01- FOOD

DIGIEYE- CASE STUDY

DIGIEYE IS MANUFACTURED
IN THE UK BY VERIVIDE LTD

The Organisation

CCFRA Group (Campden and Chorleywood Food Research Association) is the UK's largest independent membership-based organisation carrying out research and development for the food and drinks industry worldwide.

It is committed to providing industry with the research, technical and advisory services needed to ensure product safety and quality, process efficiency and product and process innovation.

Through a continuous programme of investment CCFRA ensures leading edge processing and analytical facilities for research and contract work.

In October 2003 the Group initially purchased the **DigiEye System** to use in an industry funded project to establish objective ways of measuring the appearance of food including its colour and now has **DigiEye Systems** in their laboratories in the UK and Hungary used for research and contract work for applications which include studies of the effects of food processing variations.

It is also being used to produce reliable, meaningful images for companies on their extensive client base.

Campden & Chorleywood Food
Research Association Group

01 - CCFRA - Colour Measurement in the Food Sector

CURRENT METHOD OF COLOUR MEASUREMENT OF FOOD

People buy food with, amongst other senses, their eyes. Therefore the colour and aesthetic appearance of food products is a critical element for the consumers and therefore an important quality attribute of the product.

However traditional instrumental measurement of food products is restrictive; obtained using a colorimeter or spectrophotometer, measuring only a limited area of the product with subsequent data being an average colour of the selected area.

Photographic images are also currently used by the food industry for the appearance of product to provide specification standards for quality control comparisons but the reproduction of the images is inconsistent and the variables of image, printing and viewing consistency prevent such images being relied upon for true reliable control of the quality of food product.

THE APPLICATIONS

The DigiEye system includes a calibrated digital camera; printer and monitor and also critically a lighting environment for image capture which ensures consistent colour and lighting. The immediate advantage over traditional methods is the ability to capture an accurate colour, which will match the actual appearance of the product.

As the DigiEye system has applications and capabilities well beyond those achievable with traditional measurement techniques CCFRA uses the system in two distinct areas and end-uses;

➢ To provide good consistent calibrated images and

➢ As a reliable colour measurement tool

CCFRA are able to measure spatial variations of colour within a product or from product to product across very diverse, and arguably limitless, types of food product.

The example below illustrate how colour distribution can be measured through a melon from centre to edge to assess and quantify the colour variation
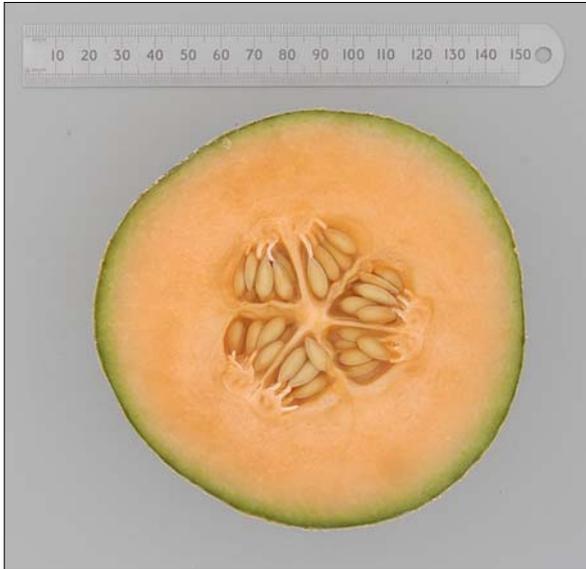
Likewise the colour variation of the differing shades of tomatoes in a selected punnet can be reliably quantified for assessment.

One of the significant advantages of the DigiEye system is, due to the consistency of the images taken, direct comparisons can be made between images taken of product in different locations worldwide and at different times.

This benefit, together with the ability to subsequently send images electronically, with the associated colour measurement data, ensures reliable visual comparisons.

The greater versatility offered by DigiEye over the measurement obtainable from a standard colorimeter makes the system an invaluable application for companies in the food sector to…..

achieve the desired objective - ensuring the consumer is able to buy consistent and reliable product.

This versatility allows specific regions of a diverse selection of food and food components to be imaged and reliable, quantifiable colour measurements to be available for analysis.

The image below of leeks illustrates the use of DigiEye to measure the colour variation along the length of the leeks; this information was used to create a plot of distribution of colour against distance from the root end. This can be used to determine the average length of the white part of the leek.

THE TECHNICAL BIT

The DigiEye system gives accurate and reproducible colour reproduction.

➤ The devices - camera and monitor are calibrated against the CIEXYZ system to establish the relationship between RGB colour values and CIEXYZ values.

➤ The images can then be converted to CIELAB colour space, enabling consistent and traceable results to be obtained for the images. Images taken using different DigiEye systems or at different times can then be compared.

➤ The product samples are captured in standardised conditions; this is achieved by placing the samples in a cabinet with a neutral grey interior which is illuminated by a light produced by VeriVide, the world leaders in the design, development and manufacture of highly specialist viewing assessment equipment for all industries.

THE TECHNICAL BIT   (from previous page).

➢ The light used in this DigiEye system closely matches the CIE D65 lighting; the standard generally used for colour measurement.

➢ DigiEye can be used with different illumination geometries.

➢ The Diffuse illumination setting is suitable for many applications, including the imaging of samples with a glossy surface, as it then avoids bright specular reflections in the image.

➢ Alternatively, directional illumination can be set at any of several fixed angles to enable the surface texture of the subject to be revealed more clearly.

APPLICATION 1. COLOUR MEASUREMENT OF A SPECIFIC AREA OF A PRODUCT

The DigiEye system provides objective, consistent and reliable measurements of a wide array of the characteristics of a seemingly unlimited range of food types, products and food constituents.

At CCFRA it has been used to measure, for example, the shape, size and structure of food including the thickness of bread crust and the distribution of cherries within fruitcake.

The use of the DigiEye system enhances the existing image analysis systems and measurement tools already used at CCFRA adding the capability to measure colour from images - thereby increasing tremendously the scope and versatility of services offered.

In addition to the average measurement of colour of a product achievable with existing facilities, the distribution of the differing colours within food products can also be measured and recorded for further analysis.

Examples of this type of application include measurement of bread assessing the visual colour effects of differing baking times upon the crust in terms of, for example depth, saturation and distribution of the colour over the surface.

The aim being to offer the facility to produce definitive colour reference scales for various foods for use by CCFRA members.

DigiEye offers measurement of colour and aesthetic appearance that is quantifiable, has traceability and objective consistent data.

The image of baked beans below shows examples of three different brands, the production methods result in differences in sauce colour.
DigiEye was able to image the samples, measure the sauce colour and the beans independently and in-situ and analyse the colour variation between the brands.
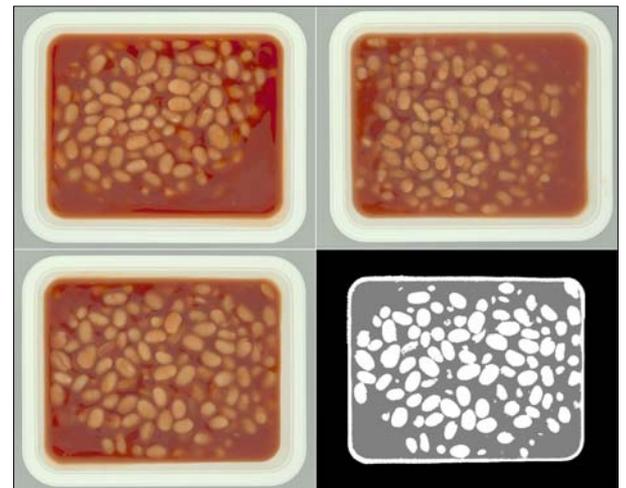
This would have been difficult to assess with a standard colorimeter due to the combination of beans and sauce and the glossy appearance of the product.

The DigiEye System, by enabling quantifiable and objective Quality Control is a tool which can assist in delivering the visual expectations of customers.

APPLICATION 2. VISUAL QC

As a result of the accurate and reproducible colour reproduction achieved by DigiEye, images taken by CCFRA can be used for visual assessment and comparison against an established standard, either via the calibrated monitor or by colour accurate printing.

CONSISTENT LIGHT SOURCE

The factors affecting the visual appearance of a product are not only a result of the reflectance of the sample but also the light source under which it is viewed or intended to be viewed.

CONSISTENT LIGHT SOURCE (from previous page).

It is therefore essential, before the start of any colour measurement work, to establish the illuminant in which the product is to be viewed.

The DigiEye has a fixed light source of D65 – artificial daylight (this is also a common light source within the food sector) but is able, through the software, to stimulate and give results in other standard light sources.

The colour measurement and images produced at CCFRA are intended for viewing under D65 illuminant.

The consistency of the viewing lighting is critical due to potential issues with metamerism, this is the experience whereby objects appear to have different colour when viewed in different lightings. (Examples of metamerism often include clothing and furnishings which, once back at home, *"look nothing like the colour they did in the shops".*)

For reliable viewing during product assessment it is therefore important to standardise the light source to ensure compatibility between the visual standard and the product viewed from a production line on the factory floor.

VeriVide produce a range of viewing cabinets, with a range of differing illuminants ideal for this end-use that are essential for visual assessment of the colour and appearance characteristics of food samples.

The image of bread rolls above illustrates diverse variations in the crust colour of a selection of bread rolls. These rolls can be images with DigiEye individually or as a group to produce appearance standards for crust colour.

These standards can be issued to manufacturing units as photographic standards, eliminating the inconsistencies in colour reproduction that commonly exist in the wide use of photographic product images for use of the quality control of food products.

The use of DigiEye, in conjunction with the appropriate VeriVide viewing cabinet, for the first time offers a reliable and accurate method for visual QC of food product.

APPLICATION 3. COLOUR CLUSTERING

The Colour Clustering technique within the DigiEye system automatically groups pixels of the same colour together and then calculates the percentage of the total pixels within the image.

By measuring the proportion of different colours within an image, this feature has uses within a range of industries, including the food sector.

This function can be used to calculate the proportions of different coloured components in a food and is able to calculate the percentage amount as a whole or in relation to the distribution of the various constituents of a food sample that are present and visible within that food sample.

The colour clustering function can enable differently coloured regions to be identified automatically.

CCFRA have developed additional software to analyse images produced by the DigiEye system for particular applications in their laboratories.

They have used a similar clustering approach to identify differently coloured regions of images, enabling further measurement then to be made for each of the regions of the cake.

The screenshot on the next page of the two slices of cherry cake shows, by the use of their own additional software, the following data was extracted by CCFRA, after the cake was separated from the background.
  - The colour of the crumbs
  - The distribution, colour, size and number of cherries.
  - Crust thickness.

COLOUR CLUSTERING - CHERRY CAKE (continued).

The following data was extracted by CCFRA, after the cake was separated from the background.
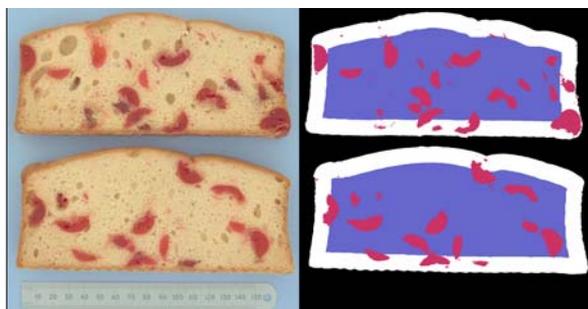
The Colour of the Crumbs

The cherries (in red) and crust (shown in white) was excluded. To measure the crumb colour using traditional methods have required a measurement of a section of cake which was *'cherry-less'*, making it more difficult to achieve colour measurement data that was representative of the cake slice as a whole.

DigiEye can separate and measure differing coloured elements of product such as the crumb colour of a cake. With the use of their own additional software, CCFRA were able to further analyse samples to provide additional data for both the cherries and the crust

The Distribution, Colour, Size and Number of Cherries.

This enables measurement of the effects upon the height distribution of the cherries in relation to of the viscosity of the cake measure against various cooking procedures and times.

Crust Thickness. Each pixel, from the edge inwards, was measured to establish the exact measurement of the crust.

DigiEye offers the ability to measure, record statistics and assess food products to a level and degree of accuracy not previously available and opens up a new range of solutions for quality measurement problems.

As the system can image whole product, from which different sectors can then be measured this allows for multiple measurements without the need for a new image.

www.digieye.co.uk

CASE STUDY -SUMMARY

DigiEye has proved to be a very versatile system for research applications, allowing images to be taken and data interpreted using the software within the system or by other software to make particular measurements or analysis.

It has allowed CCFRA to document the appearance of samples received from clients for some contracts. This has included documentation of products sent for categorisation by HM Revenue and Customs. These provide useful records for future reference. High quality prints of the images taken with the DigiEye have also been taken to meetings with other customs authorities to assist in ensuring a consistent approach to classification decisions within the EU.

There are many benefits to food companies and it is inevitable that the use of this system will increase as the food industry becomes increasingly aware of the capabilities of the system through organisations such as CCFRA. DigiEye are collaborating with CCFRA to identify further opportunities for the system in the food industry, and to develop the capabilities of the system to address any new requirements identified.

It has enabled a system for documenting product trials at CCFRA to be developed and has been used in work for the sea fish industry to assess a new High Pressure Processing method used to help remove shellfish from the shell efficiently while retaining the fish in a raw state.

It will certainly be used for more areas of research as its availability becomes more widely known within CCFRA, being applied to more and more 'funded from industry' projects.

CASE STUDY ENDS

DIGIEYE IN THE FOOD SECTOR – GENERAL INFORMATION

VeriVide's DigiEye non-contact imaging system is an invaluable tool for the Food industry.

The non-contact imaging and colour measurement of DigiEye ensures that the product is captured in its natural state and irregular shaped products such as fruit and vegetables, bread, cakes and biscuits can be imaged and assessed; giving greater versatility to measure product beyond the scope of the traditional spectrophotometer or colorimeter

The unique controlled lighting cabinet enables objective & reliable measurement of colour in a range of food products. The system is used within the Food Sector to help deliver product which conforms with the visual expectation of the Customers

Applications for the DigiEye System developed for food products include:

➢ Measurement of fruit and vegetable ripeness
➢ Measurement of bread crust colour and thickness
➢ Measurement of proportions in mixtures, such as salads and mixed vegetables
➢ Measurement of the coverage area and uniformity of coatings such as icing, enrobing or dusting
➢ Assessment of colour changes during storage trials
➢ Assessment of process effects on colour

VeriVide
See in Truth

Images in the main body text of this case study have been taken with the DigiEye system. Other food images contained herein are for illustrative purposes only to show the diverse array of food types that could be colour measured using the DigiEye System.