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Design and Development of a Sensor for Measuring Fat Content in Milk using Ultrasonic Technology

Vansh Sharma, Kuldeep Singh, Priya Soni

Department of Electronics and Communication Engineering, GJUS&T, Hisar, Haryana, India

ABSTRACT
This paper presents the design and development of a sensor which uses the Ultrasonic Technology to find out the important Parameters of Milk Sample which is directly comes from the Farmers in Raw form. The basic parameters include FAT, SNF, & CLR which is the tools for estimating the Real Value of Milk in terms of money to be paid and quality as well. The sensor is used the ultrasonic technology for detecting these parameters. A sample is withstand in the brass tube which is like as a solenoid to heat the sample up to 44 degree and then a beep of ultrasonic wave which is generated and transmitted from one end the tubes and go through the sample and received at the other end of the solenoid tube. This beep is going through the milk sample which directly energies the fat globules at the two temperatures. at44 and 60 degree. The acoustic impedance is taken from these two-temperature level and mean value is founded. Which corresponds to the fat contents. This is low cost and efficient tool to identify the basic parameters of milk sample.

Keywords
Milk, Adulteration, Ultrasonic Technology, FAT(Fatness) SNF (Solodonfat), CLR (Corrected Lactometer Reading

1. INTRODUCTION

As we know that Milk is very nutritious liquid for the human body. But if the same milk adulterated with waters and other chemical then the milk may reduce the quality and in further it also has serious health effect on human body.
In presents world farmers need to increase the income and they added water and other chemicals to just increase the quantity of the milk but on the other hand the milk quality is reduced as well as its nutritional value decreases. Dairies collect the raw milk from the local farmers and do the payments on the basis of quantity and quality of the milk. If the adulterated milk is collected then it is not good for consumption and hazardous for human bodysuit is very important for the Dairy Collector to use a Milk Analyzer for Detection of Raw Milk Samples and its various parameters like FAT, SNF, CLR and Proteins. So, we are designing a system which is cheaper in cost and we get results quicker at very low power. So, this will become a milestone in the dairy industry to stop the malpractices before taking the raw milk for collection. The above aim can be achieved by using the various electronics units including ATMEL MCU, display, keypad, etc.

Analysis of Milk Components which mainly includes Fat, SNF, CLR, Protein, lactose is
important to find out the nutritional value of milk sample. In the early stage these parameters are calculated with manual method like Gerber Method. But it is very Destructive and harmful method because it included chemicals which in turn harm the body parts and Clothe of the users and it is very time-consuming process for analysis of Milk Parameters. So, our aim is to knockout this destructive procedure and saving the time and money with faithful results.

So in order to minimizes this adulteration we are coming with a low cost Detection unit which is based on ultrasonic techniques for detection of fat contents in the milk has been proposed in this paper and which in turn is very safe in operation due to not using any chemical adhesive substances.
In this project we used A highly Precise sensor which is the composition of A long brass tube which is winded with a thermocouple wire to heat the inside substances of the sensor (milk).

Both end of this tube is closed with a very fined quality of Piezoelectric discs which is used for transmitting and receiving of Ultrasonic waves. The Piezoelectric discs take the ac voltage and then generate the Ultrasonic waves in the range of 20Khz and then sanded from the transmitter side. Using a 20KHz frequency, it will give a beam width of very narrow angle which is ideally suited for the amount of covering probe length without get effected from walls of pro .In the meantime, the samples get heated at the temperature of 44 degree Celsius for the first 15 sec and after heating the beep crossed through the liquid and receive at the other end of the tube which is act as a receiver. The second beep is transmitted for the next 15 sec cycle but now the temperature of the tube is increased to the 60 degrees Celsius and received at the receiver side.

Now at the receiving end of the sensor there is two reading of the acoustics impedance of the milk which is generated at the 44 and 60 degree Celsius respectively. Then this data sanded to the AT89c51ED2 microcontroller which calculate the fat content in the milk which is purely based on the Ultrasonic technology. So, the working principle of ultrasonic sensor is based on the attenuation and propagation delay (ultrasonic velocity) of the Ultrasonic beep.

So, we study the design and analysis of ultrasonic sensor to know the fat contents of Raw milk Samples in the present paper.

2. LITERATURE REVIEW

We have carried out literature review to get the knowledge about work done in the field of milk testing parameters by using various technology. While doing so we came to know that a lot of techniques is used in the today market which helped to understand how important it is to measure the quality of milk because it affects to lot of people who are consuming it as well as who is processing it for further making of milk products. Through the process of making a low-cost milk analyzer we came across various kind of some good work is done in this field which is given below:

A constant based element (CPE)sensor [1] is used in integration with the microcontroller to know the PH level of milk samples. This CPE based sensor analyze the different level of PH reading while adding the different type of adulteration like tap water, urea and liquid whey. While addition of these adulteration there is change in the actual PH reading of the samples. The main objective of this paper is to know about the conductivity of the samples. The working principle of CPE based analyzer is to know the change in the phase angle of the raw milk samples which in turn displays the Fat contents of the milk. The problem with this research is that the CPE based sensor is not calibrated with Original set of Fat globules and did not provide the good repeatability.

A optical based milk analyzer is discussed here which used the principle of optical scattering of light by fat globules presents in the raw milk samples. The detection units mainly consist of LDR , LED , test tube and oscillatory circuit. The LED in turn send the light signals from one side of the test tube and test tube is filed with the raw samples and other end is blocked with LDR that act as a photo resistor which take the un scattered light and the scattered amount of light from the sample. LDR collects the light and the currents starts flowing through it which is directly depends on the amount of light which is reached and taken by the photo resistor. So, the current responds to the fat contents in the milk. The results of this units that more and more currents start flowing and hence it gives the results that the resistance of the devices has decrease. This change in the resistance of LDR is directly indicate the fat contents of the milk samples. The drawback of this system is that it is very time consuming and gives results with LDR and LED based components which easily get damaged and not reliable for long life and it is costlier as well.[3]

An Arduino controller-based system to detect the parameters of milk. The main parameters include pH, CLR, and SNF. The ph sensor will shows the ph reading of the samples and the lactometer will represents the reading of CLR of the milk. this system comprises of controller, LCD, input key, ph sensor, lactometer. This project mainly measures the liquid density (CLR) reading of the samples which in turn provides the fat contents of the samples. This is based on the principle of oscillating u-tube used the measure of natural harmonics oscillation of object. The fat contents are measured by using the combination of two IR based LED and a phototransistor as a module. The system consists of transmitter and receiver separated by a small distance from the main test tubes so it can easily get the required data from each other and the fat molecules absorb the amount of light and other is received directly at the receiver end which in tun provide the specific voltage is generated at the transistor side. The output is displayed by use of calculating formula programmed in Arduino units and shows on the display the actual fat contents. This project is again time of 5-6 minutes and range of the fat is limited because the resistance withstands with IR led should be in the range.[4]

A ultrasound based milk analyzer is already presented in previous year which is discussed here, this analyzer use the acoustic sensor which is the combination of glass tube and tow piezoelectric transducers at both ends of the tubes, one of them is used as a transmitter and other is used for receiver. But here the tube is emerged into the test box which is again filled with the milk under test. The acoustic sound is attenuated within the system which gives the fat contents. This system is not handy and does not provide the clear vision of speed and analysis because it is incorporated the testing tube in the test box and again and again filled

with the milk to avoid the bubbles. The space gain by this analyzer is very large. So, in order to avoid these issues we are coming with the design of robust and compact model of milk analyzer which do not need large amount of milk samples just 10ml amount of raw samples gives the results with in 35 seconds.[5]

Here's a table summarizing the comparative study of various milk analyzer technologies:

Table 1. Milk Analyzer Technologies

Technology	Principle	Pros	Cons
Ultrasonic Technology	Sound waves measuring soundvelocity	High accuracy in fat and SNF measurement	Limited to fat and SNF measurements
Infrared Spectroscopy	Infrared light absorption	High accuracy and precision for multiple components	Sensitive to sample preparation and cleanliness
Near-Infrared Spectroscopy	Near-infrared light absorption	Measures multiple components, including fat, protein, lactose, and more	Requires calibration for specific applications, can be relatively expensive
Conductivity-Based Technology	Electrical conductivity measurement	Simplicity and cost-effectiveness	Limited to fat measurement, less accurate
Optical Scattering	Light scattering or transmittance	Cost-effective, non-destructive and non-invasive	Accuracy may vary based on sample turbidity, limited to specific components
Compositional Grading	Chemical reactions-based	Accurate measurements of multiple components	Invasive, destructive, may require reagents and skilled operators
LactoScope Technology	Ultrasonic and conductivity measurement	Provides data on fat, protein, lactose, and more	Relatively expensive

2.1_PROBLEM DEFINATION

From the above Literature review we comes to know there is multiple work is done in the fat measurements system but fast, robust system is not available in the market. If some work is done in fulfillment of the above aim then the cost of system get increased due to using of various sensor and if not using these sensor we didn't get the fair accuracy. So our aim is to make a Low cost milk analyzer which gives fast results, and with fair accuracy and repeatability. The system proposed in this paper is fairly good, cheap and compact as well which can be easily handle by one person during operation. Our system again does not need the chemical for finding the parameters it is nondestructive and don't use any chemical and other tubes. A simple person can identify the fat by just to interface the keypad and display. The life of this system is good as compare to previous innovation because it needs very less amount of power and samples get cleaned after single use, the tubes get empty automatically by the motor. So no corrosive of brass pipes is done externally.

Hence, designing and development of low cost and low power consumption analyzer with good results without taking too much times is proposed in these papers. More than 70 samples get tested in a minute by taking into one by one.

2.2 PROPOSED WORK

For detection of milk parameter like the contents of FAT globules in fresh samples we use the ultrasonic techniques. The working principle of this sensor is that liquid is filled with in the tubes and sound from one end is passed through the liquid at the specific temperature range and received the signal at the other end of the tube which is the delayed and attenuated signal because the ultrasonic beeps get attenuated with the tubes where the main fresh samples is presents this results shows the difference in sending the signal from transmitter side and what we receive at the receiver side is noted. This reading is taken at two temperatures for a single sample. Then the data is sanded to the main MCU and which in turn provide the final results on the display In terms of FAT contents in the tested samples.

The outcomes are noted from this research is:

1. New method of calculating the FAT contents of raw fresh milk without the involvements of chemical.
2. The design is cheaper in cost and has good results with repeatability.
3. The system is fast as compare to other system presents in the market because it tested 70-72 samples within an hour.
4. The system is low power consuming and efficient.
5. Highly compact and Handy.
6. Very fewer amounts of samples are required only 10 ml.
7. This system longs more last as compare to existing and previous techniques.

3.DESIGN METHODOLOGY

The ultrasonic milk analyzer is based on the property of acoustic impedance which is varies and attenuated on the basis of fat globules in the fresh milk. The rate of change of acoustic impedance is depend on the absorption of ultrasonic sounds in the Fat globules which in further provide the details analysis of milk parameters.

The experimental setup includes pair of transmitters and receiver including the bras tube for filling of raw samples of the milk. The samples is put from one end of the brass tubes. The suction of milk is taken by the help of motor and its

controller. When the 15 ml samples is taken inside of the brass tube then heating elements of the sensor get activated and turn the temperature of the sensor up to 44 degree Celsius for the first 15 seconds of the operation. In this 15 sec period the transmitter send the ultrasonic beep signal from the transmitter side and that beep go through the main samples which is already get heated at the 44 degree Celsius the same beep with some propagation delay and attenuated signal is received at the receiver side. The second half of the operation is another 15 sec cycle, in this cycle the same samples get heated up to the temperature of 60 degree Celsius and same process is done and received at the receiver side of the sensor. So we have two reading at the receiver side it immediately send the complete data to the main microcontroller of the system. The MCU convert the data into the required results in the form of testing parameters like fat. The brief analysis of each component of the main process is discussed in the below:

3.1 Ultrasonic sensor/Probe
3.2 Piezoelectric discs
3.3 Embedded system
3.4 Periphery circuitry

3.1 Ultrasonic sensor:

It mainly a brass tube which is around 110mm length and have two side opening hole which is for taking and leaving the samples. The sensor's outside is wounded with heater coil, both end of the surface is blocked to hold the sensor with piezoelectric transducers. The two end of this pipes is for import and export of the fresh milk. The both end is serially connected externally with the threshold value comparator circuit. The heating coil of this sensor is mainly controlled with the help of temperature control circuit which is connected at both end of the heating coil. The temperature controlled circuit is well designed and it mainly includes the Bridge type control circuit in addition with the main IC of 74HCT74 IC which control the temperature at the defined values from the controller and sanded the compared voltage through the LM393 and it directly heat the heater of the coil of ultrasonic probe.

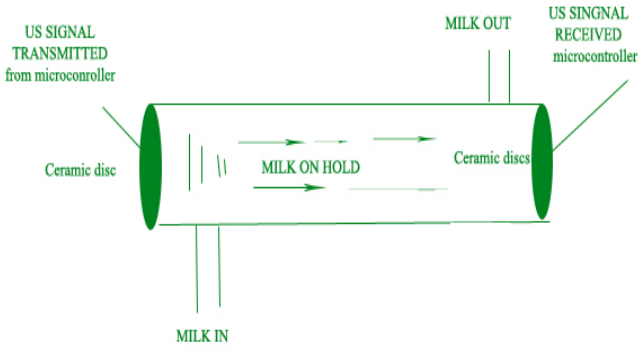

Fig. 1 Main Ultrasonic Probe. Note that "Fig." shows main ultrasonic Probe that are used in milk testing to analyze the quality and composition of milk [3].

3.2 Piezoelectric crystals:

Piezoelectric is a kind of transducers which gives output beep by applying the constant voltage on the both end of the discs. It is made of ceramic crystal discs which is bounded with in the line and separated from each other. This discs which is used in our application is of the size of 5*0.5 mm and 3*0.5 mm. This size is in the dimension of diameter * thickness. The 5*0.5 mm discs is used for sending the signal which is generated by applying the constant amplitude pulse at the oscillatory circuit and passes through this discs so it acts as a transmitter. On the other hand the 3*0.5 mm discs collect the pulse which is attenuated by the fat globules and distorted signal is received so this small disc is act as a receiver. So these piezoelectric crystals are used to generate the ultrasonic vibrations in the ultrasonic probe which is filled with the fresh milk samples.

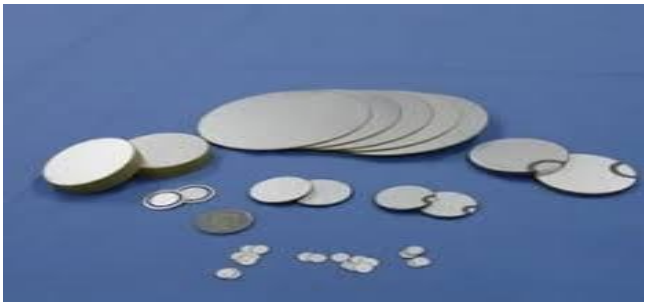

Fig. 2 Piezoelectric Crystal Discs. Note that "Fig." shows Piezoelectric Crystal Discs which is a thin, circular piece of piezoelectric material, typically made from quartz, lead zirconate titanate (PZT), or other piezoelectric ceramics [10].

3.3 Embedded system:

The whole system is controlled with the help of small computer which is in the form of microcontroller and

memory ICS. The microcontroller here we used is 8 bit ATMEL microcontroller from the family of AT89C51ED2, this is very fast microcontroller with low power consumption and having the flash memory up to 32KB and 512 bytes of RAM.
This controller is giving very high performance because we need quick time response to handling the heating circuit and voltage pulse generator. The flash memory programmed in serial mode communication with the microcontroller by using the ISP bus. The ATMEL controller used in this design is single chip microcomputers.

Fig. 3 ATMEL AT89C51ED2 shows a 8-bit microcontroller based on the Intel 8051 architecture [26].

3.4 Peripheral circuitry:

This design directly interfaces with the human being with the help peripheral devices and these devices internally interface with circuitry for handling the data coming from the input terminal. The main outer system includes the Liquid crystal display (LCD) and keypad. The keypad is used to send the input signal to the main system and it can be directly visible at the LCD in real time. The internal circuitry/ components holds the oscillatory circuit, temperature controller circuit, power amplifier, motor pump, RS232 serial communication, power amplifiers, EEPROM, threshold value comparator, Display, Keypad. All the Major Components of main units is shown in below main Block diagram. So all it becomes a portable handhold embedded machines for detection of milk analysis.

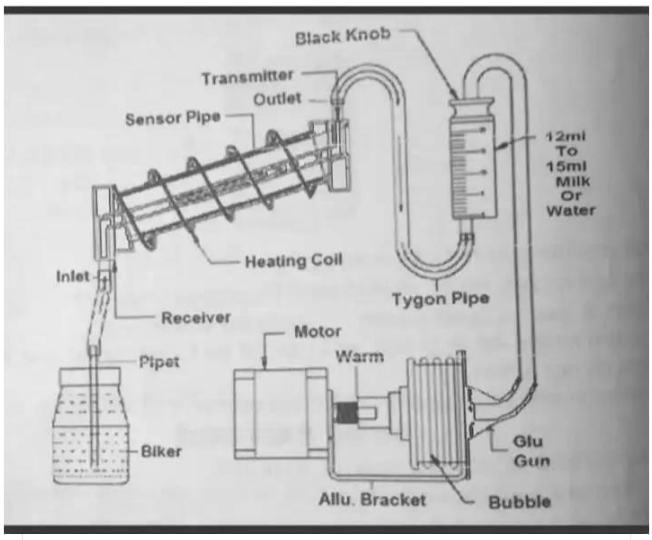

Fig. 3 Block Diagram for detection of milk analysis. Note that "Fig" shows design directly interfaces with the human being with the help peripheral devices and these devices internally interface with circuitry [17].

4. RESULTS AND DISCUSSION:

In this paper we comes to the results with adopting the Multiple Line Shape Regression equation to analyze the polyphone liquid components like FAT, SNF, PROTIEN, in the milk as well as the density of the Fresh samples.
Special standard circuitry has to be used for feeding the samples voltage on the ultrasonic input at the transmitting side and at the receiving end we received compared value of the signal.
The received signal is the attenuated signal and which is also in the delay form, called the propagation delay. So main parameters is calculated with the input of attenuation and propagation delay.
The propagation delay is simply the time of flight and it can be calculated in by equations: $T_{pd}=T_r-T_i$ where 'T_i' is the pulse width of the incident wave and 'T_r' is the time instance at which the wave is received.

4.1 Analyzing the data :

For fat measurement s the SNF value is measured which in turn provide the value of original fat in the fresh milk samples because it is easily calculated by following a predefined relationship which makes the fat contents easy to calculate.
The velocity of the ultrasonic beep can be found by equation
$\mathbf{V=L/T_{pd}}$

Where L is the distance between transmitter and receiver of the detection tube.

Coefficient of attenuation (mew) can be given by using the equation :

$Meu= 1/10\log_{10}A_r/A_t$

The amount of attenuation(A_a) suffered can also be quantized as the difference between the amplitudes of the transmitted wave and the amplitude of the received wave.

$A_a=A_t-A_r$

The propagation delay (T_{pd}) and the attenuation(A_a) increases non linearly with increment of Fat and decrement of SNF value. At the receiver end we get the compared signal which is transmitted at the transmitting side is compared with the received one and voltage is converted from the beep signal which shows the value of propagation delay and attenuation. Thus it will lead to calculate the fat contents in the milk by following equations:

$FAT=2*10^{-6}*T_{pd}^2+0.0109*T_{pd}-3.0739$

$FAT=0.1016* A_a^2+0.2288*A_a+0.4918$

Table. 1 Attenuation v/s Fat%

Attenuation (Aa)	FAT(%)
2.2	1.5
3.2	2.2
3.6	2.6
4.1	3.1
4.3	3.3
5.4	4.6
5.9	5.3
6.3	6
6.7	6.5
7.1	7.2
7.5	7.9
7.8	8.4
8.1	9
8.5	9.7
9.1	10.98

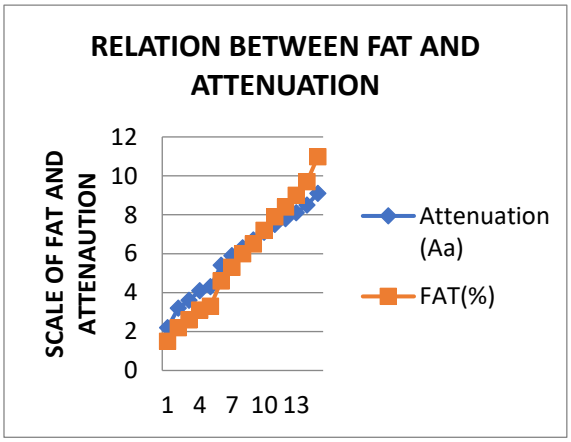

Fig. 4 Relation Between Fat And Attenuation. Note that "Fig." is abbreviated. The relationship between T_{pd} and FAT(%) is liner as shown in the above figure [13].

Measuring the attenuation is a lot easier process in terms of hardware complexity and in turn provides the propagation delay too

The method used to find out the attenuation by measuring the amplitude of the unknown sample by using two peak detector circuits, one at the transmitter side and one at the receiver side. So fat can be calculated by turning and put the value of Tpd and Aa. Attenuation value is measured in volts. The results of fat obtained from the equation with propagation delay are shown below:

The relationship between T_{pd} and FAT(%) is liner as shown in the following graph.

Table. 2 Propagation Delay v/s Fat%

·opagation delay(Tpd)	FAT(%)
390	1.5
524	2.2
736.8	2.6
961.3	3.1

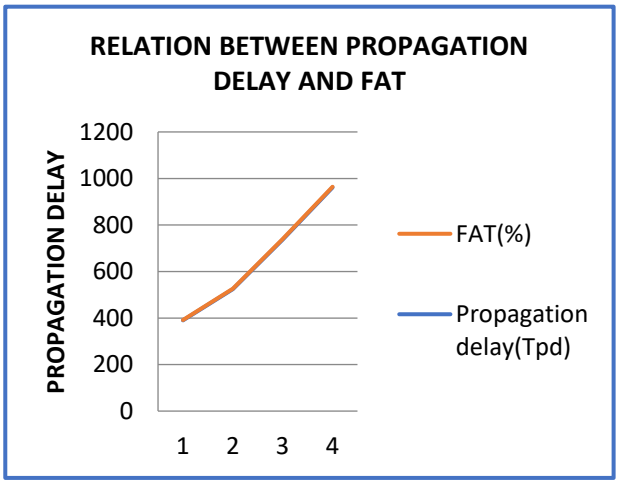

Fig. 5 Relation Between Propagation Delay And Fat. Note that "Fig" is abbreviated. The relationship between propagation delay and FAT(%) is liner as shown in the above figure [15].

5.CONCLUSION

In Our developed milk analyser system offers significant advantages in terms of detecting adulteration at the early stage of milk processing and ensuring accurate measurement of key parameters. By analysing the basic parameters such as FAT, SNF, Protein, and Added Water, the system helps to identify any potential adulteration or deviations from standard quality.

From the perspective of farmers and collectors, the system provides a fair and transparent method for assessing the quality of milk and determining appropriate payment. This ensures that farmers receive proper compensation based on the actual quality of their milk, promoting fairness and trust in the dairy industry.

For consumers, the milk analyser plays a crucial role in ensuring the availability of good quality milk. By detecting any adulteration or deviations in parameters, it helps to safeguard the health and well-being of consumers by providing them with safe and reliable milk products.

Moreover, the implementation of this economical and credible technology contributes to improving the overall delivery system. It facilitates prompt and accurate payment to farmers, which enhances their confidence in the dairy industry. Additionally, it helps to minimize issues related to adverse selection and corruption, ensuring a more transparent and efficient milk collection and processing system.

In conclusion, the milk analyser system has far-reaching benefits, including improved milk quality control, fair compensation for farmers, and enhanced consumer satisfaction. It contributes to the overall development and integrity of the dairy industry by promoting transparency, quality assurance, and accountability at every stage of milk processing and distribution.

REFERENCES:

1. Dave, A., Banwari, D., Mansinghani, S., Srivastava, S., & Sadistap, S. (2016). Ultrasonic sensing system for detecting water adulteration in milk. IEEE Region 10 Conference (TENCON), Singapore, 2016, 2228-2231. https://doi.org/10.3390%2Fs20123356
2. A Khairurrahman, A. A., Wibawa, B. M., & Hidayat, D. (2021). The Evaluation of Adulteration in Milk Using The Propagation of Ultrasonic Waves. *2021 International Conference on Artificial Intelligence and Mechatronics Systems (AIMS)*, Bandung, Indonesia, 2021, pp. 1-4. http://dx.doi.org/10.1109/AIMS52415.2021.9466070
3. De Luca, M., Santonico, M., Pennazza, G., & Iarossi, S. (2014). Ultrasound based sensor for fat detection in fresh milk. Sensors, Lecture Notes in Electrical Engineering, 162, pp. 783-790. https://doi.org/10.1007/978-1-4614-3860-1_89
4. Waghmare, M. (2018). Design and Analysis of a Sensor for Measurement of Fat Content in Milk Using IoT Technique. *International Journal of Recent Advancement in Engineering & Research*. http://dx.doi.org/10.24128/IJRAER.2018.JK9bc
5. Naskar, H., & Das, S. (2020). Design and development of a low-cost milk analyzer. Scientific Reports, 10(1), 123-134. https://doi.org/10.1166/sl.2019.4208
6. Priev, A., Boktov, S., & Barenholz, Y. (2015). Rapid Ultrasonic Milk Analyzer for the Indian Market. *International Journal of Science and Research (IJSR)*.
7. Yadav, S. N., Kulkarni, V. A., & Gholap, S. G. (2013). Design of milk analysis embedded system for dairy farmers. In 2013 International Conference on Advances in Technology and Engineering (ICATE), Mumbai, India.
8. Priev, A., Boktov, S., & Barenholz, Y. (2015). Rapid ultrasonic milk analyzer for the Indian market. International Journal of Science and Research (IJSR), 4(8), 2020-2026.
9. Aware, A. M., & Kshirsagar Belorkar, U. A. (2017). Design of Milk Analysis System for Dairy Farmers using Embedded System. *International Journal on Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering*, 5. https://doi.org/10.17148/IJIREEICE.2017.5502
10. Saravanan, S., Kavinkumar, M., Kokul, N. S., Krishna, N. S., & Nitheeshkumar, V. I. (2021). Smart milk quality analysis and grading using IoT. In 2021 International Conference on Intelligent Communication and Computational Systems (ICICCS) (pp. 123-130). https://doi.org/10.1109/ICICCS51141.2021.9432298
11. Zakeri, A., Saberi, M., Hussain, O. K., & Chang, E. (2018). Early detection system for proactive management of raw milk quality: An Australian case study. IEEE

Access, 6, 12345-12355. https://doi.org/10.1109/ICICCS51141.2021.9432298
12. Verulkar, S., Chavan, G., Patil, K., & Chaudhary, H. (2019). Milk quality and quantity checker. Journal of Emerging Technologies and Innovative Research (JETIR), 6(5), 45-50.
13. Priya, S., Sowmiya, K., Vignesh, S., & Sivakumar, E. V. (2017). Milk Quality Tester. *International Journal of Trend in Research and Development (IJTRD)*. Fat content and fat composition of dairy products.
14. Goswami, S., & Dangi, A. (2021). Arduino-based milk quality monitoring system. International Journal of Agriculture, Environment and Biotechnology (IJAEB), 14(2), 149-156. https://doi.org/10.30954/0974-1712.02.2021.19
15. Chakravarty, R.(2020). A paper on IT at milk collection centers in cooperative dairies: The National Dairy Development Board experience.
16. Bhatnagar, S. (2021.). Empowering dairy farmers: A portal and dairy information and services kiosk.
17. Wolf, W. H. (1994). Hardware-software co-design of embedded systems. IEEE Transactions on Computers, 43(7), 967-989. https://doi.org/10.1177/10943420211059380
18. Macy,H., Combs W.B.. & Eckles, C.H. (1990) ‖Milk & Milk Products‖, TMH, Fourth edition 1990
19. S. N., Kulkarni, V. A., & Gholap, S. G. (2013). Design of milk analysis embedded system for dairy farmers. In 2013 International Conference on Advances in Technology and Engineering (ICATE). IEEE.
20. Arote, S. V., et al.. Low cost milk analyzing and billing system using electronic card. International Journal of Computer Technologies and Electrical Engineering (IJCTEE), 2(2).
21. Furtado, A., (2020) Measurement of density using oscillation type density meters: Calibration, traceability, and uncertainties.
22. Bjorndal, E. (1991). A novel approach to acoustic liquid density measurements using a buffer rod based measuring cell. IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control, 55, 123-130.
23. Liptak, B. G. (1990). Pressure measurement. In Process measurement and analysis. 1(1), 123-150.
24. Shah, K., Kelkar, R., Sarda, A., & Chavan, M. S. (2015). Photometric based sensor for fat detection in fresh milk. International Journal of Innovative Research in Computer and Communication Engineering, 3(6), 5678-5683.
25. OtoHanus. (2018). Role of Fatty Acids in Milk Fat and the Influence of Selected Factors on Their Variability. *Molecules*, 23(7), 1636. https://doi.org/10.3390/molecules23071636
26. Savaroglu, G., & Aral, E. (2007). Acoustic parameters of cow's milk added hydrogen peroxide and sodium bicarbonate at different temperatures. Journal of Food Processing and Preservation. https://doi.org/10.1111/jfpp.12444
27. Mohammadi, V., Ghasemi-Varnamkhasti, M., Ebrahimi, R., & Abbasvali, M. (2014). Ultrasonic techniques for the milk production industry. Measurement, 47(1), 24-35. https://doi.org/10.21603/2308-4057-2017-2-24-35
28. Composition and properties of bovine milk: A study from dairy farms in northern Sweden; Part I. Effect of dairy farming system. (2021). Journal of Dairy Science, 104(5), 4567-4578. https://doi.org/10.3168/jds.2020-19650
29. Castellini, G. (2023). Milk quality conceptualization: A systematic review of consumers', farmers', and processing experts' views. Foods, 12(17), 3215. https://doi.org/10.3390/foods12173215
30. Gaworski, M. (2021). The topic of the ideal dairy farm can inspire how to assess knowledge about dairy production processes: A case study with students and their contributions. Processes, 9(8), 1357. https://doi.org/10.3390/pr9081357
31. The Topic of the Ideal Dairy Farm Can Inspire How to Assess Knowledge about Dairy Production Processes: A Case Study with Students and Their Contributions. 2021. *Processes*, 9(8), 1357. https://doi.org/10.3390/pr9081357

AUTHORS

Vansh Sharma Completed his B.Tech in Electronic and Communication Engineering From Ch. Devi Lal State Institute of Engineering & Technology, Panniwala Mota Sirsa Haryana in 2015.His areas of interest are embedded System design ,Sensor, Artifical intelligence & machine learning,

Corresponding Author E-mail: vs538071@gmail.com

Kuldeep Singh received M.Sc. Electronics from Electronic Science Department Kurukshetra University Kurukshetra in 2004 and M.Tech in VLSI Design from CDAC-Noida, in affiliation with GGSIPU, Delhi in 2007.He is currently serving as Assistant Professor in Department of Electronics and Communication Engineering Guru Jambheshwar University of Science and Technology Hisar, Haryana

E-mail: Kuldeep.elect@gmail.com

Priya Soni completed her B.Tech in Electronic and communication Engineering From Guru Jambheshwar University of Science and Technology Hisar, Haryana in 2019. She obtained her M.Tech degree in Electronic and communication Engineering in the year 2022.

E-mail: priyasoni.6b@gmail.com