. **pH** is used to determine the acidity or alkalinity of any solution. An acidic solution has a pH in the range of 0 to 6.9 whereas an alkaline solution has pH in the range of 7.1 to 14. Pure water is neutral with a pH of 7.0.The pH of milk is around 6.5 to 6.7, thus it is moderately acidic. Sometimes the milk is considered as neutral as its pH is as adjacent to the neutral pH value of 7.0. Milk is a hydrogen donor or proton donor as it contains lactic acid. [4]

Bulk milk cooler chills the milk from its harvest temperature of 35°C to 4 °C to seize the bacterial growth which maintains the quality of milk. The outer tank and the inner tank are isolated from each other with polyurethane foam. If the BMC faces a power failure within an environment with temperature of 30°C, the temperature of milk in the tank will warm up by only 1°C in 24 hours. To maintain unified temperature across the tank, the milk is stirred continuously. This also keeps the milk homogeneous. [5]

III. EXISTING SYSTEM:

Every village has its bulk milk cooler center where the milk is collected from the farmers. The Bulk Milk Cooler is a large storage tank with capacity ranging from 500 to 50000 liters. It holds and cools the milk until it is collected by milk hauler. The distance between two BMC centers or BMC center and mother plant is such that the distance can be travelled in 20 to 30 minutes.

Currently at the BMC center, when the farmers come to deposit the milk every morning, the milk is tested by the authorities at BMC center before adding it to the BMC. The milk is tested for its SNF, PH, and water content. When the BMC reaches its level the authorities calculate the average factor values of the milk in BMC based on the individually measured values. The receipt containing these average values is given to the respective milk hauler who will carry the milk from BMC centre to the mother plant.

This receipt is the only medium through which the milk quality data is shared between BMC centers and the mother plant. When the milk hauler reaches the mother plant, again the quality of milk is tested and compared with the values in the associated receipt.

IV. PROPOSED SYSTEM:

The principle of the proposed system is to automate the BMC centers. This will monitor the quality of milk, reduce human intervention, propose theft control, milk transport management and milk production analysis. The proposed system consist 2 main components that is hardware component & software component. The hardware component consists of sensors that will test the milk stored in the BMC. This hardware component is basically attached to the existing BMC. It fetches the specific amount of milk & measure the SNF, PH, temperature & volume of milk stored in BMC. Another function of hardware component is the surveillance of the diesel tank of the generator that is used as the power backup at the BMC center. It will continuously record the level of the diesel in the tank. All these values are recorded and stored on the database server.

The software component is an android application. This application will have different categories of users based on their roles. The basic function of this application is to continuously monitor BMC centers from remote places and with minimum human intervention. The application provides necessary data when required and notifies its users in case of undesired situations. The application also provides the live location tracking of the milk hauler when the milk is transported from the BMC to the mother plant.

Following figure 1 shows the overall system architecture of the proposed system. Following are the modules of the proposed system:

i. *Monitor the milk quality and quantity at BMC center:*

The hardware component of the proposed system is the main part of this module. Milk sample will be extracted from the BMC and the SNF, PH, temperature and volume of the milk is examined. This trial is carried out on regular interval of 15 minutes. It also surveils the diesel tank for theft. Following fihure refers to this objective.

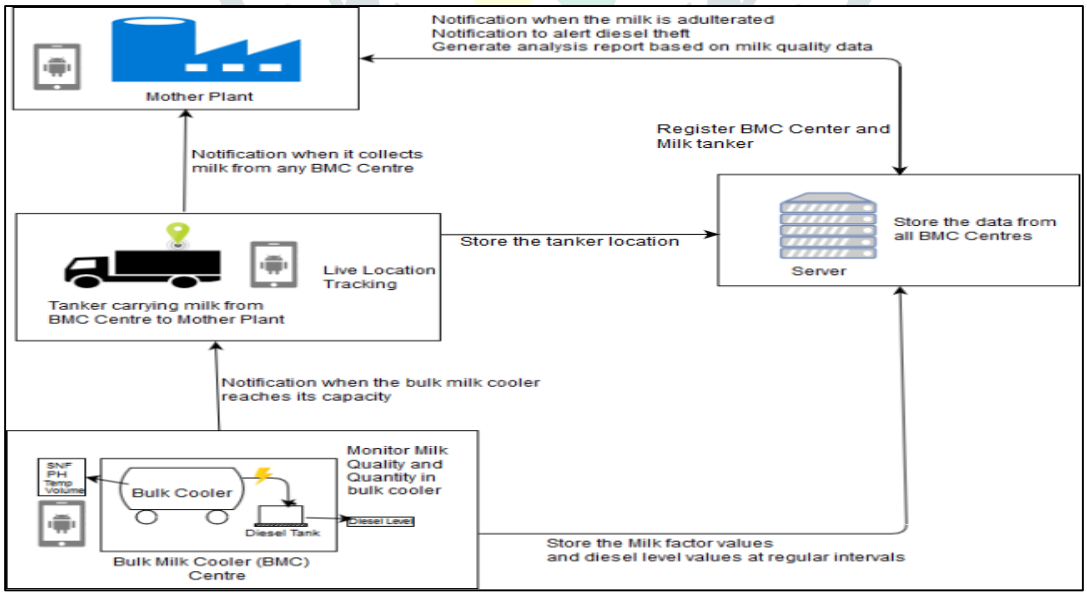

Figure 1 System Architecture

The BMC authority using this application has the access only to its own BMC's data.

ii. Milk hauler live location tracking:

When the bulk milk cooler reaches its specified capacity, the milk hauler receives the notification from the BMC center informing the name and location of the BMC center from which the milk hauler has to collect the milk. The location of the milk hauler's tanker is tracked through the application. As soon as the milk hauler collects the milk from BMC center, notification is sent to the mother plant authority regarding the status of the tanker.

iii.Central monitoring system:

The associated authority at the mother plant has the whole control over the system. The data associated with all the BMC centers working under the mother plant is accessed through this module. Any undesired situation at BMC centers is immediately notified to the authority using the application at the mother plant. The undesired situation can be adulteration of milk or diesel theft.Based on the data collected from all the BMC centers analysis report is generated related to production of milk. This analysis helps the authority in distinguishing the milk production and quality of milk in different regions. Further this analysis can be used to improve the production.

iv.Alert system:

The data generated through the system is stored in the database server. Based on the access authority this data can be accessed using the application. The notifications are generated based on the values stored. Following figure 2 depicts the BMC monitoring part of the proposed system. In this the various parameters of the BMC are tested using sensors. The sensors used here are pH sensor, Temperature sensor, SNF sensor and level sensor.The pH sensor, temperature sensor and SNF sensor are placed in a single unit called milk quality testing unit. The milk from the BMC is extracted automatically from BMC at a regular interval of 15 minutes. This milk is then tested with sensors and the measured result is stored on the database server.

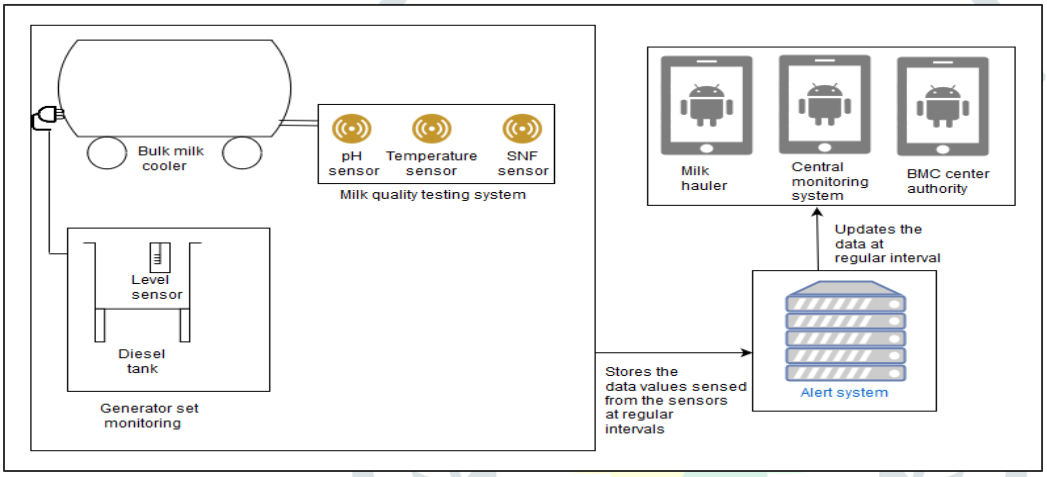

Figure 2 Bulk Milk Cooler Monitoring System

Another segment of this is the generator set that provides power backup to the BMC. The level sensor continuously monitors the diesel level in its tank. This level information too is stored on the database server. The data that is stored on the server is then available on an android application.

V. Experimentation:

As mentioned in the proposed system the pH, temperature and SNF of milk and level of diesel in the generator set is measured. In the proposed system the sensors used to measure the parameters of milk and diesel tank are pH sensor, Temperature sensor, SNF sensor and Ultrasonic sensor.

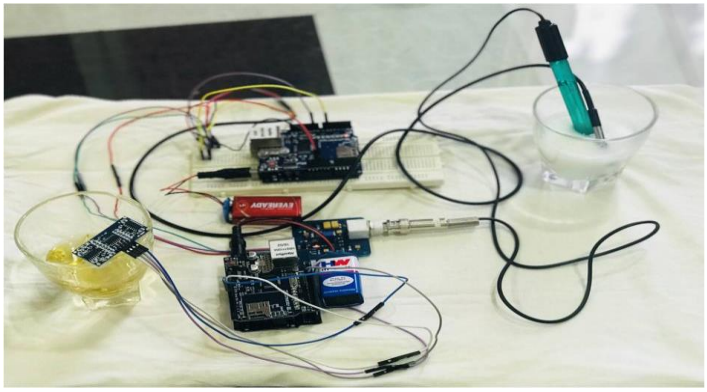

Figure 3 Experimentation of sensors

Figure 3 shows the experimentation of sensors used in the proposed system. The arduino board is used as a mediator that collects the readings of the sensors and sends the data to the database server.

Figure 4 pH and temperature sensor

Figure 4 shows the pH sensor generic electrode used for measuring the pH values. The temperature sensor DS18B20 is used to measure the temperature of the milk. The SNF can be calculated using lactometer that is based on the specific gravity principle. The lactometer is immersed in milk and a circular plate is attached on its neck as a reference for Ultrasonic sensor. [6]

Figure 5 Ultrasonic sensor

Figure 5 shows the ultrasonic sensor HC-SR04 which is used to monitor level of the diesel in the generator set. Currently the experimentation related to temperature and pH of milk as well as the level of the diesel is successfully conducted. And the measurement of SNF of milk is in process.

Factor	Cow milk	Buffalo milk
pH	6.6	6.5
Temperature	17° C	20° C

Table 1 Experimentation result

VI. CONCLUSION:

This paper proposes a system which is developed to enhance the technological support to the BMC centers. In this the qualitative factors (pH, Temperature and SNF) of milk are monitored and actions are initiated based on the recorded values. The system also tracks the usage of diesel by the generator set. As the quality of milk is based on the parametric values collected, this system is beneficial in quality study of milk. It will help to maintain the history of production and quality of milk in various regions which can be used to analyze and identify the regions that require attention to standardize the milk quality.

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