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Database Issues in Ultrasound Imaging

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Abstract
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Summary

The Beef Quality Research projects in the Animal Science Department of Iowa State University have seen a lot of growth in the last few years. Due to the substantial amount of data accumulated over the past few years, there is a need for systematic organization.

Introduction

The Ultrasound Group in Animal Science at Iowa State University employs ultrasound technology as a non-destructive evaluation method for measuring several body composition traits in beef cattle. In this process, two types of ultrasound images per animal are captured. These two images are a cross-sectional view and a longitudinal view of the rib-eye muscle near the 12^{th} and 13^{th} ribs of the animal. A transducer and an Aloka® real-time ultrasound machine are used to capture the images.

Images are processed at Iowa State University to predict some carcass measurements such as the percentage of intramuscular fat. The procedure involves going out on the farms with the equipment and scanning the cattle, tracing the images for measuring fat thickness and ribeye area, collecting additional animal data, and using various algorithms to perform the prediction of percent intramuscular fat. Finally, the generated results are sent to the cattle owners.

This work has been in progress for six years, so there has been a buildup of images and image-related data. Data gathered from other sources pertaining to the animals also have been collected. A systematic method is needed to allow for speedy retrieval of the location (address) of images and thus of the images ithemselves and also the image and animal-related data. This can be taken care of by accommodating an effective database system which will yield to the requirements of the group.

It is important to understand the different types of data and their sources. Only with thorough understanding of the data and data types can the objective and then the implementation of the system be understood.

Types of Data

- Images
- Scanning-related information
- Performance-related information
- Pedigree information
- Carcass-related information
- Processed information

Images

Ultrasound images are collected by the method described earlier. Two types of images--the longitudinal view and the cross-sectional view of the muscle of the animal--are scanned. These images can be further classified as either a live-animal image or the image of the carcass of the animal. This type of data is the most important source of information and is invaluable to the process of prediction of percent intramuscular fat. In the future, more views of the animal scanned.

Scanning-Related Information

Two parameters are extracted by tracing part of the cross-sectional view image. These are the ribeye area and backfat.

A lot of other parameters are extracted by doing various histogram analyses, texture analysis, and fast-Fourier transformations on the longitudinal images.

All of these parameters extracted from the longitudinal images need not be stored because they are used temporarily for other calculations and can always be regenerated by performing the transformations again. This is certainly in contrast to the image storage, which is permanent and deletion of a critical image means the loss of vital information which can never be retrieved in its original manner because the animal which it represented might no longer be alive or its features might have changed since then.

Performance-Related Information

The height and weight of the animal are included in performance-related information because the way the animal develops at an early stage is cause for prediction of the percent intramuscular fat.

Pedigree Information

This consists of information related to the sire and dam (father and mother) of the animal. In addition to the pedigree information, the sex, breed, age, and date of birth of the animal are stored. Animal identification (ID) need not be unique across different herds or farms, but in a particular farm or project, there must be a unique combination of the ID and the date of birth. This is one of the reasons why the LongID or a unique ID is required to identify an animal across different projects or farms.

Carcass-Related Information

After the animal is slaughtered, its carcass is scanned and images are collected again. Further tests also are performed on the carcass. This information comes from different sources, such as the Packaging Plant and the Meats (chemical) Laboratory of Iowa State University, and at different times ranging from two to six weeks.

The information that comes from the packaging plant consists of the actual backfat thickness, actual ribeye area, weight of the carcass, kidney, pelvic, and heart fat (KPH), and a marbling score. The eartag (animal ID) along with carcass ID also are provided to prevent loss of relevant information. The chemical laboratory of Iowa State University provides a set of data per animal consisting of the actual percent intramuscular fat and Instron data. An Instron machine collects data relating to the hardness or tenderness of the meat by mechanical means.

Processed Information

This is the end result of all the analyses on the different types of data and is generated by the application of the various algorithms. The different kinds of data this category contains are predicted percent fat, predicted percent fat after adjustment, etc.

Work on the Beef Quality Research projects can be commercial or for research for the use of graduate students and faculty. The projects which are commercial in nature do not have to go into extensive processing and thus do not deal with carcass-related information.

Objective of the System

Concepts associated with developing a multi-media database are summarized in this paper. Currently, retrieving the data might take an extremely long time. Sometimes the data are lost the animal IDs and the images are not matched.

In essence, a database management system must be created which efficiently incorporates and manages data and which allows for proper query formation to retrieve data of use. Once such a system is developed, data will be integrated to form a unified system, and any deficiency of data will be immediately noticeable, thus avoiding the loss of data.

The following factors were considered while developing the system:

- Ability to form queries.
- Allow for modification of the stored data, such as addition and deletion.
- Ability to add more parameters to the tables.
- Generate unique identifiers for the animals.
- Generate unique filenames for the images and record their storage location.
- Allow retrieval of data in any format the user wants from a set of options.
- Backup of the data.

Ability to Form Queries

The user should be allowed to choose the Table or View (one or more tables which may have common fields) from which he or she wants the data. In addition to that, the user might want only certain data fields from that particular table or view. Again, the user might want just the data relating to a particular condition so there should be a capability to filter the table.

Modification of Stored Data

After choosing the table, the user should be able to add or delete records to a table (provided the table is not write protected). There should be a provision to open a table in the browse mode or show it as a form wherein the user should be able to modify any field value. After the modifications are performed, the user should be given the option to save or cancel the changes made to a table. Some fields are such as the LongID, which should be write-critical protected and modification of such a value should be handled by a completely different procedure.

Addition of Extra Parameters as Fields to a Table

The Beef Quality Research project incorporates a number of different parameters for trait measurement. Because it is ongoing research, a time may come when an existing parameter might be rendered less useful and might no longer need to be stored, while a totally new parameter may become more important. Thus, a change in the structure of the table might be desired. To incorporate this change, it is necessary to have an option allowing for the addition of extra fields to a table and the deletion of unwanted fields from it.

Generation of Unique Identifiers

As mentioned before, short IDs are given to an animal. These short IDs contain three digits. But these short ID's can be repeated for different animals over the different projects or farms, or on the same farm or project after a few years. Because an effort is being made to integrate all the data over the years for the different farms into one database, there must be a way to uniquely identify an animal in the database system. The current thought is that the long ID should be made up of the farm or project name, the birth date and the short ID appended to it. All three entities are to be separated by an underscore. Generation of unique identifiers should be automatic to avoid mistakes in manual keying.

Generation of Unique Filenames

The ultrasound images representing the animals currently are stored on optical disks under DOS as the work is being done on a personal computer. As DOS

allows no more than eight characters as the name of a file followed by an extension of three characters, the total number of files available becomes restricted, so care must be taken in naming the files. As an animal might have several images taken at different times, it is very important to come up with a convention to name the image files to avoid a mix-up. Also, it is important to keep track of the optical disk where an image might be found so there must be a naming convention for optical disks too. The convention to be used will have the first letter of the name of the farm as the first letter of the filename followed by the animal ID, followed by the three-character extension which is made up of a code for the year of scan and the batch number.

Flexibility of Mode of Retrieval

Once the data desired to be retrieved are chosen from a menu or a set of options, it is important to choose the form in which the output is desired. This could be a text file, a print-file (postscript), another temporary table, or a report to be printed directly.

Backup of Data

Last but not the least data must be backed up regularly and systematically checking the validity of the images, authenticity of storage location, storing the data as text files, and then transferring them to a different location.

Features of the System

The system is implemented using the database software Microsoft Access® over Microsoft Windows 3.11. There are different menus for the various tasks to be performed. The menu capability is made available by the Object *Forms*. Various other tasks are performed. These are executed with the help of the language Access Basic® provided with the database software and similar to Visual Basic®. The main menu consists of four major options:

- Retrieve the data.
- Append or edit data into the system.
- Delete existing data from the system.
- Modify the structure of the table.

Retrieval of Data

In the menu for retrieval of data the user is asked to choose the project which he or she would like to work with from a listed set. The user then may choose all or only some of the fields from the project table, and whether he or she would like to filter the records based on a condition using SQL in MS Access.

If the user does not select all the fields, then the appropriate fields will be displayed as radio buttons or option buttons, and the user may select one or more of them. Similarly, for filtering, an option will be provided, the appropriate SQL instruction will be constructed, and execution will result in the fetching of a temporary table containing the information the user requested.

After that, the user has an option to export the file either as a text file or in the other formats supported by MS Access. The user also can print the file either in the same format or as a report, or save it as a print file.

Append or Edit Data into the System

Here also, the user is asked to choose the project that he or she would like to work with or after this, depending on the project different types of tables are displayed in a menu and the user again has the option of choosing one and being granted access to modify the data. Appending of data is done in a similar fashion. Generation of long IDs and the assigning of unique filenames are done here.

Delete Existing Data from the System

This is a very tricky operation, as data once deleted are very hard to retrieve. This function also involves the similar process of choosing the project and then the table with which the user will work. The user also can form queries here to delete selected records from a table satisfying a particular condition.

Modify the structure of the table

If a new data field is to be used extensively in processing, there is a mechanism to attach that data field to an existing table. Similarly, if an existing data field loses importance and is of no value to the ultrasound group, then the field can be removed from the table. Care must be taken before making such a decision, as once a field is deleted, there is no way of retrieving the data unless a backup has been made. Care should be taken that critical fields like Long ID are not deleted.

Finally, backup of the data should be done at regular intervals. This involves the copying of the tables and storing them at another location.