STUDY ON LINEAR APPRAISAL OF DAIRY COW'S CONFORMATION BASED ON IMAGE PROCESSING

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Abstract: Image processing technology is more commonly applied to such fields as virtual reality, biological medicine and permeates rapidly through agricultural scientific research. This paper described a linear appraisal system for analyzing dairy cow types based on image processing, which consists of hardware design, software design, realization of characters click points operating and the interactive measurement of type character parameter for dairy cow. We use NI Lab windows/CVI and NI IMAQ Vision to develop the system software. The key purpose of image preconditioning is to clear up noise, and we use median filtering to eliminate noise during this process. Adopting image measurement method to make dairy cow type linear appraisal is convenient and swift, precision satisfying the request, being able to replace manual appraisal. The system conduces greatly to application research of image processing technology in the type linear appraisal for dairy cows.

Keywords: image processing, linear appraisal, median filtering, Dairy cow.

1. INTRODUCTION

Dairy cow type linear appraisal, which was used formally in dairy cow type appraisal in 1983, is a type appraisal method that was developed in America in 1980s (Li et al., 2002; Liu et al., 1994; Chu et al., 1996). The application of dairy cow type linear appraisal has been studied in China

since 1987. The trial standard and demand of appraisal was released in 1995, which stipulates fifteen first-class trait indexes for appraisal (Dao, 2002). The information of type conformation and appearance was used in cattle's inheritance appraisal in China from the result of linear appraisal. Because the items of dairy cow appraisal and data processed are too much, it is necessary to develop a rational and efficient dairy cow linear appraisal system based on computer image processing instead of manual appraisal.

At present, image processing technology is more and more applied to such fields as industry measurement, control and guide, virtual reality and biology medicine so on, and permeates rapidly through agriculture scientific research and produce technology field. Image measuring method makes dairy cow type linear appraisal, which not only reduces workload but also gets rid of the shortcoming of manual appraisal standard changing with men and time changing and the disadvantage of lacking impersonal impartiality. Shunsan Chen, one of graduate students in China Agricultural University, has studied image processing technology of dairy cow type linear appraisal, but they only selected monochrome acquisition board so that the information that was acquired was not enough and measurement was inaccurate. Moreover they measured only 9 traits, other 6 traits have been given score by eyeballing, so they can not appraise all traits automatically. The system adopts a camera to acquire dairy cow image, color image acquisition board to convert its signal into digital signal, image processing technology to measure every trait, so that measurement precision improved and workload is reduced.

There are at least several meanings to use image measurement method in dairy cow type linear appraisal as follows:

(1)It is a not touched measurement method and does not disturb object monitored;(2)Workload of manual measurement is not only more but also has definite danger, which is avoided by computer measuring;(3)Get rid of the shortcoming of manual appraisal standard changing with men and time changing and the disadvantage of lacking impersonal impartiality.

2. SCHEME DESIGN OF IMAGE ACQUISITION AND MEASUREMENT SYSTEM

2.1 System hardware design

System hardware is made up of computer, system display, image acquisition board, CCD Camera, printer and so on, as Fig.1 shows. Image acquisition board is DH-CG300 type color video acquisition board made by

Daheng company, image resolution is maximal: PAL: 768×576×24 BIT; NTSC:640×480×24 BIT, supporting single field, single frame, continuous field and continuous frame acquisition way, having red, green and blue three route D/A, color image signal may be inputted to R, G, B three frames deposit body at the same time, and also saved in R, G, B three frames deposit body separately. CCD camera applies Panasonic WV-CP240/G color camera, its pixel is 752(horizontal)×582(vertical),CCD is row transform, its scanning area is 4.89(horizontal) ×3.67(vertical)mm(corresponding 1/3inch vidicon scanning area),signal-to-noise is about 50 db.

Dairy cow image may be acquired real-time, and also use dairy cow picture by scanner scanning. Concrete steps as follows: camera acquires dairy cow picture, and converts it into digital image file, image file are inputted computer by color image acquisition board, after that, first converting color image into gray image, then computer processing measuring dairy cow gray image and calculating the score of linear appraisal.

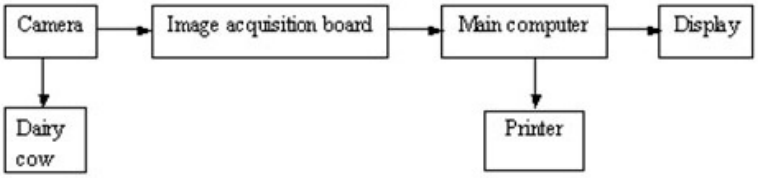


Fig.1. The block diagram of the hardware structure.

2.2 Software design of the system

The development tool (Deng et al., 2001) of system software is NI IMAQ Vision and NI Lab Window/CVI 6.0. Operating system is Chinese Win2000. IMAQ Vision is a advanced image processing analysis software package. It includes a set of rich MMX optimized library, having gray, color and binary image displaying, processing (statistic filtering and geometry transform)and image morphological processing etc functions, improving rapidly the development course of user image processing and machine vision application. Lab Windows/CVI6.0 (Zhang et al., 2002) is development environment of virtual instruments, holding libraries of powerful function which is used to build the application program of data acquisition and instrument control. Developing program can use developed C language object module, DLL, C static library and instrument driver program. It integrates source code programming, 32 bit ANSIC compiling, connecting, debugging and standard ANSIC library in a interactive development platform. Lab Windows/CVI provides plenty of functional libraries for user

transferring, including VXI, GPIB, serial, hardware control subprogram of data acquisition board and 600 source code instrument driver program, in addition, file I/O function, advanced analysis library(including signal filter design and curve fitting function)etc, almost holding all functions for instrument design application.

3. REALIZATION OF CHARACTER CLICK POINTS OPERATING

3.1 Image acquisition and preprocessing

The quality of image acquisition is one of main factors which decide the precision of type appraisal, requiring acquiring image layer to be abundant, detail to be clear, background contrast to be big(Jimenez et al., 1998-2002); so background should be chosen blue one and lighting should adopt reflection light, which can avoid shadow and reduce measurement error. With dairy cow in the standard state of four limbs coexisting, acquire three positive side images, choose the clearest one, similarly positive frontage and positive rear three, and separately choose the clearest one. After passing through window reduced, image of entering inspect view is saved, which will decrease processing time and economize storage space.

Making dairy cow image processing is difficult, because of black and white figure of dairy cow affecting. The image which this research acquires is RGB pattern, it is necessary to change RGB pattern into HSL pattern by extracting Saturation S value, so that color image is converted into gray scale image to realize gray scale processing of dairy cow(Huang et al., 2000; Zhou et al., 2003).

The system applies to median filtering to wipe off noise. In some condition, median filtering method may not only eliminate noise, but also protect image edge to gain satisfactory recover. Basic principle of median filtering is that a point in the digital image or numerical sequence is replaced by the middle value of every point value in a neighborhood of the point.

Assume that there is one dimension array $x_1,x_2,x_3,\ldots,x_n$, according to size order ranged just as $x(1) \le x(2) \le x(3) \cdots \le x(n)$

So that their median filtering output is written as

$y=\mathrm{med}(x_1,x_2,x_3,\cdots,x_n)$

$$= \begin{cases} x(\frac{n+1}{2}) & n \text{ is odd} \\ \frac{1}{2}[x(\frac{n}{2}) + x(\frac{n}{2}+1)] & n \text{ is even} \end{cases} \quad (1)$$

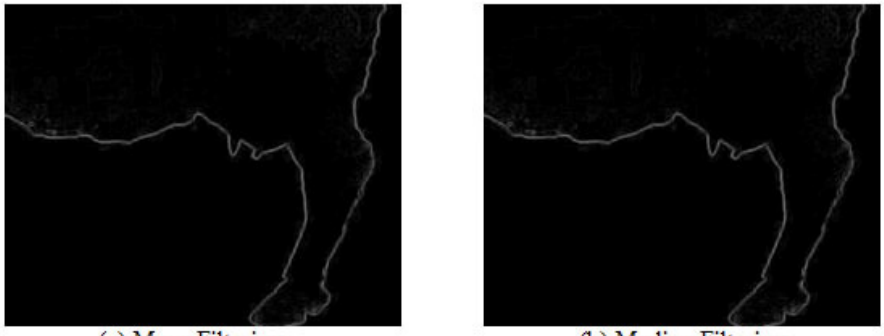
Median filtering is easy to extend two dimensions; here two dimension of some formal can be used. Each point gray scale value of digital image is expressed as $\{x_{i,j}, (i,j) \in I^2\}$, two dimension median filtering is calculated as

$$y_{i,j} = Med\{x_{i,j}\} = Med\{x_{(i+r),(j+s)}, (r,s) \in A, (i,j) \in I^2\} \quad (2)$$

Where A is filtering window

Filtering window chooses 3×3 window.

Fig.2 shows that dairy cow's edge image is smoothed by mean filtering and median filtering. It can be seen that mean filtering wipes off noise, and blur dairy cow's image edge simultaneously, the effect of median filtering is better, not only wiping off noise availably, but also saving image edge information clearer(Castlman, 2002).



(a) Mean Filtering (b) Median Filtering

Fig.2: Diary cow's edge image

3.2 Calibration

In control of system, click to standard ruler then measure the number of pixel between two points n_1,and input corresponding trim size l_1, consequently work out trim size that each pixel delegates $s_1=l_1/n_1$, measure the number of pixel between character two points n_2, again multiply s_1, educe dairy cow length between two points. According to the measured

length of two points, using cosine theorem gains angle among three points (Xu et al., 2002).

4. THE INTERACTIVE MEASUERMENT OF TYPE CHARACTER PARAMETER FOR DAIRY COW

The measurement of most character for dairy cow may convert to measure the distance between two points or angle among three points, therefore make sign for corresponding character points. Fig.3 shows interface of clicking operation. The measurement way of each type character for dairy cow as follows.

(1). Stature: according to the height of wither point make linear grade. Line out wither point and point of intersection between wither point and ground then gain body height of dairy cow.

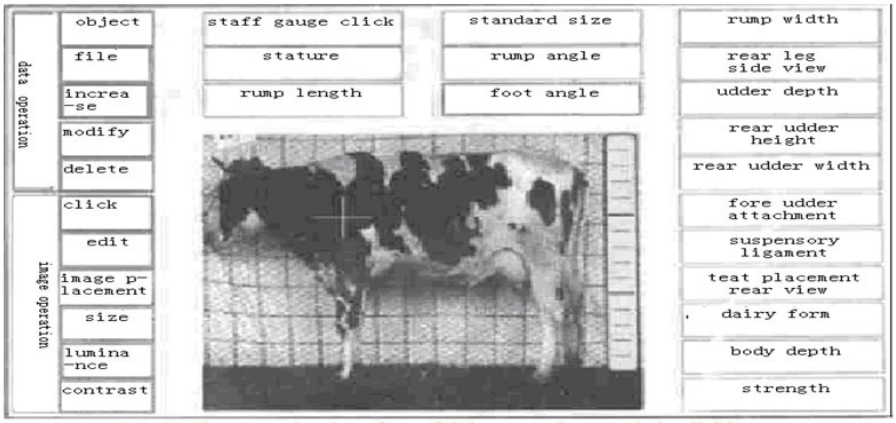


Fig.3: The operation interface of dairy cow characteristic clicking

(2). Rump angle: according to angle between the line of hip connecting ischium and horizontal make linear grade. Line out hip point and ischium point then gain rump angle.

(3). Rump length: according to the length of line between hip and ischium make linear grade. At the front hip point and ischium point are lined out.

(4). Rump width: according to thurl make linear grade. Line out two points of thurl at rear view figure then gain rump width.

(5). Rear legs side view: look at the posture of rear legs from side, according to the angle of hock angle at the tarsal joint make linear grade. Tag three points on the hock of rear legs at the side view fig then work out the angle of hock angle.

(6). Foot angle: according to the angle between hoof parietal and hoof bottom make linear grade. Tag three points on the toes, hoof parietal and hoof bottom then gain foot angle.

(7). Rear udder height: according to rear udder attachment point (transition point of rear legs socket connecting udder) changing between ischium and hock point make linear grade. Tag right and left attachment point, ischium point, hock point then work out rear udder height.

(8). Rear udder width: according to the width of two attachment points of rear view udder make linear grade. Two attachment points are tagged in front.

(9). Udder depth: according to relative position of udder bottom plane and hock make linear, and line out the placement of udder floor at rear view fig then udder depth.

(10). Fore udder attachment: the angle of joint of udder fore hem and abdominal wall.

(11). Suspensory ligament: depth from rear udder basal to median suspensory ligament.

Four fuzzy traits such as strength, body depth, dairy form, teat placement rear view are given to grade by eyes.

5. GRADE TEST

Primary test chose image of six dairy cows to make appraisal, making image click then measure appraisal to eleven traits such as stature, rump width, rump length, rump angle, rear legs side view, udder depth, rear udder height, rear udder width, foot angle, fore udder attachment, suspensory ligament, giving appraisal to four fuzzy traits such as strength, body depth, dairy form, teat placement rear view by eyes. Because linear appraisal is uniform scale size that represents different state between two extremeness of biology, it can not illuminate good or bad of each type trait exactly. To embody better or inferior of type trait, gain linear appraisal of dairy cow, after that, convert them to functional appraisal, finally work out total appraisal. The time which appraising each dairy cow takes is less than 3 min, which is less than 5 min standard regulating, choosing stature that can reflect most measurement precision, appraisal result of computer image appraisal are compared with mutual appraisal, which biggest absolute error is 1.3 cm, relative error 0.9%. The biggest error between computer appraisal and mutual appraisal is 4 point, which is within confessional range. From Table 1, it can be seen appraisal results is gained by linear appraisal method of dairy cow's conformation based on image processing for six dairy cows.

Table 1. Score comparison

Dairy cow	stature/cm		Score		Grade
	Manual	Image	Manual	Image	
1	137.4	136.7	75	76	G
2	140.8	139.9	82	81	G+
3	134.5	134.2	70	72	F

4	137.1	136.4	76	78	G
5	141.3	139.7	84	80	G+
6	132.4	132.2	67	69	F

6. CONCLUSIONS

(1)Making use of Lab Windows/CVI 6.0 and analysis function library of image processing IMAQ Vision put up the development of type linear appraisal system for dairy cow, which is feasible in technology and conduces greatly to application research of image processing technology in the type linear appraisal for dairy cow, and which makes system take on such characters as interface friendly, agility using easily, favorable extensibility.

(2)Adopting image measurement method to make dairy cow type linear appraisal is convenient and swift, precision satisfying request, being able to replace manual appraisal.

(3)Central factor of affecting appraisal precision is the quality of image acquired. The more evident administrative levels of image are, the clearer character points are, the bigger background contrast is, the higher orientation precision is.

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