Fuzzy-Meater – Image Processing System for Quality Grading of Beef

Quality Grading in the Meat Industry
The products in the meat industry are valuated by quantity (weight, yield) as well as by quality grades. Typically a certain product has several quality grades, which are taken into consideration for the product price. The products and the quality grades specified for each product are not the same in different countries. The evaluation criteria may also differ depending on the country. In many cases the quality evaluation proceeds by visual criteria. This gives a strong motivation for introducing an automatic image analysis for quality grading. This tendency is encouraged by the demand for the traceability of product history. Thus an increasing number of companies is introducing image processing systems for both: evaluating the meat and supporting the quality and product management.

The automatic assessment of biological materials is a challenging task because of the biological variations of the material. Certain measurements are needed for evaluating the biological material, but the definition of measurements is rather complex compared to situation in other techniques. Thus the quality analysis of biological materials requires a lot of research. Some years of research were realized in the department of "Fuzzy Applications" of GFaI e. V., a research institute involved with Applied Computer Sciences. The basic intention of Fuzzy Technology is well suited to the problem of quality grading: The decision rules of the experts are transferred to a computer program. Based on the earlier research, a cooperative project was started by CSB-System AG and GFaI e.V. as research institute. The project aimed in a first step at quality grading of high-quality beef products in China. The Chinese group Yu Xian Yuan Husbandry Ltd. was the pilot user, which presented the special meat sorts and evaluation criteria needed on the Chinese market. The new system was called Fuzzy-Meater with reference to the Image-Meater, another image analysis system of CSB for evaluating pork meat.

Fuzzy-Meater starts with Chinese Beef Classification
At the first stage, the project started from the Chinese conditions of grading high-quality beef. There are six cattle meat sorts the cutting area of which is investigated for determining a quality grade. Each meat sort defines other quality grades, and the criteria used for grading are not always the same. Up to now the classification, i.e. the determination of the quality grade,
work of the human expert is restricted to a more rough procedure. Typically he assigns the marbling to several marbling grades, which are defined in some countries by means of reference images.

**Color:** The color of fat and muscle is regarded as a next important criterion in China and in other countries. If the fat does not have a pure white color, it is regarded as inferior. The muscle color should not be too dark, and it should not be too pale. For evaluating the color of beef, some countries have specified tables with reference colors (e.g. USA, Japan, China). Fuzzy-Meater follows this approach by using a color table, which is placed near the meat, thus allowing to assign the meat colors to the different color fields of the color table. The placement of the color table near to the meat reduces the dependency on the light, which is inherent to any kind of color analysis.

**Thickness of muscle:** The evaluation of some meat sorts depends on measuring the thickness of a certain muscle. This is carried out, for example, in the case of "Dai Gu Fu Rou." The human expert in China did not measure this thicknesses exactly, but he estimated the thickness class (e.g. the thickness is between 2.5 and 3.5 cm).

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The application of these criteria is changing in dependence on the meat sort. For instance, the thickness of a certain muscle is a dominant criterion for "Dai Gu Fu Rou," and the same criterion does not apply to other meat sorts.

**Marbling:** The marbling of muscle is the most important quality criterion in China. In most cases, the higher the degree of marbling the better the meat. A very lean muscle is evaluated as inferior (which might be contradicted by a German consumer). The evaluation of marbling has two main aspects: first, the share of marbling fat in the muscle tissue. A second aspect is the fineness or granularity of the marbling, which may be measured by different criteria.

The modern meat research is interested in developing more comprehensive criteria for evaluating the marbling. The measurements for them may be delivered by an image analysis algorithm that can calculate detailed measurements on the basis of the high-resolution image. The

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**The Development of the Fuzzy-Meater**

Fuzzy-Meater is a cooperation of

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