

## SOFTWARE AS A SERVICE IN MEASUREMENT SCIENCE AND EDUCATION

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**Abstract** – The main purpose of the paper is to present the new convenient, reliable and affordable possibilities of the Internet to use software as a service for the solution of complex measurement problems in quality control. The focal point is directed on innovative vision sensor systems for fast, contactless and non-destructive measurements of dimensions and colours. For these systems new developed intuitive see & click programming instructions will be introduced and explained. During the oral presentation of the paper a hands-on application of vision sensors for quality inspections with software as a service (SaaS) will be demonstrated.

**Keywords:** software as a service (SaaS), vision sensors  
quality control

### 1. INTRODUCTION

An actual problem in research and industry, food and health care, environmental protection, security and administration is the mobilization of objective quality measurements with digital image processing systems. Innovative smart vision sensor systems (SVSS) are new challenges especially for small and medium sized enterprises (SME). SVSS are characterized by compact designs, true color sensitivities, integrated cameras and controllable lightings [1]. SVSS must not be programmed in higher programming languages. The measurement functions are predefined. Programming (operating) is accomplished windows-like with intuitive icons and in native language on touch screens. This fundamental new operation principle of SVSS causes their over proportional growth rates on the global market. Nevertheless one problem must be mentioned. Conventional image processing systems for quality measurements are operated by specialists. They have a profound qualification and technical documentations as usual [2]. Innovative SVSS with their new operation principles and their fast distribution also in the hands of lower qualified users strongly demand a new kind of technical documentations and programming software. We developed the so called see & click operation instructions (SCOI). They are icon- and solution-driven. The user has only to follow red, yellow and green frames in the

innovative operation and programming instructions. Red, yellow and green frames are used in analogy to traffic lights: Red (see), Yellow (wait), Green (click).

The next step to support the global distribution of SVSS was the barrier-free access to these see & click instructions. We applied the new possibilities of SaaS (software as a service) [3] and CC (cloud computing) [4] within our specialized collaboration platform for digital color image processing and spectral imaging [5].

Software as a Service (SaaS) is a model of software deployment where an application is hosted as a service provided to customers across the Internet. By eliminating the need to install and run the application on the customer's own computer, SaaS alleviates the customer's burden of software maintenance, ongoing operation, and support [3].

Cloud computing (CC) refers to the use of scalable, real-time, Internet-based services and resources [6]. The common theme stresses reliance on the Internet for satisfying the computing needs of users, without them needing knowledge over the technology infrastructure that supports them [7][8].

The Collaboration Platform [www.spectronet.de](http://www.spectronet.de) [5] provides the intuitive programming instructions online which can be accessed from a web browser, while the software and data are stored on SITEFORUM servers [9].

More than 30 practical examples are given in the collaboration platform [www.spectronet.de](http://www.spectronet.de) from optical character recognition over data matrix code and pattern recognition till geometrical and spectral measurements. During the XIX IMEKO World Congress the practical operation of smart vision sensor systems SVSS with intuitive see & click programming supported by software as a service and cloud computing will be demonstrated.

### 2. SMART VISION SENSOR SYSTEMS

Smart vision sensors systems are a new kind of measuring instruments on the market. The OMRONs ZFX-C and Xpectia smart vision sensor systems are complex image processing systems for visual quality control that include everything from cameras with integrated light sources to image-processing units (Fig. 1) and (Fig. 2). With Omron's newly developed proprietary measurement algorithms, the parameters can be set through only a few steps involving the

operation of touch-panel color monitors, colored functional icons or full-text functional icons and see & click programming instructions. (Tab. 1).



Fig. 1. ZFX-C vision sensor system  
[http://www.ia.omron.com/product/family/1892/index\\_fea.html](http://www.ia.omron.com/product/family/1892/index_fea.html)



Fig. 2. Xpectia vision sensor system  
<http://www.visquanet.de/servlets/SITEFORUM?i=1122540720771&&e=UTF-8&l=1&t=/contentManager/selectCatalog&intro=1&active=no&ParentID=1222358585640>

Tab.1. List of see & click programming instructions for Xpectia (selected 6 from 24)  
<http://www.visquanet.de/servlets/SITEFORUM?i=1122540720771&&e=UTF-8&l=1&t=/contentManager/selectCatalog&intro=1&active=no&ParentID=1216223013452>

05		<b>M01. Zeichenerkennung / Character Inspection</b> <a href="#">m01_xpectia_print.pdf</a> <a href="#">m01_xpectia_web.pdf</a>
06		<b>M02. Winkelmessung / Circle Angle</b> <a href="#">m02_xpectia_print.pdf</a> <a href="#">m02_xpectia_web.pdf</a>
07		<b>M03. Musterklassifikation / Classification</b> <a href="#">m03_xpectia_print.pdf</a> <a href="#">m03_xpectia_web.pdf</a>
08		<b>M04. Farbflächenmessung / Gravity and Area</b> <a href="#">m04_xpectia_print.pdf</a> <a href="#">m04_xpectia_web.pdf</a>
09		<b>M05. Farbtonmessung / Color Data</b> <a href="#">m05_xpectia_print.pdf</a> <a href="#">m05_xpectia_web.pdf</a>
10		<b>M06. Farbbobjekterkennung / Labeling</b> <a href="#">m06_xpectia_print.pdf</a> <a href="#">m06_xpectia_web.pdf</a>

The new smart vision sensor systems and the new intuitive programming methods are milestones in the digitalization of measurements and therefore a breakthrough in measurement science as well as in measurement education and training.

### 3. OBJECTIVE COLOR MEASUREMENTS

Optical quality inspections are fast, contactless and non-destructive. Most visual quality inspections still provided by human eyes. Visual quality inspections by man have four significant disadvantages:

1. The human inspector decides subjectively
2. The human inspector must be specialized
3. The human inspector is expensive
4. What human inspect in subjective visual perception is not simply a translation of the image on the retina. Thus people interested in perception have long struggled to explain what visual processing does to create what we actually see. This problem is unsolved till today.

Therefore an increasing interest is observable to use objective vision sensor systems and image processing software for visual quality measurements.

Special interest is centered on visual quality assurance with color image processing and spectral imaging. The simple reason is the huge information content of color scales in comparison to gray scales (Fig. 4).

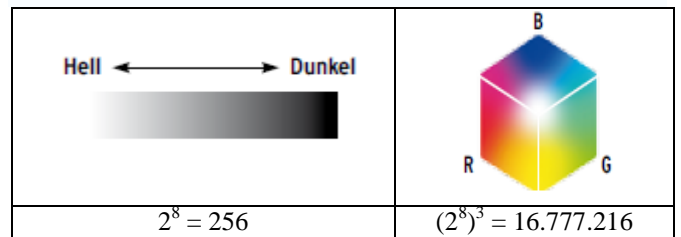


Fig. 4. Information content of different scales

Another reason is the availability of affordable color cameras under the influence of an exploding color camera market for consumer goods. But design and programming of industrial cameras are different to consumer goods. Therefore the see & click programming instructions has been also elaborated for color measurements.

### 4. SEE & CLICK PROGRAMMING

To understand the philosophy of the new programming method selected instruction steps for color measurements with the smart vision sensor system Xpectia are shown in Fig. 5 through Fig. 12.

The task is to measure the color of the red pencil. The results of the measurements are displayed on the graphical user interface in Fig. 12. The measurement results concerning the red pencil are:

Average R(ed): 255.0000  
 Average G(reen): 97.7804  
 Average B(lue): 51.1250.

For measurements of the green and the blue pencils the same procedures have to be run again.

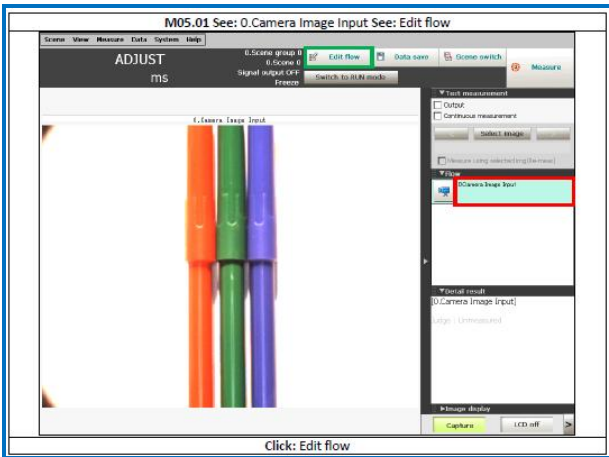


Fig. 5. **Step 1** of programming the color measurement for Xpectia (Red frame: see Camera Image Input & wait; green frame: see Edit flow & click Edit flow)

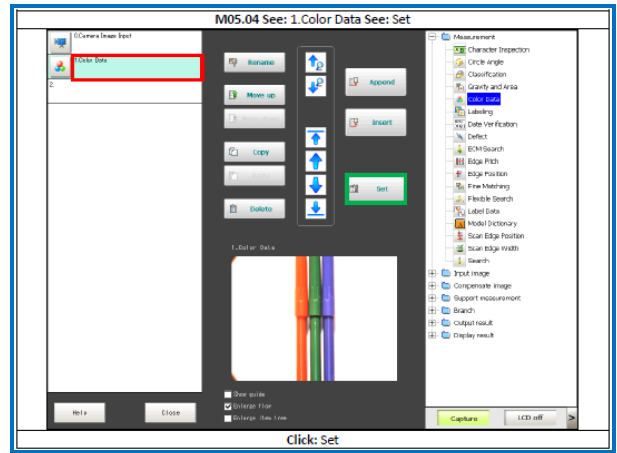


Fig. 8. **Step 4** of programming the color measurement for Xpectia (Red frame: see Color Data & wait; green frame: see Set & click Set)

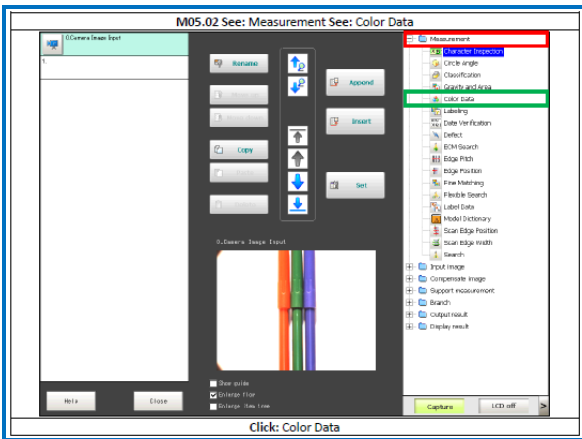


Fig. 6. **Step 2** of programming the color measurement for Xpectia (Red frame: see Measurement & wait; green frame: see Color data & click Color data)

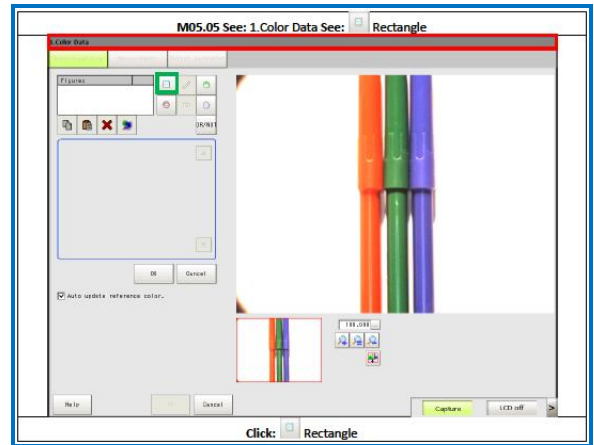


Fig. 9. **Step 5** of programming the color measurement for Xpectia (Red frame: see Color Data & wait; green frame: see Rectangle & click Rectangle)

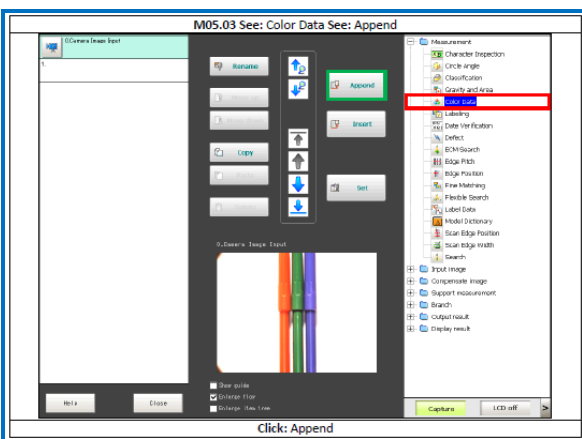


Fig. 7. **Step 3** of programming the color measurement for Xpectia (Red frame: see Color data & wait; green frame: see Append & click Append)

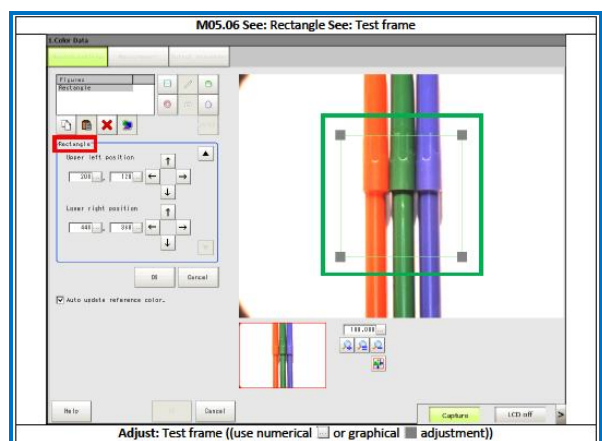


Fig. 10. **Step 6** of programming the color measurement for Xpectia (Red frame: see Rectangle & wait; green frame: see Test frame & click Test frame)

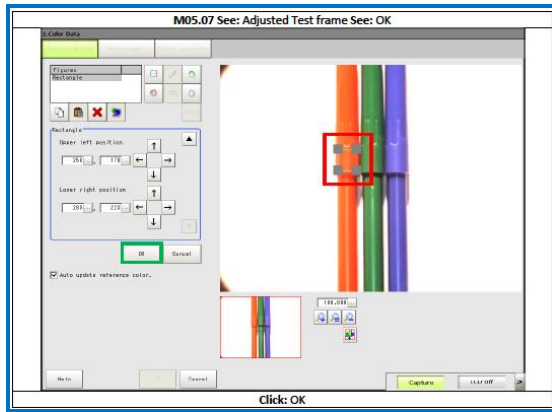


Fig. 11. **Step 7** of programming the color measurement for Xpectia (Red frame: see Adjusted Test frame & wait; green frame: see OK & click OK)

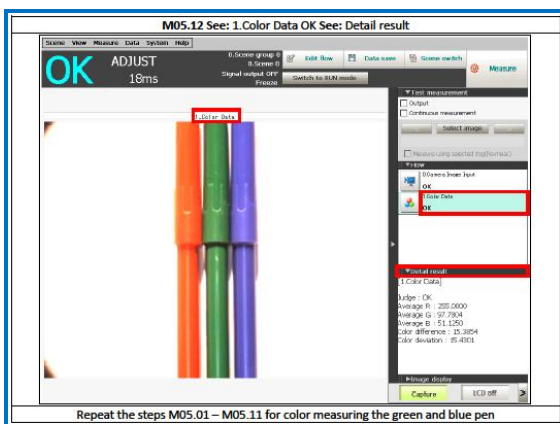


Fig. 12. **Step 12** of programming the color measurement for Xpectia (Red frame: see Color Data OK & wait, green frame: see Detail result & click nothing, it is the END)

## 5. SOFTWARE AS A SERVICE

Software as a Service (SaaS) – as mentioned above - is a model of software deployment where an application is hosted as a service provided to customers across the Internet. The see & click programming instructions are hosted in the spectronet platform (Fig 13).



Fig. 13. SpectroNet platform [www.spectronet.de](http://www.spectronet.de)

The see & click instructions can be downloaded via browser on the track:

[www.spectronet.de](http://www.spectronet.de) > Akademie > BV Anwendungen > Bedienungsanleitungen > OMRON Xpectia.

Details concerning color measurements are explained for example in a laboratory course of the Technical University Ilmenau:

[www.spectronet.de](http://www.spectronet.de) > Akademie > BV Unternehmen > TU Ilmenau

Uncertainty estimation models for optical dimensional measurements are given in:

[www.spectronet.de](http://www.spectronet.de) > Nachrichten > 53. IWK Ilmenau > 080909\_01\_weissensee\_tu\_ilmenau.pdf.

## 6. CONCLUSIONS

In the paper has been shown that innovative instrumentation and programming facilities are enriching and changing the fundamentals of measurement science and education. Smart vision sensor systems and see & click programming instructions making the visual quality control objective, convenient, reliable and affordable. Together with software as a service we are at the beginning of a new era for the application of external eyes in research and industry, food and healthcare, traffic and environmental protection, security and administration. Further investigations will focus on enhanced capabilities of the spectronet platform in audio and video and in the mobility of the hardware.

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