

IoT-Based Smart Necklace for Goat Health Monitoring

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DOI: <https://doi.org/10.30880/ritvet.2022.02.02.032>

Received 19 July 2022; Accepted 12 September 2022; Available online 30 September 2022

Abstract: The Internet of Things is very helpful in smart agriculture, especially for the livestock sector. Difficulties of livestock monitoring such as health problems, feeding, presence and safety can be facilitated through monitoring via smartphones. Livestock such as goats needs breeders' help, especially for sick goats. Therefore, this study aims to design a device for monitoring goats' heart rate and body temperature. The smart necklace product for goats was developed according to the waterfall model guide, allowing the device to obtain heart rate readings and temperature sensors using the Blynk app. It was created using NodeMcu ESP8266, Oled Display, Temperature Sensor, and Particle Burst Sensor. A charging module is required to charge the 3.7 v Lithium Polymer LiPo Battery when the battery is low. Tests have been done on this product, functional and design asp, an, dl as expert validation. The findings show that there is a shortage of power sources that are 3.7 v lithium battery cannot support the function of the circuit for a long period. Therefore, 5v power source is required. Further studies need to be carried out to improve this product for commercialisation, including the design and ergonomic aspects of the goat body.

Keywords: Monitoring System Device, Temperature, Heartbeat, Blynk

1. Introduction

In this era of rapid technological advancement, the internet has become a necessity for everyone on this earth because everyone has their smartphone regardless of age, whether children, adults, or the elderly. Through the Internet of Things, firms have become more productive, sped up procedures, decreased error, avoid theft, and integrated complex and adaptable organisational systems (Madakam, S, Ramaswamy, R. & Tripathi, S., 2015).

When goats are sick, breeders have a difficult time they cannot be in the barn all the time and ill goats will have body temperatures of up to 42 degrees (National Cooperative Extension Resource, 2019). Three main objectives have been identified to ensure the purpose of this research can be archived, such as designing a monitoring system device for the goat's heart rate and body temperature, to develop

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an online monitoring system for the goat. Test the functionality of the heart rate and body temperature sensors of goats.

The smart necklace for goats can access heart rate readings and temperature sensors using the Blynk app. Also, use NodeMcu ESP8266, OLED Display, temperature Sensor, and Particle Sensor Breakout. The most important of these products is to observe the goats' condition, heartbeat, and body temperature to make sure the breeder is better prepared if the goats are in need. The respiration rate for sheep and goats is about 12 to 15 breaths per minute (depending on environmental temperature), and the heart rate should be between 70 and 80 beats per minute (Common Diseases and Health Problem in Sheep & Goats); inspection carried out using a digital thermometer. The problem breeders face is that it is difficult to monitor sick goats from as far away as home. Breeders also had to be in the barn for a long time to monitor the condition of sick goats.

This product can help breeders be prepared when goats are in need by notifying them via smartphones. Thus, breeders can spend more time with family than feeling in the barn to monitor sick goats. This project was developed to create a device that resembles a smartwatch for humans, but this time focuses on animals like goats and is called a smart necklace. The device is equipped with the Internet of Things (IoT) concept and temperature and heart rate sensors to make it easier for breeders to monitor the health of their goats in the barn from far by smartphone.

2. Methodology

This product development was carried out using Waterfall Model. Waterfall Model is a sequential software development process in which progress flows gradually 'like a waterfall' through project phases: analysis, design, development, testing and maintenance. Figure 1 shows the waterfall model.

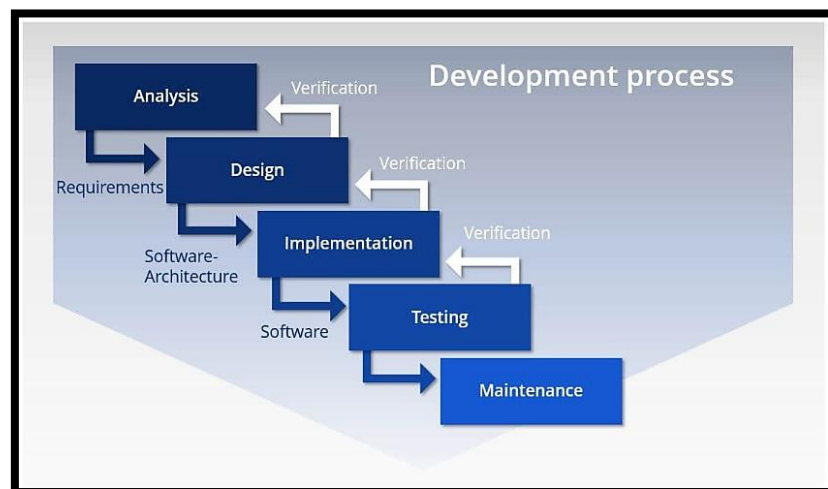


Figure 1: The Waterfall Model (IONOS, 2019)

These steps all contribute to the success of the development of the product and may be described as follows:

- i. **ANALYSIS:** In the analysis phase, the system or product is analysed in terms of expenses, revenue, and long-term potential. The research project includes a basic description of the requirements, a project plan and calculation, and an offer to the customer, if appropriate. The criteria are then thoroughly outlined, including an analysis of the current situation and a target idea. The first step in determining the optimal research method is defining the research topic and study objectives.

The most important of these products is to observe the goats' condition, heartbeat, and body temperature to make sure the breeder is better prepared if the goats are in need. Normally, breeders need

to lift the goat's tail by slowly inserting the thermometer under the tail into the rectum and holding it there for 3 minutes, remove the thermometer then read the results (General Health Guidelines for Meat Goats, 2022). Breeders need a new method or way that is easier to get heart rate readings and body temperature of goats. Smart necklaces are the best answer to breeders' problems because they are equipped with the latest technological advances, such as IoT, that can take advantage of the internet.

ii. DESIGN: Designing and operating an automated process to maintain profitability, quality and safety specifications require close interaction between experts from different disciplines. The design of this product is smaller because it is made according to the size of the goat's neck. Based on a previous study, Livestock Monitoring in Agriculture, using IoT, a GPS sensor mounted on the neck of livestock monitors the location of animals. The size of the product is fitted to the neck of the livestock and has an adjustable strap. Figure 2 below shows the design.

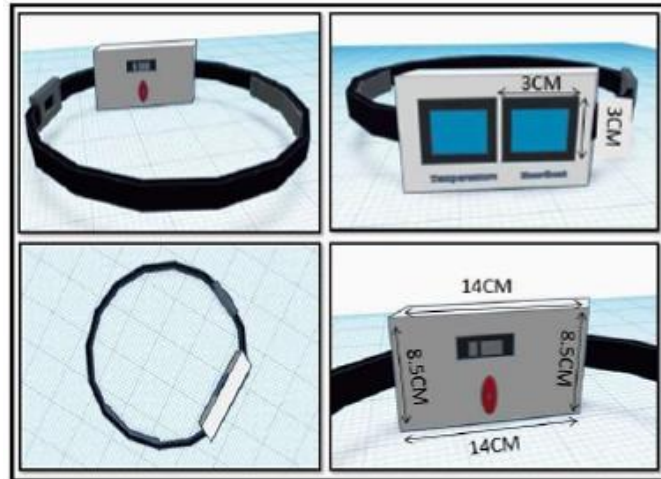


Figure 2: Smart Necklace Design

A block diagram is a visual representation of the processes that must be carried out to show how the product works. Figure 3 shows the detail of the block diagram.

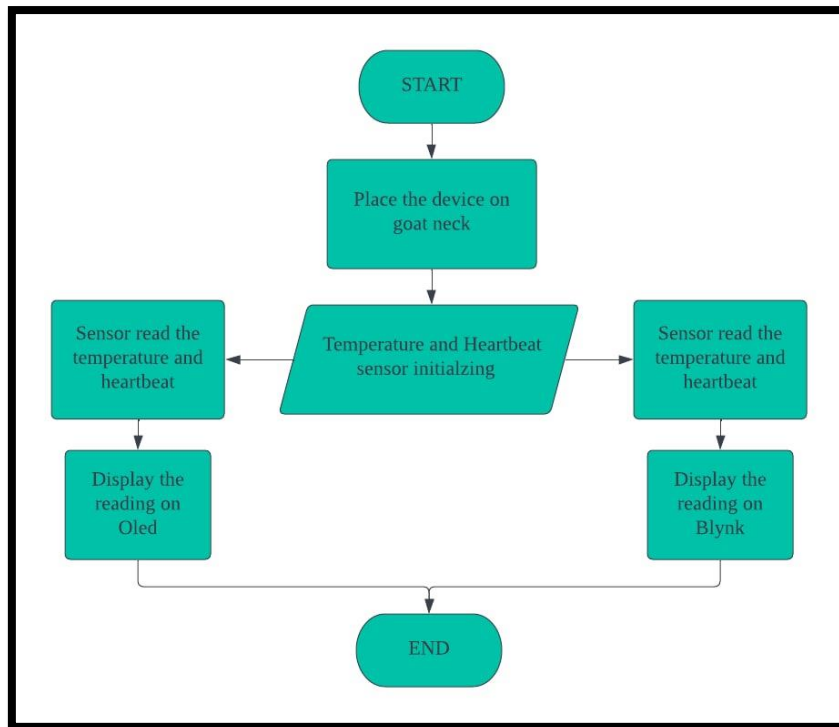


Figure 3: Block Diagram Smart Necklace

A flowchart is a visual representation of the processes that must be carried out to overcome the problems on the topic. Figure 4 show the flowchart about Smart Necklace for Goat. The figure shows how the hardware and cable connect each other and is very helpful when the product creation process. the electrical connections and functions of a given circuit configuration are shown using visual symbols in a schematic diagram. The schematic diagram is used to trace the circuit and its operations without consideration of the component devices or parts' physical size, shape, or placement.

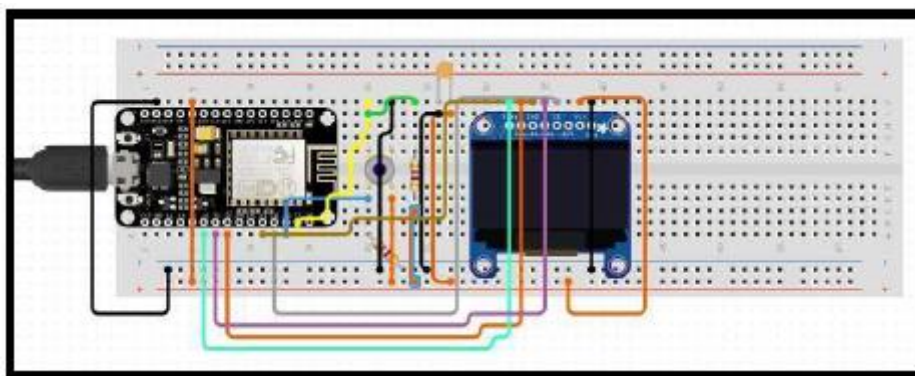


Figure 4: Circuit design for Temperature

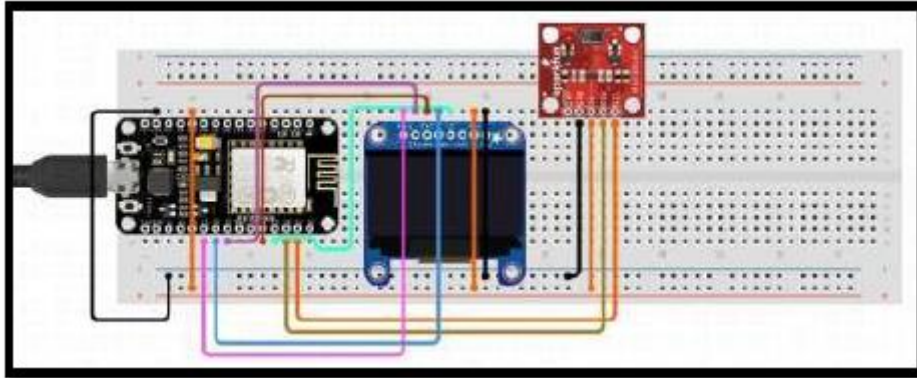


Figure 5: Circuit design for Heartbeat

iii. **IMPLEMENTATION:** In the implementation phase, several processes are carried out, such as software development, hardware development, problem solving and software architecture. The software design is implemented in the desired programming language during the implementation phase.



Figure 6: Front View of the smart necklace



Figure 7: Back view of the smart necklace

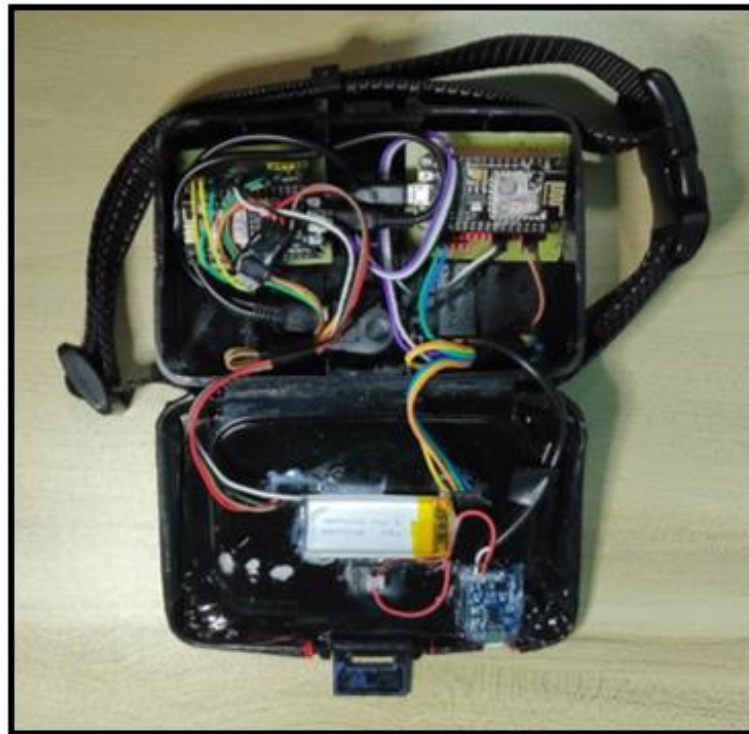


Figure 8: Inside view of the smart necklace

Individual components are created, tested in the framework of module testing, and then gradually integrated into the overall product. During this phase, the source code is written according to the standards. Code is created from the physical design specifications.

iv. TESTING: Once the Smart Necklace for Goats has been completed on the hardware and software side, functionality testing will be conducted to ensure that all temperature and heart rate sensors are working properly. The smart necklace for goats is tested directly on the neck of the goat to get the value reading on the OLED display.

v. This product is installed on live animals such as goats that are not too aggressive, thus reducing the rate of damage to the product when installed on the neck of goats. Breeders need to install Blynk software on smartphones to access smart necklaces to track temperature readings and goat heart rate from a distance.

3. Result and Discussion

The results section presents the data from the study.

3.1 Result of the sensor reading

This product is placed on the goat's neck, so breeders can see the goat's body temperature rate from the OLED display on the smart necklace. Furthermore, the smart necklace can be accessed using a smartphone, thus ensuring the breeder arrives just in time for the goats to need it. Through the Blynk app display, there will be a display of temperature readings and goat heart rate readings.

The first step in evaluating whether an animal is healthy is to take its temperature, and the goat's normal temperature should be 103°F to 104°F or 39°C to 40°C (National Cooperative Extension Resource, 2019). The average body temperature for goats is 38.5 C (normal), but for sick goats, the temperature is higher or lower than normal (Buku Panduan Ternakan Kambing Dan Bebiri, 2012).



Figure 9: Temperature and pulse reading on goat 1



Figure 10: Temperature and pulse reading on goat 2



Figure 11: Notification appears upon the temperature hits the limit of the value

3.2 Discussion

The discussion section presents the analysis of the study.

3.1.1 Analysis Reading of Heartbeat and Temperature

When the temperature and heartbeat sensor work, the OLED display will show the reading, and the blynk will see the same reading as the OLED display. Table 1 show analysis of reading from the reading of temperature and heartbeat.

Table 1: The analysis of heartbeat and temperature reading

Goat Numbers	Temperature		Heartbeat	Notification
	Celsius (c)	Fahrenheit (f)	Beats/minute (Bpm)	
1.	36.69	98.04	40.89	No
2.	35.89	96.60	43.82	No
3.	36.69	98.04	43.82	No
4.	37.37	99.26	70.56	Yes
5.	30.81	87.45	53.88	No
6.	35.89	96.60	40.89	No
7.	34.99	94.98	53.88	No
8.	37.27	99.08	71.23	Yes
9.	36.69	98.04	43.82	No
10.	30.81	87.45	53.88	No
11.	36.69	98.04	40.89	No
12.	35.89	96.60	43.82	No
13.	36.69	98.04	43.82	No

14.	37.37	99.26	70.56	Yes
15.	30.81	87.45	53.88	No
16.	35.89	96.60	40.89	No
17.	34.99	94.98	53.88	No
18.	37.27	99.08	71.23	Yes
19.	36.69	98.04	43.82	No
20.	30.81	87.45	53.88	No
21.	36.69	98.04	40.89	No
22.	35.89	96.60	43.82	No
23.	36.69	98.04	43.82	No
24.	37.37	99.26	70.56	Yes
25.	30.81	87.45	53.88	No
26.	35.89	96.60	40.89	No
27.	34.99	94.98	53.88	No
28.	37.27	99.08	71.23	Yes
29.	36.69	98.04	43.82	No
30.	30.81	87.45	53.88	No

3.1.2 Instrument for Expert Evaluation

Three experts have evaluated this product to confirm the functionality of the IoT-Based Smart Necklace for Goats. In the reviews section, all the experts have confirmed the product's functionality and met the set objectives. There are 3 parts of evaluation: design, functionality, and commercial aspects.

3.1.3 Product Design Evaluation

There are 6 items to evaluate the smart necklace design. Table 2 shows the result of the evaluation for the expert.

Table 2: Product design evaluation

No.	Question	Consent		Total (%)
		Yes	No	
Casing				
1.	The product has a solid shape	E1, E2, E3		100
2.	The size of the casing made corresponds to the size of the goat's body.	E1, E2, E3		100
3.	The casing material is waterproof	E1, E3	E2	90
Circuit				
4.	The circuit made is safe	E1, E2, E3		100
5.	The power supply is safer because it uses a 3v battery.	E1, E2, E3		100
6.	The circuit is well soldered and neat	E1, E2, E3		100

E1= Expert 1, E2=Expert 2 and E3=Expert 3

The product design focuses on the design aspects of the Smart Necklace for Goats IoT-Based product. The process for designing this product is a step after analysis before the product is fully developed. Expert 3 suggests improving the casing because not fully waterproof.

3.1.4 Product Function Evaluation

There are 9 items to evaluate the smart necklace design. Table 3 shows the result of the evaluation for the experts. All expert agrees with the question.

Table 3: Product functionality Evaluation

No.	Question	Consent		Total (%)
		Yes	No	
Temperature Sensor				
1.	The sensor used is suitable for goats	E1, E2, E3		100
2.	The temperature sensor gets a good reading.	E1, E2, E3		100
Heartbeat Sensor				
3.	The sensor used is suitable for goats	E1, E2, E3		100
4.	The pulse sensor gets a good reading	E1, E2, E3		100
OLED Display				
5.	The OLED display shows the Pulse reading	E1, E2, E3		100
6.	The OLED display shows the Temperature reading	E1, E2, E3		100
Blynk Apps				
7.	The Blynk app displays Temperature readings	E1, E2, E3		100
8.	The Blynk app displays Pulse readings	E1, E2, E3		100
9.	The Blynk app shows Warning notifications.	E1, E2, E3		100

E1= Expert 1, E2=Expert 2 and E3=Expert 3

3.1.5 Commercial Potential Evaluation

There are 6 items to evaluate the smart necklace design. Table 4 shows the result of the evaluation for the expert. All expert agrees with the questions.

Table 4: Evaluation of Commercial Evaluation

No.	Question	Consent		Total (%)
		Yes	No	
1.	The product is easy to carry and store	E1,E2,E3		100
2.	The product is not too heavy	E1,E2,E3		100
3.	The product is more durable because of the quality goods.	E1,E2,E3		100
4.	The product is easy to repair	E1,E2,E3		100
5.	The product is easy to repair	E1,E2,E3		100
6.	The product is very suitable for marketing	E1,E2,E3		100

E1= Expert 1, E2=Expert 2 and E3=Expert 3

4. Conclusion

The testing and analysing of the functionality of this produced product have achieved its objective. As a result of expert validation, these prototypes can be made to improve the quality of the project. Also, the LiPo battery used is 3.7V, not enable to accommodate two esp8266s, so it needs to be changed to a 5v battery. In the future, words are required in order to improve this product, such as the casing and the design to a more modern using a 3D printer.

Acknowledgement

The author would like to thank the Faculty of Technical and Vocational Education, Universiti Tun Hussein Onn Malaysia.

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