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GENERAL CONCEPTS IN THE LABELLING PROCESS

OGÓLNE POJĘCIA W PROCESIE ETYKIETOWANIA

Summary: *The present paper is the first part of a series of articles, introducing the comprehensive issue of an attempt to compare the work of detection sensor with the ZFV vision system in the process of labelling the packaging.*

Keywords: *label, labeling, packaging, detection sensor, the ZFV vision system*

Streszczenie: *Artykuł jest pierwszą częścią wprowadzającą w obszerne zagadnienie jakim jest próba porównania pracy czujnika detekcji z systemem wizyjnym ZFV w procesie etykietowania opakowań.*

Słowa kluczowe: *etykieta, etykietowanie, opakowania, czujnik detekcji, system wizyjny ZFV*

Introduction

More and more products have become recently delivered to the customers in protective or in bulk packaging. The customer expects information about the product's country of origin, its composition, way of functioning etc. All mentioned information is placed on the packaging in a form of label. Due to the automation of the way of filling of packing the products, the increase in the performance of manufacturing lines has been observed; it resulted in the necessity of increasing the rate of placing the labels.

At present, the manual labelling of the packaging is employed only in the case of the products with complicated shapes, or in the small-series production, up to 10 000 pcs. The mentioned value is caused by psychomotor limitations of human body construction. They are individual features of every employee; therefore, the discussed value varies between 15 and 30 labels per minute what gives about 6 000÷10 000 labels during one 8-hour shift. Above the mentioned quantity, it is more profitable to use machine; in consequence, we obtain a stable performance and precision of labelling. Marking of the packaging is a necessity, both from the point of legal rules and the marketing aspects.

For majority of the products, the way of placing the labels is strictly specified in the national or international standards, e.g. in food and cosmetic industries. The example may be the Council Directive 76/211/EEC of 20 January 1976 [1].

Aesthetic and attractive packaging is nowadays indispensable for the customers. Labelling is, therefore, the important part of the total manufacturing line. The choice of the components of the production line is dependent on the expected performance, shape as well as volume of the packaging and the type of the dosed medium.

Automation of the process allows obtaining a high effectiveness and repeatability of precision of label placing. It is reflected in a small number of defectively marked packaging, increasing thus the positive economic balance of production. Consequently, when designing a manufacturing line, a big attention is paid to precision, repeatability and universality. Designing of machines or manufacturing lines requires individual approach to each device as well as to the successive stage of production. There are available different types of labels in the market and, also, different systems of their positioning on the labelling machine.

The purpose of the present work was to develop the stand, enabling positioning of the packaging with the use of the sensor, and to compare its functioning and that of the earlier employed vision system. The implementation of the mentioned above aim could help obtaining the answer to the question: which system of positioning is most suitable for a given type of label.

To understand better the essence of the present work, the attention of this part has been focused on definition of certain general concepts, relevant to the submitted elaboration. They include as follows:

- measurement error,
- technical device,
- marking of the product,
- labelling,
- the methods of label positioning,

- environment conditions during the implementation of measurements.

To have the possibility of comparing some phenomena each other, it is necessary to ensure the uniform conditions of environment during obtaining the results. According to contemporary physics, the process of measuring device's effect on the examined object, occurring at time and space, as a result of which the information about the object's properties is obtained, is called the measurement. There are some types of measurements employed, including, *inter alia*:

- continuous,
- discrete.

The continuous process is the process which supplies the results in the continuous way; they may be available on the current basis, e.g. speedometer in mechanical vehicle, or with a certain delay, e.g. room thermometer reacting with the delay to the change of temperature.

Another type of measurement is the *discrete* measurement (from Latin – *discretus* – separate). It is a sort of measurement which supplies the results in a given site. Such measurements may be conducted cyclically or irregularly. The example of such type of the measurement includes measurement of body temperature with the use of medical thermometer or control of oil level in a car, using dipstick.

To perform the measurement, we need the appropriately calibrated measuring stand, containing a device and enabling the repeatability of measuring operation. Each measurement has a measurement error which is a deviation from the unit result of the measurement as compared to real value; the mentioned value is generally known. We do not, however, treat it as an error but as inherent factor of measuring process. We can distinguish the following errors:

- rough
- systematic
- random
- in control point
- in zero.

The rough error occurs usually due to inattention of the operator or the change of the measuring environment. It is removed from the table of the results during the analysis of the series of measuring data.

The systematic error repeats constantly or in foreseeable way. It is a result of inaccuracy of measuring device and measurement method. It is treated as a correction to the result.

In repeatable measurements, we may find **the random error**, resulting from the difference in temperature or motion of the air. It may be determined during the repeatability test for the results obtained from a given measuring device.

In the control point

In the control point, we may meet the error of the measurement of measuring device or measuring system at the specified value of the measurand. For example, we may indicate the errors stated during the calibration of the measuring device in the specified points.

In the case when the specified measured value is closely approximate or equal to zero, then we have to deal with **the error in zero**. For example, the mentioned error for electronic balances means the stability of zero indication. The discussed stability may be important during long-lasting measurements of the same sample. We should note that the smaller the weight of the sample is, the higher is the participation of "zero error".

Technical device is specified as the object, enabling performance of the defined process, according to its destination, being often a set of connected mutually parts. The mentioned elements create the integrity, serving for the specified functions of a given process. It concerns, for example, information processing. Such device has a specified form of construction, depending on the purpose of destination and the satisfying work parameters. Hence, the discussed equipment may be classified according to destination:

- machines, i.e. the objects for energy transformation or performance of specified mechanical work;
- the tools – they are the equipment of man or of a given machine, so they affect directly the object of the work;
- fitting – a set of auxiliary elements, assembled in machines or in devices, facilitating the correct and indispensable functioning;
- equipment means the technical object that is dependent on the presence of electromagnetic field or supply of electric current; it serves for production and transmission or measurement of intensity of electromagnetic field.

Marking

Marking of the product is obtained *via* application of label, which was earlier called a tag. It is a company mark, trademark, illustration or another written, extruded or copied sign, or the image, placed on the packaging by another method, or enclosed to it. The mentioned mark may have a form of paper or film product; it is directly fixed to the product or placed on it in order to identify or specify its contents. Labels serve also, more and more frequently, for marketing activity, when promoting the product and attracting the attention of the customers. To this end, the designers of the labels suggest more and more differentiated shapes and they are constantly seeking for new materials to be used as the labels. They conduct also the experiments with the printing technology employed in their production. It generates many new problems to be solved owing the labelling machines and creates their additional classification according to the type of the labels [2]. We may distinguish the following types of the labels:

- in-wet glued
- self-stick
- in-mould (IML)
- shrink sleeve
- bands
- transparent

- multi-page
- reactive (smart)
- VOID type
- PEEL-OFF
- collectible.

In-wet glued label may be historically called as traditional. At the past, the glue was applied in a wet form on the packaging. Since the seventies of the 20th century, there has been observed a strong change of in-wet labels into the self-stick ones.

The **self-adhesive** label is printed on the self-adhesive material, e.g. on self-adhesive paper or film. The substrate is covered with a layer of glue from the side being stick to the labelled product and the glue is protected by the protective layer after removal of which the label is ready to be glued. The labels of this type are most frequently performed on a ribbon rolled into a roll. Such form facilitates automatic feeding on labelling machine. To make the appearance of the labels more attractive, and to prolong their stability, they are coated with a transparent film or they are covered with UV lacquer.

IML (in-mould) labels are employed, *inter alia*, in food packaging such as e.g. cheese, fish, yoghurts etc. At present, the discussed type of label is performed on a substrate made from plastic. It is the same plastic as the packaging. It is introduced into injection mould and embedded in the packaging during its manufacture. Printing techniques employed in production of IML labels include: sheet offset, inks preserved by oxidation or UV radiation, intaglio printing, rolled narrow-band offset, with the use of UV inks and flexographic printing with the application of UV inks, as well.

Shrink (heat-shrinkable sleeve) label is a contemporary type of label, performed on plastic substrate, in a form of shrink sleeve which is applied on packaging, cut and shrink as affected by temperature, so it strictly adheres to the packaging, e.g. glass bottle. The mentioned label may also play protective functions on the principle of plum, protecting against opening of the product. Sometimes, it is used for combining two products within the frames of promotion: two in price of one, or added to a given product when the other one is gratis. Owing to the fact that the SSL label may cover the total product, it strengthens the rigidity of the product's packaging. In the so-called multipacks, i.e. bulk packaging, it is possible to employ thinner walls in the packaging as well as to make the attractive decoration. The discussed labels are printed inside what protects the printing from wear. Usually, they are produced from the following films: PVC, PET, oriented PS. The films of 50 μm thickness are most frequently used for production of the mentioned above labels [3].

Bands, being sometimes used wrappings, are dry labels, destined for marking of round surfaces such as cables, pipelines or pipes.

We meet also the labels with mirror printing on transparent film. The adhesive is applied on the printed side and after gluing of the label, the **transparent** film becomes simultaneously the protection of printing.

To facilitate placing of a big quantity of text, e.g. in few languages, the **multi-page** labels are employed. They are folded in accordion way and are laminated at the top, with the possibility of designing a very small handle, making opening easy, sometimes with the additional short story or image for the children.

The label, which reacts to the changes in the product's environment, and by this, bears specified information on the product, is called **reactive** label. It is most frequently employed on food packaging. The examples of such type of labels include the labels with printing made by thermochromic ink on bee packaging. In the case when the product is properly cooled down, the proper inscription appears. The labels with temperature identifier (Time Temperature Indicator – TTI) are overprinted with UV radiation-reactivated ink in the packaging process and they change their colour irreversibly if the temperature exceeds e.g. 5oC. They inform, in this way, the consumer that the product was not correctly stored in the supply chain. The label with the silver nanoparticles will change their colour as affected by hydrogen sulphide and by this, it signalizes that a given product is deteriorating.

Plumb used in a form of label, applied in the protection of cupboards, doors or bottles is called **VOID** label. It occurs in two forms: dirtying and non-dirtying. The dirtying form leaves the trace on the plumbed surface whereas the non-dirtying one leaves the trace only on the plumb in a form of inscription reading: VOID OPEN or another one, signalizing infringement of the plumb.

PEEL-OFF is a technology allowing peeling away and repeated sticking of the label one on another: it is used on the products with a small surface and, simultaneously requiring a lot of information to be placed on the packaging for the user.

To encourage the customers to buy the products, their producers employ sometimes the mentioned label as the so-called collector's label. In such case, it appears as a piece of film or paper, and, it is most frequently self-sticking what facilitates its affixation to a flat surface as e.g. in the collector's book.

Labelling is an operation of applying the label on the product. It is performed with the use of device, called labelling machine. It is a mechanical device furnished with the following systems: driving, detection of labels, detection of packaging and positioning of the product. The most frequently employed labels include the self-sticking ones, those printed on paper or film, die-cut and remaining on silicone liner paper after removal of unnecessary openwork. The labels without glue require separate glue applicators. The labels with glue without liner (linerless or liner-free) have not found a wider application due to technical difficulties with their feeding.

The industrial labelling machines are employed mainly during series production intended for self-sticking labels. These latter are the most often chosen method for marking of the products due to their universality. Depending on the needs, the discussed machine applies the labels on any part of packaging. Owing to this ability, the discussed equipment ensures constant and measurable profits and a high increase of the manufacturing efficiency, with the relatively low investment outlays. The constructional solutions of labelling machines can

be distinguished according to the following aspects:

- **work of labelling machines:**
— automatic labelling machines with a high performance, working with transporters in manufacturing lines;
— semi-automatic labelling machines where the product is manually delivered to automatic wrapping device;
— manual wrappers for manual applying of precisely positioned labels;
— applicators without positioning of the packaging and labels for manual downloading of the labels;
- **implementation of liner drive with the labels:**
— direct without wrapping;
— direct with the wrapped roller,
— liner of pulling roller with the additional wrapping system;
— liner of feeding roller with the additional wrapping system;
— liner of the feeding and pulling roller with the additional wrapping system;
- **detection of labels:**
— optoelectronic
— mechanical
— volume and ultrasound
- **implementation of packaging wrapping:**
— manual;
— with drive from label liner;
— with drive from the engine of label drive;
— with drive from the independent engine;
- **implementation of winding the used label liner:**
— liner from the engine of the main drive and belt transmission with slippage of coupling with friction belt and wheel;
— liner from the engine of the main drive, belt transmission and clutch on roller for removal of used film.

The submitted methods of classification of labelling machines facilitate the choice of the equipment, considering the type of label and packaging and the expected performance.

Summing up

In the process of labelling, it is important that the label is properly applied on the packaging. To implement it, there is a need of correct positioning the packaging in relation to labelling head. The application of sensors allows counting, positioning, detecting of shape and determining the level of the packaging contents and even detection of undesirable elements.

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