MATHEMATICAL MODELING OF PIXEL IDENTIFICATION BASE ON THERMAL IMAGING FOR REAL TIME DEAD ANIMAL DETECTION

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ABSTRACT

In this paper, we present mathematical modeling of pixel identification base on thermal imaging for real time dead animal detection for use in dead chickens detection in massive farm we present idea and mathematical model or method In order to determine the position of the image pixels in the event that indicates that there is a dead chicken by using thermal imaging. In order to make the monitoring system is working as fast as possible. We found that the temperature of the chicken is still alive, which would be more than the temperature in the surroundings. And we also found that the temperature of the chicken that died, which has a temperature close to ambient temperature in the surrounding environment. From this results led to a method for checking the dead chickens.

1. INTRODUCTION

At present, the poultry industry has expanded extensively both locally and around the world. From traditional farming has developed into a comprehensive industrial system. Fully With the use of modern technology As well as the equipment used to feed more efficiently. However, one issue that continues to come up is the death of the chickens on the farm. This issue affects people waited to collect the remains of dead chickens on the farm to be left or discarded. It is well known that if farms are small farms to dispose of dead carcasses is very simple and will not take much. However, in case of a large chicken farm with a lot of chickens that died of chicken each day, it will be a lot more. This affects the removal process carcasses of dead is going to be difficult and takes more time and may make mistakes in the process of eliminating the remains of dead chickens have not completely thorough. Not only that, getting rid of dead carcasses, it can not be done in real-time because of that we did not watch it all the time.

Currently there are several research related to thermal imaging. From the variety of creatures that use thermal imaging recognition for finding food and livelihood (Angela, et al., 2002). Some research used FLIR imager to detect competing heat signatures in that environment to consistently detect denning polar bears on the land (Steven, et al., 2004). Thermal imaging is used to help distinguish between background and foreground or used to extract the foreground from the background (James, et al., 2007). Someone propose algorithms for use with detection and tracking in infrared (IR) images as part of automatic target recognition (ATR) systems (Shaik, et al., 2009). Thermal imaging also is used to distinguish or identify the people in the picture (Antonio, et al., 2010) and (Antonio, et al., 2011). We found that from the above, there is none that offer a way to check the chicken or animals that die on the farm using a thermal camera.

Therefore, this paper presents a method to investigate the death of a chicken without a man. Which can be monitored in real-time. In this paper we discuss the identity of dead chickens, which are the parameters to be used in the calculation to derive the way to investigate the death of chickens. Which will be presented in the form of mathematical models. To be useful in applying to the system for investigating the death of chickens in automation for deployment in various farms in the future.

2. EXPERIMENT

2.1 Materials

This section discusses the materials and equipment used in experiments to gather ideas or hypotheses come to prove that it meets the requirements or not. The Laboratory is an experiment in a closed system, which will result in measured values is minimal interference. This experiment used in a closed container that is made out of a large box, which is equal to the size of the width of 50 cm size of a length of 40 cm and a height of 65 cm. To keep the results more clearly, thus dividing the lower half of the box into two parts in order to divide the laying hens live and dead chickens apart. Then install a thermal imaging camera (FLIR TG165) that has the ability to capture heat from the temperature of -25 degrees to 380 degrees and the image size is 174 x 220 pixels and a response time is 150 ms per one shooting. Which is installed in a central position in the top of the box, as shown in Figure 1.

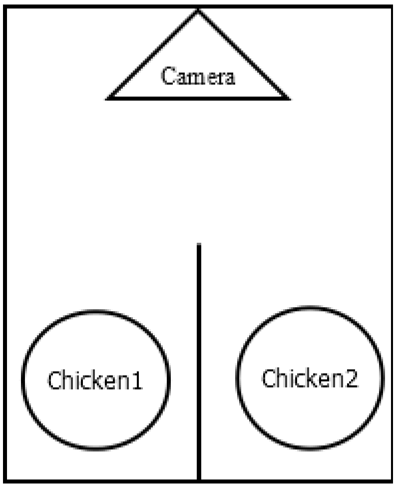


Fig. 1 Structure of system.

2.2 Methods

2.2.1 Initial conditions. This section discusses the default conditions that would apply in the calculation process for a pixel with the death of chickens in the next section. These values are the values obtained from experiments and calculations in parallel. Start by measuring the temperature at which the chickens were dead by the start measure of the chicken did not die and then record it into T(t). Where t is time, which refers to the temperature at the time of the chickens were dead. Then save the start time, the temperature began to drop and record it into t_1 to the point where the temperature barely dropped, then record it into t_2. These values are for the use of the terms that are used to calculate the slope in the next section. Next, bring the temperature of the recording T(t) to plot a graph, and then calculate the slope and record it into m as equation 1

$$m = \frac{T(t_2) - T(t_1)}{t_2 - t_1} \tag{1}$$

By which to calculate the slope to the line drawn straight from the top spot at the temperatures begin to drop to the lowest point in the first cut, the temperature started to not drop already. It can be seen that this step will have to calculate the cross slope is not steep-peer computing. Then calculate the total value of the temperature from the time t_1 to t_2 and record it into T_s as equation 2

$$T_s = \sum_{i=t_1}^{t_2} T(i) \tag{2}$$

Then, do the experimental and computational process from the start to the above mentioned repeatedly as an amount M by which an amount is to be determined according to the location or environments surround experiment. Then we will have a slope of M unit that define as m_i where i is the order of the recorded other words, m_i is the slope in order to i. At the same time, recording the time t_1 and t_2 of M unit into $t_1(i)$ and $t_2(i)$ respectively. And finally save the results of every T_s temperature into $T_s(i)$. All of above can be viewed in Figure 2.

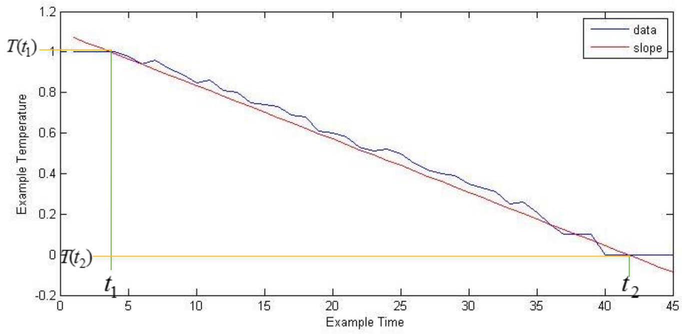


Fig. 2 Record a slope for initial conditions.

The next step is to import value from above to calculated for find the maximum and minimum of the slope from all M unit and then record it into m_{max} and m_{min} respectively as in equations 3 and 4

$$m_{\max} = MAX(m_1, m_2, \ldots, m_M) \tag{3}$$

$$m_{\min} = MIN(m_1, m_2, \ldots, m_M) \tag{4}$$

Then calculate the average value of t_1 and t_2 from all M unit and then record it into t_{1avg} and t_{2avg} respectively as equation 5 and 6

$$t_{1avg} = \frac{\sum_{i=1}^{M} t_1(i)}{\sum_{i=1}^{M} i} \tag{5}$$

$$t_{2avg} = \frac{\sum_{i=1}^{M} t_2(i)}{\sum_{i=1}^{M} i} \tag{6}$$

Then calculate the maximum and minimum value of T_s from all M unit and then record it into T_{smax} and T_{smin} respectively as equation 7 and 8

$$T_{s\max} = MAX(T_s(1), T_s(2), \ldots, T_s(M)) \tag{7}$$

$$T_{s\min} = MIN(T_s(1), T_s(2), \ldots, T_s(M)) \tag{8}$$

Then calculate the new m_{max} and m_{min} from threshold value, which can be selected as appropriate in the circumstances, or in other words, This threshold is a value that can be adjusted for use in detect as best as possible. Then record it into m_{nmax} and m_{nmin} as equation 9 and 10

$$m_{n\max} = m_{\max} + m_{th} \tag{9}$$

$$m_{n\min} = m_{\min} - m_{th} \tag{10}$$

The m_{th} is the threshold that has been selected. Then calculate the new T_{smax} and T_{smin} from threshold value, which can be selected as appropriate in the circumstances. Then record it into T_{snmax} and T_{snmin} as equation 11 and 12

$$T_{sn\max} = T_{s\max} + T_{th} \tag{11}$$

$$T_{sn\min} = T_{s\min} - T_{th} \tag{12}$$

2.2.2 Pixels Identification. This section discusses about how to calculated for identify the pixels that have caused the death of chickens. In the computation will be imports some value from Initial conditions for use to calculate in this section. The first is to record thermal image and present it as matrix T with dimension pxq as equation 13

$$T = \begin{bmatrix} t_{11} & t_{12} & . & . & t_{1q} \\ t_{21} & t_{22} & . & . & t_{2q} \\ . & . & . & . & . \\ . & . & . & . & . \\ t_{p1} & t_{p2} & . & . & t_{pq} \end{bmatrix} \tag{13}$$

From equation 13, which value t_{pq} is a temperature in each pixel in thermal image. For about value T it can represent in the form of T(x,y) that x is value from 1 to p and y is value from 1 to q. Next step is to record thermal image in many image and represent it as $T_j(x,y)$, which j is value between 1 to M. And M is number of all image that have been record. The following is the calculation used to identify. But at this stage, the calculations for preparing the first. It will be stored in $A_j(x,y)$ and $B_j(x,y)$ as equation 14 and 15

$$A_j(x,y) = \frac{\left(T_{j+(t_{2avg}-t_{1avg})}(x,y) - T_j(x,y)\right)}{\left(t_{2avg} - t_{1avg}\right)} \tag{14}$$

$$B_j(x,y) = \sum_{k=j}^{L} T_k(x,y) \tag{15}$$

which j, x, y and L is:

$$y = \{1,2,3,\ldots,q\}$$

$$x = x(y) = \{1,2,3,\ldots,p\}$$

$$j = j(x,y) = \{1,2,3,\ldots,(M-(t_{2avg}-t_{1avg}))\}$$

$$L = j(x,y) + t_{2avg} - t_{1avg}$$

Then, bring the value $A_j(x,y)$ to compare with slope conditions from the previous section, which is m_{nmax} and m_{nmin} and stored it into C(x, y) as equation 16

$$C(x,y) = \begin{cases} 1; if\ 1 \in E(x,y) \\ 0; otherwise \end{cases} \tag{16}$$

$$E(x,y) = \left\{ \begin{array}{c} \begin{cases} 1; if\ (m_{n\min} \le A_1(x,y) \le m_{n\max}) \\ 0; otherwise \end{cases} \\ \cup \\ \begin{cases} 1; if\ (m_{n\min} \le A_2(x,y) \le m_{n\max}) \\ 0; otherwise \end{cases} \\ \cup \\ \vdots \\ \cup \\ \begin{cases} 1; if\ (m_{n\min} \le A_L(x,y) \le m_{n\max}) \\ 0; otherwise \end{cases} \end{array} \right\}$$

which x, y and L is:

$$y = \{1,2,3,\ldots,q\}$$

$$x = x(y) = \{1,2,3,\ldots,p\}$$

$$L = M - t_{2avg} - t_{1avg}$$

Then, bring the value $B_j(x,y)$ to compare with temperature conditions from the previous section, which is T_{snmax} and T_{snmin} and stored it into D(x, y) as equation 17

$$D(x,y) = \begin{cases} 1; if\ 1 \in F(x,y) \\ 0; otherwise \end{cases} \tag{17}$$

$$F(x,y) = \left\{ \begin{array}{c} \begin{cases} 1; if\ (T_{sn\min} \le B_1(x,y) \le T_{sn\max}) \\ 0; otherwise \end{cases} \\ \cup \\ \begin{cases} 1; if\ (T_{sn\min} \le B_2(x,y) \le T_{sn\max}) \\ 0; otherwise \end{cases} \\ \cup \\ \vdots \\ \cup \\ \begin{cases} 1; if\ (T_{sn\min} \le B_L(x,y) \le T_{sn\max}) \\ 0; otherwise \end{cases} \end{array} \right\}$$

which x, y and L is:

$$y = \{1,2,3,\ldots,q\}$$

$$x = x(y) = \{1,2,3,\ldots,p\}$$

$$L = M - t_{2avg} - t_{1avg}$$

Finally, bring the value C(x,y) and D(x,y) to intersect with them all value and record it into P(x,y) as equation 18

$$P(x,y) = \begin{cases} 1; if\ 1 \in (C(x,y) \cap D(x,y)) \\ 0; otherwise \end{cases} \tag{18}$$

which x and y is:

$$y = \{1,2,3,\ldots,q\}$$

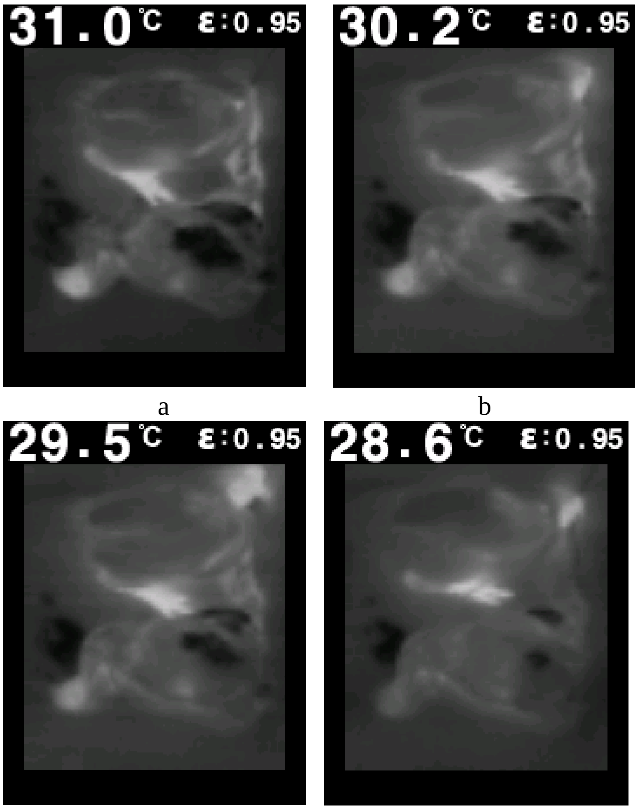
$$x = x(y) = \{1,2,3,\ldots,p\}$$

From P(x,y) value now we can identify pixels, what a pixel has found a dead chicken and what a pixel has not found a dead chicken, which P(x,y) value if P(x,y) is a value 1 that mean this pixel has found dead chicken and if P(x,y) is a value 0 that mean this pixel has not found dead chicken.

In this section we discussed about step of pixel identification from start to end, which is start from get thermal image and represent it as thermal matrix then get every image amount M image to use in calculation then calculate preidentification value that is $A_j(x,y)$, $B_j(x,y)$, C(x,y) and D(x,y). Finally we get P(x,y) value that can identify each pixel what a pixel has found dead chicken and what a pixel has not found.

3. RESULTS AND DISCUSSION

This section we will discuss the results that we was obtained from experiment. From the initial stages we recorded a ambient temperature about 27.3 degrees and we put two chicken into the container, where one is dead chicken and another one still alive. Then take a picture with the thermal camera for one hour. From the results, we found that the temperature of dead chickens will gradually decrease. In this experiment, the temperature of chickens began dying at 31.0 degrees. And then it decrease to 30.2 degrees within five minutes. Then the temperature was gradually reduced until 10 minutes the temperature dropped to 29.5 degrees. And then over time, 60 minutes, the temperature dropped to 28.6 degrees as shown in Figure 3a to 3d.

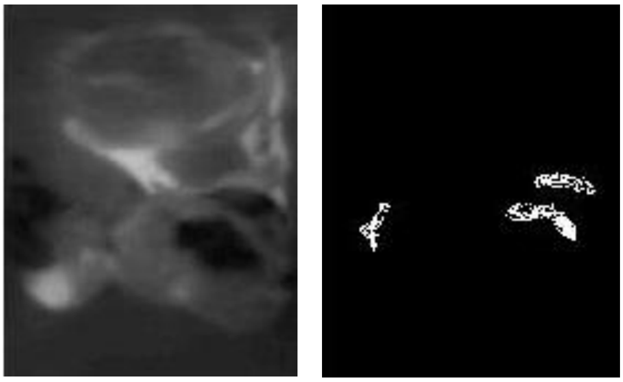


a b

c d

Fig 3 (a) Thermal image at initial time (b) thermal image at 5 minute (c) thermal image at 10 minute (d) thermal image at 60 minute.

Then we found that we can use changes of temperature within a short period such as 10 minutes to check the dead chicken. We made a program for use in monitoring chickens died by trying to bring images from the experiment to processed in the program, we found this concept can be used to check the dead chicken. We also found that in the short time we can detect dead chicken has only partially of body in chicken, that mean it not all body, that is the part of the chicken with few feathers cover. The temperature will decrease faster than the temperature at thick feathers. As shown in Figure 4a and 4b, which Figure 4a is the original image at initial and Figure 4b is a result from pixel identification program, which the white spots is the position of dead chicken.



a b

Fig 4 (a) Original image at initial time (b) Detection image of dead chicken.

CONCLUSION

We presented mathematical modeling of pixel identification base on thermal imaging for use in dead chickens detection in massive farm we found that if we want to detect dead chicken we have to use minimum time at least 10 minute. And we found that within 10 minute we can not detect all of body of chicken that mean we just can detect some part of body that has a few feathers cover. Finally we expect our information will be useful to who is interested in the automatic detection system of pet or animal deaths in farm or in wild. And sincerely hope, that this information is useful for people that will bring this idea to developed for more effective in the future.

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