*Mechatronics and Automation Technology*
*J. Xu (Ed.)*

*doi:10.3233/ATDE221145*

# Study on Special Temperature Measuring Equipment for Fermentation Bed in Large Scale Chicken Farm

Wanpeng TANG[a], Weijian WEN[a,1] and Qingsong TANG[b]
[a] *Guangzhou City Polytechnic, Guangzhou, Guangdong Province, 510405, China*
[b] *Shenzhen Wafa Technology Co., LTD, Shenzhen,Guangdong Province, 518057, China*

**Abstract.** In this paper, a kind of temperature sensor for fermentation bed in large scale chicken farm was studied. The temperature sensing equipment includes a temperature sensor housing, a circuit board and a temperature probe detection sensor. The circuit board is provided with a microprocessor and a wireless Bluetooth communication module. The temperature probe detecting sensor is fixedly connected with the sensor housing, and at least two temperature detecting elements are arranged inside the temperature probe detecting elements, which are spaced inside the probe tube. The microprocessor is connected with the temperature detecting element and wireless Bluetooth module respectively. The temperature sensor is used to detect the wall temperature of the probe tube and generate temperature signals. The microprocessor is used to receive the detection signals and forward them to the wireless Bluetooth module. The wireless Bluetooth module is used to convert the temperature detection signals into wireless signals and send them out.

**Keywords.** Sensing equipment, wireless bluetooth communication, detection signal, probe tube.

## 1. Introduction

This research belongs to the field of temperature sensor technology and relates to a temperature sensing equipment for fermentation bed in the aquaculture industry. In the farming industry, large amounts of animal waste are produced every day by feeding plants, which usually turn the accumulation of manure into organic fertilizer through fermentation. The staff should check the temperature and humidity of the fermentation bed regularly, and turn over and operate according to the temperature and humidity in time to avoid problems such as dead bed.

Large farms, such as chicken farms or pig farms, due to the fear of epidemic impact, artificial detection of fermentation bed temperature may bring viruses, so it is necessary to use intelligent temperature fermentation bed temperature sensor; Artificial intervention will bring stress response to chickens[1], artificial detection is not only time-consuming, laborious, and artificial detection is bound to bring stress response to chickens, affecting the normal growth of chickens.

[1] Corresponding Author, Weijian WEN, Guangzhou City Polytechnic, Guangzhou, Guangdong Province, 510405, China; E-mail: wenweijian@gcp.edu.cn.

For some large farms, in order to prevent the epidemic, the staff is generally not allowed to enter the farm to detect the temperature and humidity. It is necessary to timely study the temperature and humidity status of the accumulation of animal feces by remote detection, and send the collected information to the platform terminal for further processing.

Existing temperature sensor is called multi-function probe thermometer, the multifunctional probe thermometer consists of shell parts, metal probe, touch keys, such as temperature sensor, the main body shell and cover inside the cavity under Settings have touch buttons, OLED display screen, battery[2], magnets and control main board part, setting of shell part of the front end has a metal probe, A temperature sensor is arranged inside the metal probe, and a USB interface is arranged at the rear end of the shell part. The control board is integrated with power module, single chip microcomputer, Bluetooth module, Flash module, buzzer module and temperature detection module. Among them, the temperature detection module is used to process the temperature data into digital signals transmitted to the MCU; The Bluetooth module is used to convert various data into Bluetooth protocol and communicate with the connected host device; The buzzer module is used to prompt device exceptions and temperature alarm [3].

Through the cultivation Internet of Things platform, the private UDP Internet of Things protocol with low power Bluetooth technology is used to transmit fermentation bed temperature data, which can ensure reliable data transmission[4].

The probe-based thermometer uses a buzzer, OLED display, and blue-tooth module to alert workers to temperature anomalies. However, because the fermentation bed usually has a large thickness, when the thermometer is inserted into the fermentation bed, it can not be used to measure the temperature in different depths of the fermentation bed, and there are problems of great limitation in temperature measurement and poor early warning sensitivity. In addition, the buzzer is easy to be ignored by the staff in the breeding plant, and the reminding effect is poor.

## 2. The Technical Framework of the Research

In order to solve the above problems, the purpose of this study is to provide a special temperature sensing equipment for fermentation bed in the aquaculture industry, which can be used to measure temperature in different depths of fermentation bed in multiple areas, solve the problems of temperature measurement limitation and poor warning sensitivity, and improve the alarm and reminder effect.

Figure 1 and figure 2 show the structure of temperature sensing equipment dedicated to fermentation bed in aquaculture industry.

Figure 1 is a three-dimensional diagram of the temperature sensing equipment dedicated to the fermentation bed in the aquaculture industry of the utility model, and figure 2 is a circuit diagram of the temperature sensing equipment dedicated to the fermentation bed in the aquaculture industry. Figure 1: 1- chassis, 11- low power LCD, 12-LED light source, 13- charging interface, 2- probe tube, 20-NTC thermistor [5].

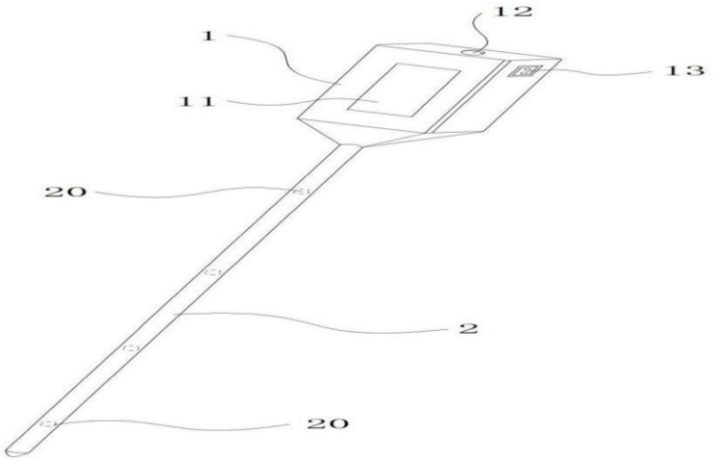


**Figure 1.** A three-dimensional diagram of the temperature sensing equipment.

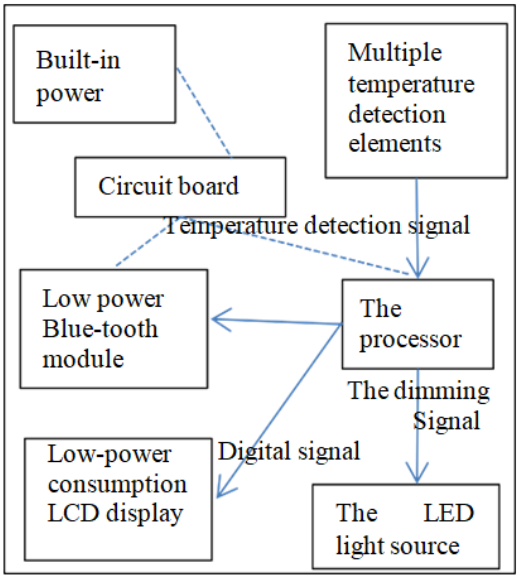


**Figure 2.** A circuit diagram of the temperature sensing equipment.

The temperature sensing equipment for fermentation bed in aquaculture industry includes chassis 1,a circuit board and a probe tube 2. The circuit board is installed in the chassis 1, and the circuit board is provided with a processor and a wireless communication module; The probe tube 2 is fixedly connected with the chassis 1. At least two temperature detecting elements are arranged inside the probe tube 2, and the two temperature detecting elements are arranged at intervals along the length direction of the probe tube 2.

Processor is respectively connected with the temperature detecting element, the wireless communication module, temperature detection device for detecting probe tube wall temperature and temperature of two testing signal, the processor used to receive temperature detecting signal and forwarded to the wireless communication module, wireless communication module is used for temperature detection signal into the wireless signal and issue [6].

Chassis 1 is also provided with a display screen and luminous components, the display screen and luminous components are respectively connected with the processor, the display screen according to the digital signal converted by the processor to display the temperature value, luminous components are used to produce different color light according to the dimming signal sent by the processor [7].

The temperature sensing equipment for fermentation beds in the aquaculture industry is equipped with at least two temperature detection elements in probe tube 2. Because the two temperature measuring elements along the length direction of the two probe tubes are spaced, when two probe tube inserted into the fermentation bed, the temperature detection elements at different positions in the probe tube 2 can detect the temperature at different depths of the fermentation bed. The temperature of fermentation bed varies greatly at different depths, the two temperature detection elements can measure the temperature difference, and thus can measure the temperature difference at different depths in different thickness directions. In this way, the temperature measurement effect is better and the warning sensitivity is higher.

The processor receives the temperature detection signal from the temperature detection element, and forwards the temperature detection signal to the wireless communication module. The wireless communication module converts the temperature detection signal into wireless signal, which can realize the remote monitoring of the fermentation bed through the user terminal. The display screen can display the temperature value of different depths of fermentation bed in real time, so that the staff can carry out on-site monitoring. Once the temperature exceeds the set temperature is detected, the processor is the luminous signal that move light, light emitting components according to different color dimming signal hint of light, a beep sound compared to the existing probe thermometer, light more significant implications, environmental noise is not affected by plants, to prevent the staff to ignore temperature prompt, remind is better [8].

In this design research, there is a preset value of warning temperature in the processor, and the processor is used to receive the temperature detection signal from at least two temperature detection components, so as to send a dimming signal to the luminous components when the value of any temperature detection signal reaches the value of warning temperature. For example, the preset warning temperature value in the processor is 60°C. When the internal temperature measured by any temperature detection element reaches 60°C, it means that the fermentation bed needs to be ventilated by turning and raking, and the remote terminal or on-site prompt light can be used to remind the staff in time.

The two temperature detection elements are equidistant along the length direction of probe tube 2, and the distance between the two adjacent temperature detection elements is between 3cm and 15cm.

Among them, the temperature detection element is NTC thermistor 20, probe tube 2 is the lower end of the stainless steel pipe plugging. Probe tube 2 is made of 304 stainless steel tubes with corrosion resistance[9], the length of the probe tube is 2 to 50 cm, Four NTC thermistors 20 are arranged in probe tube 2, NTC thermistor 20 has a large temperature measuring range and high sensitivity, the distance between the adjacent two NTC thermistor[10] 20 is 12 cm, in order to accurately detect fermentation bed internal temperature of different depth.

The luminous component is arranged on the top of the casing 1, and the luminous component is an LED light source 12. LED light source 12 is a color- changing LED light source, and the color-changing LED light source has at least two kinds of red and yellow hint light. In this implementation case, LED light source 12 is made of GaAsP material and has at least two colors: red and yellow. When the detected temperature does not reach the value of warning temperature, LED light source 12 normally emits yellow light. When the detected temperature exceeds 60℃, the processor sends a dimming signal to LED light source 12. When the light is adjusted from yellow to red, the color change of red and yellow light can play a significant warning role .

A built-in power supply is provided in the chassis 1, which is electrically connected with the circuit board. A charging interface 13 is also provided on the chassis 1, which is electrically connected with the built-in power supply. The wireless communication module is low-power Bluetooth module, which is also called "BLE Bluetooth module", and has the characteristics of low power consumption and low cost. The display is a low-power LCD 11, which can save power consumption to the maximum extent, prolong the standby time of the entire temperature sensor device, avoid frequent charging operation, and provide better durability and reliability [11].

## 3. Primary Product Testing

Because the real products are in the primary state, there is a lack of a large number of comparative experiments on the test results of the early products when they are tested in the farm. In the flat broiler flocks of large farms, the thickness of chicken excretion produced by a large number of chickens was not deep enough after a day of activity. The data of shallow accumulated chicken excretion was transmitted accurately and could be timely and conveniently transmitted to the mobile phone of the detector, with accurate alarm and normal function of bluetooth module. For chicken droppings up to 40CM, the data start to become unstable. The external installation box of the product needs to be stronger and more corrosion-resistant, because the chicken excrement is highly acidic, and the external packaging material also needs to be considered. Currently, the primary product lacks this design, which needs to be improved. Field experiment is shown in figure 3-5.


**Figure 3.** Field experiment


**Figure 4.** Field experiment

**Figure 5.** Farm environment experiment simulation environment test

The equipment has not been tested in the fermentation beds of pig and cattle farms. Considering that there may be certain differences in feces of different animals, the large-scale promotion of the equipment needs more experimental verification.

## 4. Conclusion

In this paper, a kind of temperature sensing equipment for fermentation bed in large scale chicken farm was studied. The temperature sensing device comprises a housing, a circuit board and a probe tube, on which a processor and a wireless communication module are provided. The probe tube is fixedly connected with the casing, and at least two temperature detecting elements are arranged inside the probe tube, and the detecting elements are arranged in intervals along the length direction of the probe tube. The processor is electrically connected with the temperature detecting element and wireless communication module respectively. The temperature detection element is used to detect the wall temperature of the probe tube and generate temperature detection signal. The processor is used to receive the temperature detection signal and forward it to the wireless communication module. The wireless communication module is used to convert the temperature detection signal into wireless signal and send it. It solves the problem of multi-zone accurate temperature measurement in different depth of fermentation bed, improves the width and thickness of temperature measurement area, and improves the sensitivity of early warning.

The product is accurate in temperature measurement, good in data transmission and sensitive in alarm. However, when the accumulation of chicken feces reaches 40CM, the data start to become unstable, and further research is needed.The external installation box of the product needs to be stronger and more corrosion-resistant, because the chicken excrement is highly acidic, and the external packaging material also needs to be considered.

## References


[1] Sun H Y, Jiang R S, Xu S Y, Zhang Z B, Xu G Y, Zheng J X, Qu L J. Transcriptome responses to heat stress in hypothalamus of a meat-type chicken[J]. Journal of Animal Science and Biotechnology. 2015, 6(03).

[2] Hurtado-Pomares Miriam, Valera-Gran Desirée, Sánchez-Pérez Alicia, Peral-Gómez Paula, Navarrete-Muñoz Eva-María, Terol-Cantero María-Carmen, Adaptation of the Spanish version of the Frontal Assessment Battery for detection of executive dysfunction. Medicina Clínica (English Edition), 2021, 156(5): 229-232.

[3] CN211291782U 2020 A Multifunctional Probe Thermometer

[4] Zhao Z H, Li S F, Huang H Y, Li C M, Wang Q B, Xue L G. Comparative Study on Growth and Developmental Model of Indigenous Chicken Breeds in China.Open Journal of Animal Sciences, 2015, 5(2): 219-223.

[5] Tang W P, Wen W J. A temperature sensing equipment for fermentation bed in aquaculture industry, 2020, 202011384768.5

[6] Sumeet Kumar Sharma, Ashok Kumar Sivarathri and Vishal S Chauhan. Effect of high temperature and poling on the wireless signal detection from soft and hard PZT[J]. Journal of Materials Science: Materials in Electronics, 2020:1-13

[7] Li Z H, Li J Z, Bao C C, Hou G F, Liu C X, Cheng F and Xiao N X. Automatic calibration system of the temperature instrument display based on computer vision measuring. Physica A: Statistical Mechanics and its Applications, 2010, 7749: 774908-774908-7

[8] Li M W. Application of wireless communication in multi-channel temperature control system. Applied Mechanics and Materials, 2013, 2658( 397-400): 1918-1922

[9] Zhang M, Li M S, Zhang H M, Kamale Tuokedaerhan. Chang A M. Synthesis of pilot-scale Co 2 Mn 1.5 Fe 2.1 Zn 0.4 O 8 fabricated by hydrothermal method for NTC thermistor[J]. Journal of Alloys and Compounds, 2019, 797(C): 1295-1298

[10] K. Narayana Swamy; Nandeesh M; Nagaraj Hediyal. Modeling, Characterization and linearization of Negative Temperature Coefficient (NTC) Thermistor and Pressure Sensors[J]. International Journal of Recent Technology and Engineering, 2020, 8(6): 82-88

[11] Matthieu Dubarry, Arnaud Devie, Katherine McKenzie. Durability and reliability of electric vehicle batteries under electric utility grid operations: Bidirectional charging impact analysis[J]. Journal of Power Sources, 2017, 358: 39-49.