Deep Detecting at the Anuga FoodTec!

HEUFT *reflexx* ᴬ·ᴵ· realises an X-ray image analysis which goes deeper – and exceeds the limits of visibility when detecting foreign objects. At Anuga FoodTec 2024 in Cologne, the trade fair team from HEUFT SYSTEMTECHNIK GMBH, at Stand B-030 / C-031 in Hall 5.2, will be taking a deeper look at what deep learning can do for in-line inspection in the food filling and packaging process.

Aluminium in gherkins, wire in pasta, stones in red cabbage, metal in metal and glass in glass: dangerous foreign bodies such as these are best detected with pulsed X-ray technology, which HEUFT launched onto the market over 20 years ago and has been continuously further developed ever since. The fact that it achieves full detection reliability with minimal radiation is also thanks to the company's own hardware and software for real-time processing of the X-ray images. It has long been using artificial intelligence (AI) to recognise and smartly assess a wide variety of objects.

In order to further increase the reliability of foreign object detection and at the same time further reduce the proportion of incorrectly rejected uncontaminated food and packaging materials, a more in-depth AI discipline is now used as standard in X-ray systems from the HEUFT *eXaminer* ᴵᴵ series – namely deep learning: HEUFT *reflexx* ᴬ·ᴵ· combines tried and tested image processing methods with a multi-layered neural network. This enables significantly more to be achieved, especially when analysing X-ray images.

That applies above all to loose and disorganised packaged foods such as muesli, pasta or red cabbage. But also for unpackaged bulk goods. Even in structured products in which the detection of the smallest foreign bodies with a high density was previously completely impossible can now be reliably achieved with the latest HEUFT *reflexx* ᴬ·ᴵ· version.

Its new deep learning algorithm identifies aluminium fragments between

gherkins just as smartly as ring-shaped wire in ring-shaped pasta or the small stone in a jar of red cabbage. Products that are actually contaminated are simply recognised more reliably and productivity losses, packaging and food waste due to unnecessary incorrect rejections are effectively prevented.

HEUFT will be demonstrating how well this works with pulsed X-ray inspection at Stand B-030 / C-031 in Hall 5.2 at Anuga FoodTec 2024. In addition to the compact HEUFT *eXaminer ^{II} XS* lateral inspector and the HEUFT *eXaminer ^{II} XT* for the inspection of unpackaged product masses, the correspondingly equipped HEUFT *eXaminer ^{II} XAC*, which now inspects filled jars and cans in even deeper detail for example, will be one of the highlights at the international supplier trade fair for the food industry from 19th to 22nd March in Cologne.

Deep learning during image processing

HEUFT *reflexx* ^{A.I.} is now even smarter! A newly integrated deep learning algorithm goes into deeper detail when analysing X-ray images – and makes the previously invisible visible. Dangerous foreign bodies are now also recognised in places where they were previously unrecognisable.

Whether gherkins or red cabbage in a food jar, muesli in a bag, pasta in a carton or unpackaged food: foreign bodies of high density such as glass splinters or metal fragments were not always recognisable in the X-ray image of a disordered quantity of such structured products, even with HEUFT's specially developed and in-house manufactured hardware and software for image processing. Even artificial intelligence (AI), which has been used for more than ten years to not only identify a wide variety of objects, but also to classify and smartly evaluate them in a multidimensional process, reached its limits with such structured food products. This has changed with the latest HEUFT *reflexx* ^{A.I.} version, which is now available for foreign object detectors from the current HEUFT *eXaminer* ^{II} series:

Using deep learning, it makes the invisible visible when analysing X-ray images and identifies the smallest foreign bodies even in places where this could not be done before: in inhomogeneous product mass with cavities of different sizes between their individual components – and with irregular structures which absorb X-rays to varying degrees.

Thanks to the new deep learning algorithm, the aluminium fragment between the gherkins can now be detected just as reliably as the small stone in the red cabbage, the wire in the muesli or the ring-shaped piece of cable in ring-shaped pasta of the same size. HEUFT *reflexx* ^{A.I.} finds and marks the dangerous foreign objects in real time – and at the same time reliably distinguishes them from harmless product and packaging structures so that the false rejection rate in pulsed X-ray

inspection continues to approach zero.

Proven image analysis and AI processes have been combined with a new multi-layered neural network that goes into greater depth and therefore processes even abstract patterns independently in a meaningful way. The deep-learning-capable HEUFT *reflexx* [A.I.] is therefore far superior to conventional analysis methods such as grey scale determination, contrast detection and machine learning for the recognition and classification of different objects.

What was previously invisible becomes visible – and the proportion of incorrectly rejected products which are actually not contaminated is significantly reduced once again; no more valuable packaging or food is wasted in vain.

Press release

Reliability in pulsed X-ray inspection

HEUFT has consistently further developed its unique X-ray technology with new tubes, generators, high-voltage components and the right know-how. This further increases the detection accuracy and availability of HEUFT *eXaminer* ^{II} systems and reduces the Total Cost of Ownership (TCO).

Full precision with minimal radiation! This has characterised the pulsed X-ray technology exclusively available from HEUFT for the gentle and precise detection of foreign objects, product faults and packaging defects right from the start. New X-ray components developed in-house now further increase the detection and operational reliability of the radiometric inline quality inspection with HEUFT *eXaminer* ^{II} systems.

Since HEUFT developed it and brought it onto the market in 1998 the patented pulsed X-ray has scored points above all with its extremely short exposure time for significantly clearer detection images. Because an X-ray flash of no more than one millisecond is only emitted at the moment when something really needs to be checked, there is no motion blurring. In conventional line scanning with uninterrupted X-ray radiation, this makes it difficult to recognise objects, especially in high-speed lines. In contrast, pulsed X-ray inspection of up to 1,200 products per minute virtually freezes the product flow: streaks and blurred areas cannot occur in the first place. And no radiation is emitted for up to 99 per cent of the operating time!

If it does, the intensity of an X-ray pulse of just 0.000015 Gray is a full 600 million times below the limit value up to which the World Health Organisation (WHO) considers the irradiation of food to be harmless. The maximum radiation energy is 90 kilo-electron volts. And at 0.01 microsievert, the respective radiation dose is only a hundredth of what conventional X-ray scanners emit on average. For medical X-rays, it is even 900 times higher.

New X-ray tubes, generators and high-voltage components developed in-house in combination with optimised image converter technology increase the coverage, sensitivity, detection and operational reliability of HEUFT *eXaminer* ^{II} systems! Each individual X-ray pulse now penetrates significantly larger packaging volumes and product quantities than before so that the gentle and precise detection of foreign bodies, e.g. even in oversized tinned food cans, is successful. Depending on the application, the size of reliably recognisable foreign objects is halved.

At the same time, the lifetime is increased. And before important components can fail completely, the user is informed in good time so that there is still enough time for preventive maintenance. Essential X-ray components are even integrated redundantly – should one fail, the other takes over immediately to avoid unplanned production interruptions.

Whether for the pipeline inspection of still unpacked product mass, the top-down inspection of thermoformed trays, the sideways inspection of tins and stand-up pouches or the glass-in-glass detection: the further developed pulsed X-ray not only increases the detection reliability but also the operational reliability – and sustainably reduces the TCO of foreign object inspectors from the HEUFT *eXaminer* ^{II} series.

Safety in glass-in-glass detection

With lifetime-optimised components the HEUFT eXaminer II XAC increases the sensitivity, coverage and reliability of pulsed X-ray inspection for precise glass-in-glass detection. The new deep learning for intelligent X-ray image processing with HEUFT *reflexx* ^{A.I.} additionally increases the detection and rejection reliability.

HEUFT *SPECTRUM* ^{II} alone, its comprehensive, highly automated device platform, ensures significantly better performance in the detection and rejection of filled food jars which are contaminated with dangerous glass splinters. In addition, lifetime-optimised new tubes, generators and full-field image converters increase the bandwidth, speed, reliability and sensitivity of pulsed X-ray inspection with the further developed HEUFT *eXaminer* ^{II} *XAC* with a significantly higher resolution and lower radiation. With line outputs of up to 1,200 food jars per minute this alone halves the size of the foreign objects which can be reliably recognised. The new deep learning in X-ray image analysis with HEUFT *reflexx* ^{A.I.} now finally makes the previously invisible visible.

This applies to the double bottom as well as the 360° side wall inspection. In combination they ensure full coverage when detecting foreign objects in jars and other food containers. Even if the products, which appear very inhomogeneous in the X-ray image, are filled with differently absorbent structures and irregular cavities between their components, glass and metal foreign bodies, among others, can now be identified for the first time with the new deep learning functionality of the consistently further developed hardware and software for intelligent image processing: the glass splinter in the red cabbage jar is detected and smartly marked just as reliably as the aluminium fragment in the cucumber jar. In addition, the selectivity in differentiating between critical and harmless objects increases, further reducing the false rejection rate.

This protects against unnecessary packaging and food waste and the resulting follow-up costs. At the same time, the total cost of ownership (TCO) of the HEUFT *eXaminer* ^{II} *XAC* is also reduced because the new X-ray components are now even more durable. They also require less space so that the compact full container inspector offers more space and flexibility at the end of line with unchanged dimensions – for example for the reliable inspection of containers of different heights and also oversized containers.

Its HEUFT *CleanDesign* predestines it for use in hygienically sensitive areas. Inclined surfaces make cleaning easier and prevent the accumulation of stubborn dirt. Special channels and openings allow the liquid required for cleaning to drain away completely. Dangerous germs and bacteria therefore have no surface to attack.

The significantly increased automation and computing power of its HEUFT *SPECTRUM* ^{II} head with self-explanatory HEUFT *NaVi* user guidance simplifies the safe operation of the HEUFT *eXaminer* ^{II} *XAC* which now also makes the previously invisible visible with the further developed HEUFT *reflexx* $^{A.I.}$ image processing.

Performance in pipeline inspection

Completely revised mechanics, new X-ray components and the latest HEUFT *reflexx* ^{A.I.} version for particularly intelligent X-ray image processing further increase the performance of the HEUFT *eXaminer* ^{II} *XT* pipeline inspector when detecting foreign objects in liquid, pasty or scatterable product mass even before packaging – and makes it possible to identify what previously remained hidden.

An optimised mechanical design for space-saving integration in the tightest of spaces. Perfected X-ray and image converter technology for greater coverage and sensitivity in the gentle detection of foreign bodies in unpackaged product mass. And a new deep-learning-capable X-ray image processing system which finally makes the previously invisible visible: the latest release of the HEUFT *eXaminer* ^{II} *XT* for pipeline inspection now offers even more flexibility, performance and detection accuracy!

Its completely redesigned construction offers even more possibilities for integration. New X-ray generators and receivers, the product guiding tube, the device housing as well as the compact control terminal with self-explanatory HEUFT *NaVi* user guidance can now be positioned almost anywhere so that a wide variety of installation positions can be realised – including wall and ceiling mounting.

Thanks to new tubes, generators and full-field image converters, millisecond X-ray flashes penetrate product masses such as jam, yoghurt, syrup or even muesli in even larger tube dimensions of up to 150 DN in order to identify high-density foreign bodies such as glass splinters or metal particles even before the actual filling and packaging process. Even at high or fluctuating transport speeds within the pipework the X-ray, which is exclusively available from HEUFT, ensures clear images without motion blurring. And HEUFT *reflexx* ^{A.I.} now

analyses these even more deeply with a new deep learning algorithm so that foreign objects are also visible in places where this was previously completely impossible:

The small stone, wire or glass splinter in an inhomogeneous mass of structured individual products of similar shape, size and density, such as loose almonds or muesli mixes, is clearly recognised and marked immediately. Intelligent filtering, classification and learning processes also help to reliably distinguish real risks from harmless deviations. This ensures that only goods that are really no longer marketable are removed from circulation. A rejection valve is activated for this purpose.

Variety and programme changes are carried out fully automatically and without any time-consuming recalibration. HEUFT *NaVi* supports the user individually and step by step. This also applies to regular self-tests to check the detection performance using a test wheel prepared with typical foreign bodies. The detection reliability of the HEUFT *eXaminer* ^{II} *XT* can thus be checked under real production conditions and fully documented.

The new generation pipeline inspector with the current deep-learning-capable HEUFT *reflexx* $^{A.I.}$ image processing works just as reliably. This enables exactly what is becoming increasingly important in the supply chain to be achieved in the smallest of spaces: the delivery and processing of pre-inspected, foreign object-free bulk goods as effective protection against pointless packaging and food waste.

<u>**Press release**</u>

New perspectives in sidewall inspection

Flexibly applicable pulsed X-rays and multi-layered neural networks in real-time image processing open up completely new perspectives during the gentle and precise detection of foreign objects at the end of line with the compact HEUFT *eXaminer*^{II} *XS*. Previously invisible objects now also become visible during the space-saving sideways inspection of packaging filled with food.

The slim turnkey solution for the pulsed X-ray inspection of tin cans, doypacks, squeeze bottles, stand-up pouches or cardboard packaging achieves full detection reliability in the smallest of spaces: dangerous high-density foreign bodies such as metal particles or hard plastic fragments in the product are gently and precisely identified. The modular system can be flexibly equipped with one or two sidewall X-ray flash units. This ensures that the inspection always covers the entire filling volume and, together with the new deep detection in X-ray image processing with HEUFT *reflexx* ^{A.I.}, increases the precision of the foreign object detection.

The deep learning algorithm based on multi-layered neural networks now even makes visible what was difficult or impossible to recognise even with HEUFT *eXaminer* ^{II} systems until recently: the ring-shaped wire in the ring-shaped pasta and similar inconspicuous foreign objects in foodstuffs with special structures which absorb the X-ray impulses to varying degrees.

If, as with liquid products in cardboard packaging, only a bottom inspection is required, the HEUFT *reflexx* ^{A.I.} image processing system realises an "unfolded" bottom view. Small foreign bodies lying flat at the bottom of the packaging can therefore be recognised even more clearly.

A new option for particularly tall full packages, the complete volume of which has to be inspected, is a special oblique alignment during X-ray

with only one detection unit. This makes it possible to identify foreign objects not only at the bottom, but also anywhere else in the packaging. A full-surface image converter provides increased sensitivity and ensures that each individual X-ray pulse covers a significantly larger container area than before.

The superordinate HEUFT *SPECTRUM* [II] control unit of the HEUFT *eXaminer* [II] *XS*, to which many other detection systems can be connected – among other things for the precise verification of product labelling – is highly automated. For example, the height and alignment of the upper X-ray flash module automatically adapts to the changed container format when changing types and programmes. The HEUFT *NaVi* user guidance offers the user comprehensive audio-visual step-by-step assistance.

All of this makes the compact HEUFT *eXaminer* [II] *XS* a real turnkey solution for full-coverage foreign body detection at the end of line. Thanks to the new deep-learning-capable HEUFT *reflexx* [A.I.] image processing even the previously invisible now becomes visible.

<u>**Press release**</u>

Teach-in for label inspection

Simply teach in new labels more quickly: the HEUFT *FinalView*^{II} *LBL* for detailed label inspection reduces downtimes with intelligent image processing and thus sustainably increases the availability of entire filling lines.

It takes time to put new varieties into operation. This applies in particular to new labels which differ only in the smallest details from those previously used – for example when a new jam variant is introduced.

To ensure reliable inspection at the end of the line, a new label had to be assessed by an expert and manually categorised as a new variety using a large number of appropriately equipped food jars. Otherwise, it could happen that tiny deviations in the new label design were interpreted as errors and all affected containers were rejected. Anyone can imagine what all this means for the availability and productivity of entire filling lines, especially in the high-speed range. The innovative teach-in of the HEUFT *FinalView*^{II} *LBL* puts an end to this.

With the latest expansion stage of the AI-supported HEUFT *reflexx*^{A.I.} image processing the recognition unit for the detailed label inspection significantly accelerates the commissioning of new types – and simplifies it at the same time: with an unchanged container shape, for example, a jam jar which has been correctly labelled only has to go through the inspection once: In under a minute, the system permanently memorises the new label with all its characteristic features and design elements.

Even if labels of a different variety differ from this template in just one minor detail, the affected containers are always recognised and rejected from then on. It is now quicker and easier than ever to commission new varieties and adapt the optical label inspection to them; downtimes are reduced in the long term.

In addition to labels of different types, differently coloured and printed labels, the HEUFT *FinalView* *II* *LBL* can also find labels which are misaligned, crooked, wrinkled or torn. Four high-performance cameras on two levels in combination with adaptive LED lighting and intelligent HEUFT *reflexx* *A.I.* image processing generate an undistorted 360° panoramic view of each individual primary packaging item. Non-critical features such as slight misprints can be taught in as good objects so that they no longer lead to rejection.

The height and alignment of the two camera levels adapt automatically to the changed container size as do the individually controllable LEDs for optimum illumination in order to implement format changes simply and quickly. The HEUFT *NaVi* user guidance system not only offers the user audiovisual step-by-step assistance.

Connected to the HEUFT *SPECTRUM* *II* *VX* fill management system the HEUFT *FinalView* *II* *LBL* takes over the fill level check including fill valve monitoring or even the checking of the presence of the cap in addition to the detailed label inspection with artificial intelligence.

And with the latest HEUFT *reflexx* *A.I.* version it adapts smartly to new equipment variants: Commissioning new label types now only takes a fraction of the time previously required. Lengthy, unproductive downtimes are therefore no longer an issue and the availability of entire filling and packaging lines is noticeably increased.

Full coverage during tethered cap inspection

The tethered cap obligation can come: The HEUFT *FinalView* ^{II} *CAP* now also inspects difficult closure types seamlessly and with high precision.

Full closure safety all round! The HEUFT *FinalView* ^{II} *CAP* is now fit for new challenges in the optical inline inspection of freshly applied tethered caps in order to guarantee this even with the most varied types of tethered caps:

A software upgrade makes it possible to roll out four individual camera images of asymmetrical tethered caps into a 360° view. This ensures seamless coverage. New lighting hardware facilitates the all-round inspection of the tamper-evidence bands of rPET containers. And the advanced closure angle detection system reliably checks whether all containers are actually closed correctly and tightly.

Transmitted light is used to detect defects on the tamper-evident band of all types of closures. Combined with a realistic frontal inspection in incident light, much more is possible, especially with asymmetrical tethered caps. Protruding hinges and unusual gaps in the tamper-evidence area then no longer lead to false rejections. The rotational asymmetry of some of these new types of caps can even be precisely calculated with the intelligent HEUFT *reflexx* ^{A.I.} image processing.

Where it used to be common practice to only generate a black and white view, four colour cameras with incident and transmitted light can now be integrated into the HEUFT *FinalView* ^{II} *CAP*. The size of the errors recognisable on the tamper-evidence band is reduced by a factor of three. Blind spots are no longer an issue and the software update mentioned at the beginning also increases the precision of the gapless 360-degree inspection by a good 50 per cent.

Compared to its predecessors, the HEUFT *FinalView* ^{II} *CAP* offers twice

as many colour cameras and six times the resolution. The maximum diameter of closures that can be fully inspected has been increased by a factor of 1.5 and the possible height difference between the smallest and largest full bottle that can be safely inspected has been increased to 30 centimetres.

Type and format changes are possible at the touch of a button. Easy to connect to full container inspectors and fill management systems such as the HEUFT *SPECTRUM* ^{II} *VX*, the high degree of automation and the intuitively understandable, audiovisual HEUFT NaVi user guidance of the HEUFT *SPECTRUM* ^{II} platform make the complete inspection of the closures simple – and also realise complete coverage for tethered caps which will soon become mandatory throughout the EU.

Company profile: HEUFT is SYSTEMTECHNIK

Quality, safety, efficiency: this is what matters when filling and packaging food, beverages and pharmaceuticals! Modular quality checking, inspection and labelling systems from HEUFT SYSTEMTECHNIK GMBH implement these key factors effectively and simply. With maximum productivity, they ensure that only flawless products reach the market.

Unique camera, X-ray and image processing technologies for precise empty and full container inspection, trend-setting labelling technology and smart tools for container flow optimisation, production data acquisition and performance analysis ensure sustainable product quality and line efficiency!

A consistent modular principle with a cross-system control unit for a wide range of technologies, processes and modules generates the right automation solution for every application with a high degree of component harmonisation.

Anyone who decides in favour of a user-friendly HEUFT system can rely on a high level of operational reliability. With long-term availability of spare parts and 24/7 service availability, competent support is always guaranteed.

This concept keeps the globally operating company on a dynamic growth course. The number of employees has long since exceeded the 1,000 mark. The company's own sites in 18 different countries and a close-knit network of service centres on all five continents satisfy the high demand for HEUFT systems manufactured exclusively in Germany.

The result: greater safety, quality and efficiency in the filling and packaging of food, beverages and pharmaceuticals. HEUFT ... knows how!

Fact Sheet

Company:	HEUFT SYSTEMTECHNIK GMBH
Management:	Alexandra Heuft, Bastian Heuft, Bernhard Heuft, Dr Thomas Jahnen, Thomas Holzberger
Headquarter:	Burgbrohl, Rhineland-Palatinate, Germany
Other locations:	Argentina, Australia, Austria, Brazil, China, Denmark, France, Great Britain, Hong Kong, India, Italy, Mexico, Netherlands, Russia, Spain, Thailand, USA
Foundation:	01.04.1979
Employees:	over 1,200 in the HEUFT Group
Industry:	Special machine construction
Product range:	Inspection, quality control, labelling, rejection, transport and IT systems for the food, beverage and pharmaceutical industries
Applications:	Empty container inspection, container sorting, , fill management, full container inspection, foreign object detection, label inspection, closure inspection, rejection systems, track & trace transport optimisation, conveyor control, labelling technology, code reading, production data acquisition, line analysis
Internet:	heuft.com
Press contact:	marketing@heuft.com