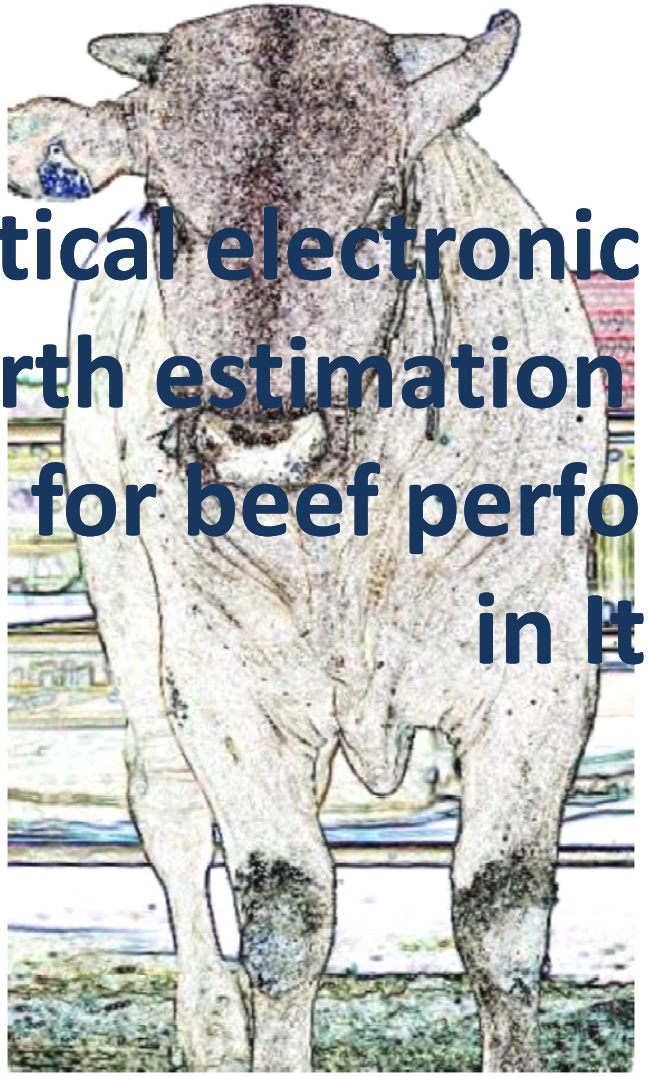

Optical electronic system for chest girth estimation in cattle: a new tool for beef performance recording in Italy

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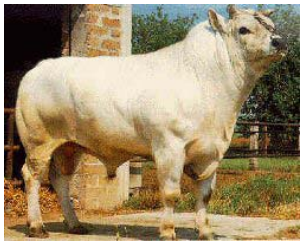
- Reliable performance recording on beef cattle is required for selection and extension services
- Accurate recording of animal performances is the basis for
  - estimation of the genetic merit of animals for economic and/or relevant productive traits like growth, fertility etc.
  - Farmer's evaluation of his management (producing animals with the best possible conformation, as efficiently as possible)

- Body live weight is a key recorded trait in beef production
- It is normally determined using a scale
- Especially in extensive beef cattle management systems, live weight is difficult to be recorded directly, either because scales are available only in some farms or mobile scales are difficult to transport and install.
- To overcome these difficulties an alternative way of estimating body weight has been investigated in Italy, focusing on the high correlation between circumference of chest and body weight (usually greater than 0.90).

- Chest circumference of animals, taken by a measuring tape, may be indeed used as a proxy trait for growth traits in beef performance recording
- particularly, live weight can be estimated from chest circumference using a transformation formula that includes both the age of the animal, and its chest circumference.
- Transformation formulas are specific for animal's breed and sex.

- To be correctly measured by tape, however, animals need to be immobilized
- This step is time consuming and often a source of stress on both animal (and operator..), especially in extensive system, where animals are minimally handled and thus not used to be close to human operators.
- Immobilizing animals is not sufficient to create a safety environment and guarantee full operator's security during the chest measurement by tape.





- Italy has several native beef breeds as Chianina, Marchigiana, Romagnola, Maremmana and Podolica, Piemontese, most of them worldwide recognized for the quality of their production.
- They are strong, rough and long-living breeds, adapted to different climates and bred easily in a confined rearing system as well as in an open herding or a semi-open herding system.
- It is indeed of major interest for Italian Breeders Association and Italian Beef Cattle Herdbook to record live weight, mandatory to achieve the selection goals in a simpler, faster and more economic way as possible
- Live weight estimation by chest girth recording: a solution for peculiar situations for beef cattle

In Italian beef performance recording activity, chest circumference is largely use for several reasons:

- Recording cost (time)
- Instrument cost (comprising cost for calibration)
- Easy use

Since 2005, A.I.A. financed a team of experts (engineers, farmers, animal scientists, veterinarians) working to estimation of chest circumference by opto-electronic devices.

- Mauro Fioretti (A.I.A.), member of Beef Working Group, during the meeting held in Kuopio (Finland) in June 6th, 2006, reported the research progress for an automatic system
- Technically:
  - Video recording of the animal
  - raw volumetric picture of an animal
  - weight estimated by a proprietary algorithm.
- Problems:
  - final device cost
  - difficulties for the final user to get correctly the frames
  - lack of automatic measures taking

- In the last two years, boosted by technological development, a new research line come up towards the production of a simpler and user-friendly device.
- The new device is based on a standard digital camera, connected to a netbook and equipped with two laser pointers.
- Exploiting an high performing proprietary algorithm, it is now sufficient to take a series of 3-5 raw images of an animals on which the two points generated by laser could be identified to estimate **a highly reliable chest girth.**
- **Automatic performance from image processing to chest circumference estimation, no operator work is required**

Technical highlights

The proposed solution implements a new method for interpreting information collected from the cameras, through the projection of a laser pattern, for the estimation of chest circumference.

The system integrates

- a ***GPS*** for geographical location
- a ***laser generator***
- a ***digital camera***
- an ***operator interface*** and
- a ***computerized control unit*** (connected to all devices)

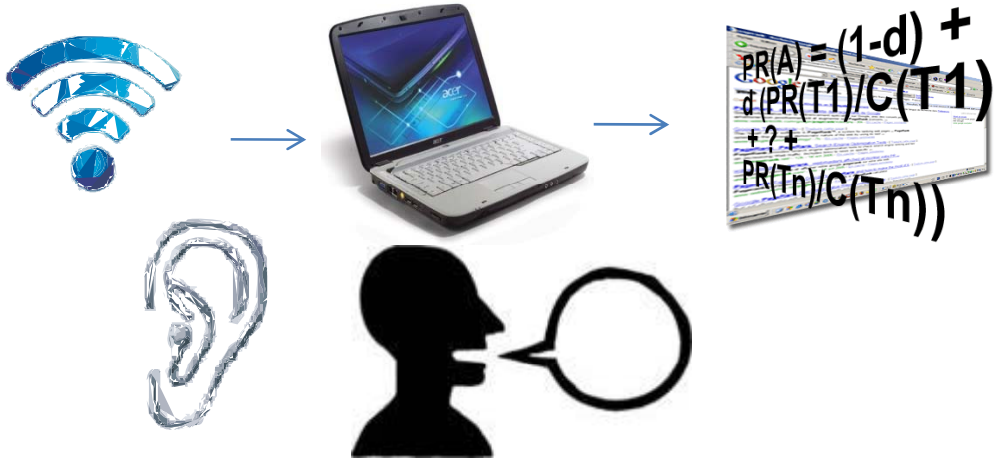
Main needs

- **Measures on “free” (not tied) animals**
  - Maximizing operator’s safeness
  - Minimize animal’s stress
- **Get a measure in real time, minimizing recording times**
- **Measure repeatability**
- **Ergonomic device**
  - Shock resistant
  - Waterproof
  - User friendly

Proposed solution

- **Use of a digital camera**
  - No contact with animals
  - Distance is not a problem

- **Portable elaboration system**
  - Wire or Wireless data transmission
  - Advanced image processing algorithms



- **Vocal interface + remote control**
  - User friendly system
  - Very intelligible vocal synthesis

- **Reliability**
  - Watermarked images with
    - Hour
    - Date
    - GPS location

Components

PATENTED

- Digital camera
  - To take images of the animal
- Earphone
- Laser beam projector
  - Two parallel laser beams
  - Aligned with camera optics
  - Safe for animals
  - Constant distance between them regardless distance
- GPS Device
- Netbook & dedicated software

How it works

•An animal in paddock/pasture/box is chosen to be measured

•Animal identification:

- ✓Animals ID are preloaded in the netbook
- ✓The system speaks in the earphone pronounciating each preloaded ID
- ✓When the right ID is pronounced, the operators push a button and the system gets ready for image taking and processing of the specified animal
- ✓ Available operator's voice recording notes

•Recording place (GPS) , date and time recording: are authomatically saved on each image

SYSTEM READY

How it works

Laser beams are projected on animal's surface; two laser points are visible on animal's body

Laser points are detected by digital camera's system

Digital camera focuses on the animal part in which laser points are

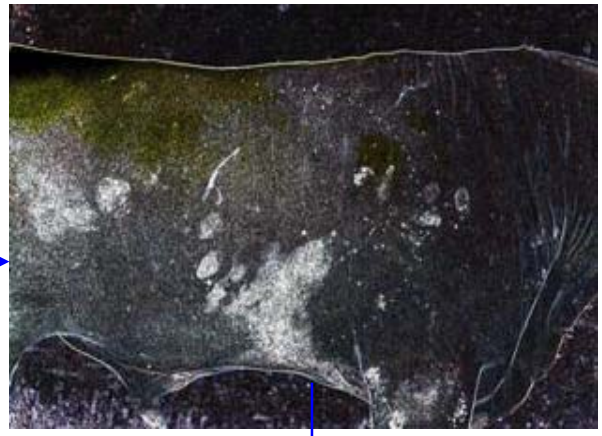
A synthetic voice from the system ask to the operator (earphone) to take a picture

Picture is taken

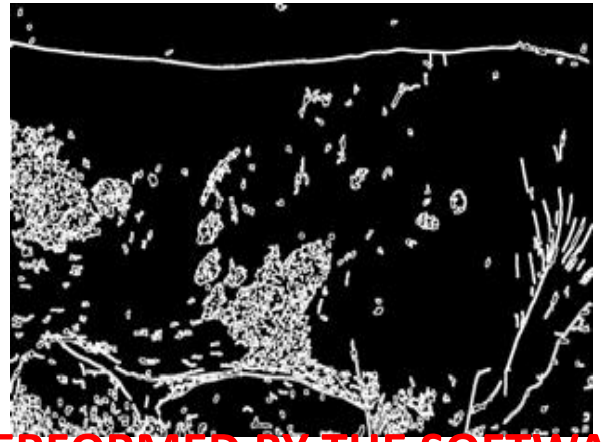
Picture is tranferred to **computer's** software

Image processing

Edge enhancement



Color elimination



Dedicated software

Measure estimation

ALL THESE OPERATIONS ARE AUTOMATICALLY PERFORMED BY THE SOFTWARE
=> NO HUMAN ERROR, HIGH REPEATABILITY OF MEASURE

What operator does

- Take several front and side images

The system

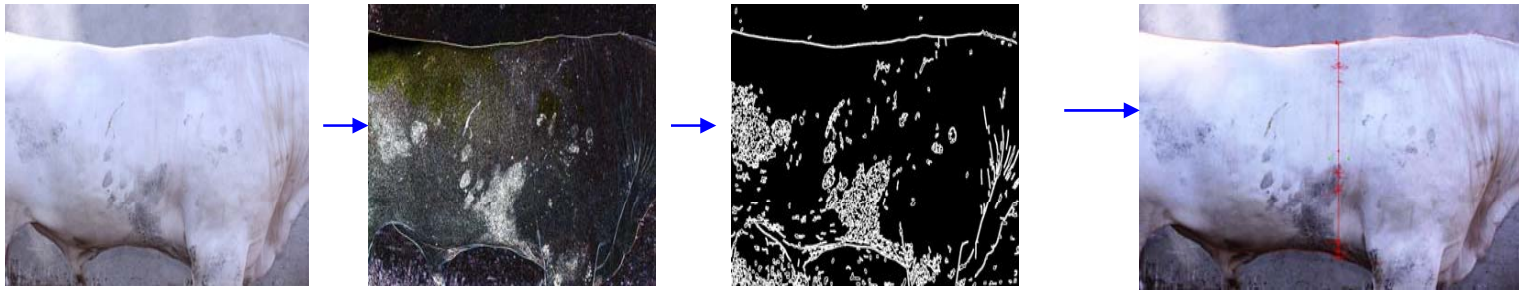
- informs the operator (synthetic voice by earphone) when no more images are required in real time
- Saves images and measures and **gets ready for a new animal's recording**

then …….

- Operator identifies another animal to start again

What the **system** does

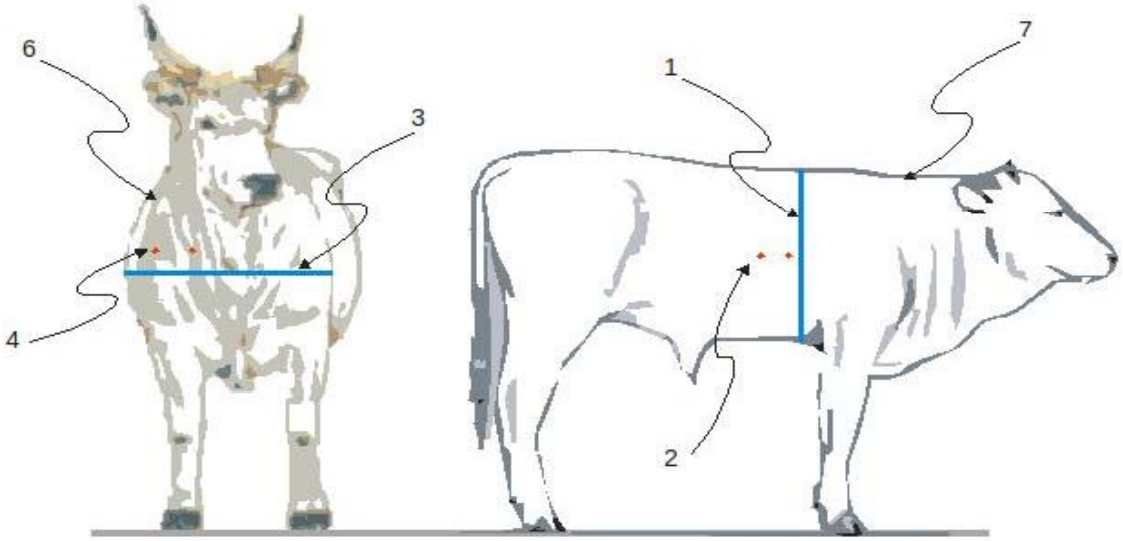
Processing **side** ……



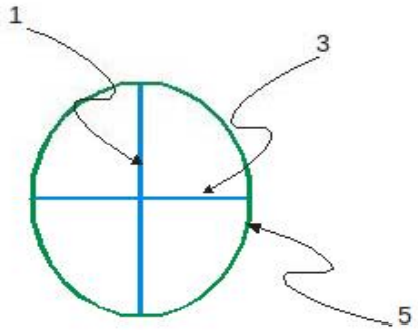
and **front** images

What the **system** does

Reconstruction of chest circumference



Front (3) and side (1) measures are the axis of an ellipse



The ellipse circumference is the estimation of chest circumference

What the **system** does

- Every time a new picture is taken, the software automatically estimates a new measure for the side/front axis and a new chest girth is estimated.
- The variation coefficient of the n^{th} respect to $(n-1)^{th}$ measure is calculated
- When a convergence criterion is met, then there is no need of new digital images => system **tells** to the operator (earphone) to stop taking pictures

What the **system** does

- Pictures are stored in the computer and **watermaked** with **GPS location**, **animal ID**, **date** and **time**
- Estimated measures are stored too
- All data are then sent to national central database (A.I.A., Rome)

Results

- Basing on fields experience in different environmental conditions, the difference between tape and image chest girth is **almost null**

Use of measured chest circumference

- Estimated chest circumference (expressed in cm) are transformed in live weight (kg) basing on algorithms working by
  - ***Breed***
  - ***Sex***
  - ***Test animal age***

  following ICAR's guidelines

Advantages

- **Handy and ergonomic device**
- **Accessible price**
- **Few and simple rules to be followed**
- **Maximum operator safety**
- **Fast recording with repeatability of measures**
- **Uneditable and georeferenced images**
- **Creation of a multimedia database available for further researchs and developments (biometric measures, etc)**

Patented by A.I.A.

For (next) future

- Software down-sizing
  - Linux
  - Android (smartphone : digital camera, image processing, data transmission)

INTERBEEF WG meeting, June 20 - 21, 2011
- Bourg-en-Bresse