

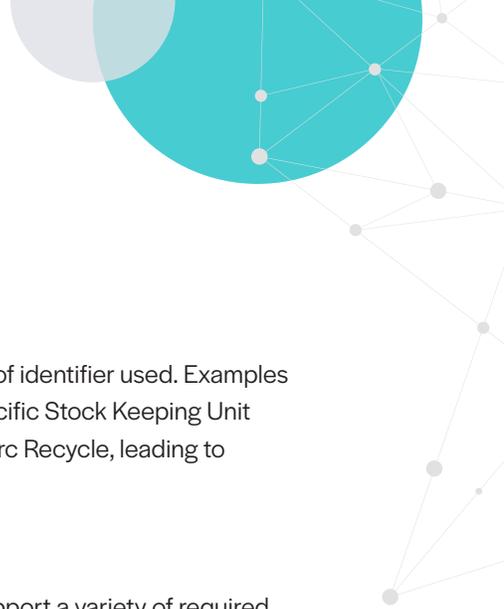


Digimarc® Recycle Product Overview

Description

Digimarc® Recycle is a digital watermarking-based solution that enables waste sorting machines to deterministically identify recyclable products, packaging and similar items in the waste stream. Among other benefits, this deterministic identification enables an increase in the accuracy and precision of sortation, which in turn leads to an increase in the quality and quantity of recyclate. Our solution includes a watermark that is embedded on the label of a package and/or in the substrate of the package itself. This watermark can be imperceptible to the human eye, and thus can cover a large percentage of the package's surface, which increases the detectable area for extremely high rates of detection. Camera equipment can readily identify this watermark, even in the harsh conditions present in waste facilities (soiled, crushed, contaminated,

or otherwise mutilated packaging traveling at high speeds). As a package is presented to the camera, the watermark is identified, and if that package belongs to the category being sorted, its location is shared with the blowout mechanism (or any other sortation technology so desired by the facility). This information is then used in real-time to sort the package into an appropriate bin at high speeds. Sorts can be programmed as either positive (eject this item) or negative (do not eject this item), and can also be performed at any desired granularity or by any desired attribute (e.g. food grade vs non-food grade, SKU specific, etc.) chosen by the facility. Finally, there is no limit to what attributes can inform the sortation, helping deliver more precise sorting and greater purity of recyclate to support a more circular economy now and in the future.



System Components

Identifier

Each package is associated with an identifier. Digimarc Recycle is agnostic to the type of identifier used. Examples of identifiers include the Global Trade Item Number (GTIN) from GS1 or a company specific Stock Keeping Unit (SKU). This identifier is what is used to communicate information into and out of Digimarc Recycle, leading to seamless integration with all existing data management systems.

Recycling Attributes

Our system is extremely flexible and can support any set of specified attributes. We support a variety of required attributes as determined by the industry and sortation partners, and the attributes can be unlimited to ensure fulfillment of future needs. Beyond attributes required for sortation, other supported attributes include (but are not limited to) product images, product description and product specifications.

Secure Digital Watermark

The digital watermark is a code embedded either in the substrate itself (e.g. plastic bottle), or in the labelling on the package (e.g. shrinkwrap sleeve). Each product can have a watermark that is unique to the product, to a batch of products, or to each physical instance of the product via serialization for item-level precision. See the “Other Uses” section for the benefits of more granular watermarks. Due to the imperceptible nature of the digital watermark, numerous copies of the watermark can be present on the package, improving survivability due to damage and increasing detectability in recycling centers.

Detection Software

Digimarc detection software runs on the sortation machines. It rapidly analyses the images of products captured as they travel down the conveyor belt of the machine. The analysis locates the watermark and indicates a “yes” if the package includes the category of attributes/SKUs chosen by the sorting operator. The software shares the location of the product on the belt with the machine’s blowout mechanism (or other ejection technology) for proper sortation. The software also records the detection of the package, along with relevant information such as date and geography.

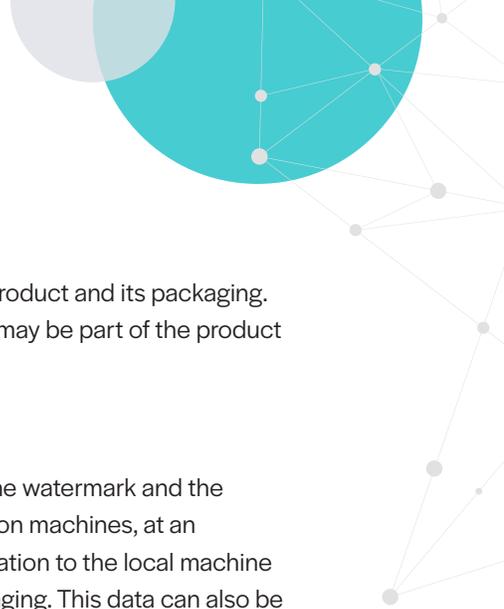
Data Flow

Digimarc respects the privacy of data that is entered into our system and created through the use of our system. We use modern software techniques to encrypt all data in our system, and as a result data is only viewable and controllable by the owner of that data. The flow of data into our system is simple, and described in the following steps:

Product Setup

A product and its associated product attributes are entered into our system using the identifier entered by the product owner (see above for descriptions of the identifier and the attributes). This data can be entered into the Digimarc system through web-based data entry, file upload, or machine-to-machine transfer (including but not limited to ERP systems, PIMs, or any other recycling databases). Digimarc encrypts data as it is entered into our systems. Once entered into the Digimarc system, the data is encrypted again and stored for use by the Digimarc platform for the purpose of detecting the package on the sortation equipment.

Digimarc expects to support any data attributes, machine-to-machine protocols, and data sources that are agreed upon by our industry partners.



Watermark Creation

Once product setup is complete, a digital watermark is created and associated to the product and its packaging. In the case of watermarks embedded in the substrate itself, the watermark information may be part of the product setup step above.

Data Replication

Once a digital watermark is associated with a product, appropriate information about the watermark and the product are replicated to local copies of the Digimarc detection software on the sortation machines, at an appropriate cadence. This data is encrypted at all times in transit and at rest. The replication to the local machine is required in order to support the real-time detection and sortation of the plastic packaging. This data can also be replicated to other recycling, industry, or partner databases permissioned by the product owner.

Product Detection and Data Distribution

As a product travels down the conveyor of a sortation system, images are captured and shared with the Digimarc detection software. The watermark identifies the product, and the pertinent information needed to sort the product is shared with the sortation equipment. The detection event is recorded and associated with the product's identifier, along with other relevant metadata such as time and geography. This information is replicated back to the Digimarc platform in the cloud. At all times during data replication and exchange, the data is encrypted for security purposes. This data can also be replicated to any recycling database or any recipients so permissioned to receive by the owner of that data. It can be shared using the same identifier used during data set up or that identifier can be hidden/the data can be aggregated. Digimarc Recycle is designed to share this data with any recipient so permissioned by the data owner. This data can be shared via machine to machine, file download, or web-based viewing.

Technical FAQ

How does the detection software associate a watermark with a product?

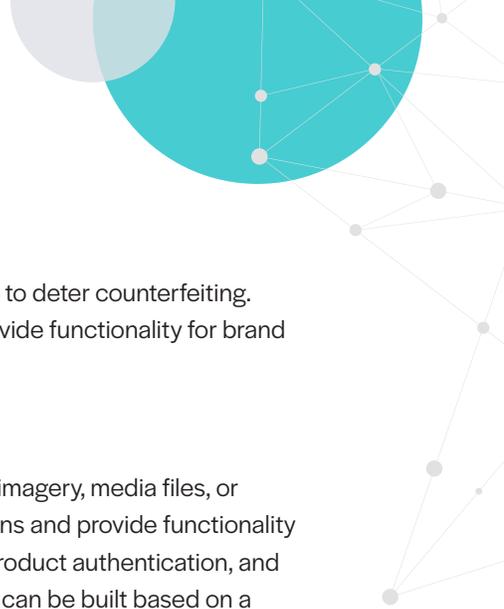
Digital watermarking is a technology that uses a unique signal that must be read by software that understands that signal. The detection software identifies the signal, and then interprets it. It first reads a secure "payload," or the content of the watermark. The encryption ensures that the digital watermark is secure and can only be unencrypted by authorized actors. This information is then decrypted and associated with the unique identifier used to enter the product into the system (see Product Setup above).

How well does this technology work?

We have tested this technology alongside industry partners for the last few years as part of the HolyGrail initiative. As a result, we have seen extremely good results. Our system will accurately identify products for proper sortation 99% of the time. For more details, please see all of our published results [here](#).

Other Uses

Digimarc Recycle is one product in a larger product portfolio. As our products solve various problems for multiple industries and customers, compatibility of our solutions is key. Therefore, all products are built on the same system of identifiers, watermarks and detection software, which allows a single secure digital watermark instance to enable multiple use cases. Below are some examples of the many solutions powered by our secure digital watermark today, and the number of use cases are expected to increase in the future.



Brand Integrity

Since the watermark is covert, it can be used for the purpose of product authentication to deter counterfeiting. The secure watermark can be read by mobile web pages or native applications and provide functionality for brand owners or consumers to ensure the product is authentic and authorized.

Consumer Engagement

The Secure Digital Watermark can be associated with any type of product description, imagery, media files, or attributes. The secure watermark can be read by mobile web pages or native applications and provide functionality for many purposes. Examples include recycling instructions, provenance information, product authentication, and marketing. Additionally, the Digimarc platform enables sophisticated engagements that can be built based on a number of factors including location, time of day, number of times scanned, season, and many other conditions.

Quality Control

Since Secure Digital Watermarks can be read at high speeds with great accuracy, they can be used as part of manufacturing quality control. For example, to ensure the right type of food product is being placed into the current packaging flowing down a factory line. Also, ensuring that the tops and bottoms of containers are appropriately matched. One last example would be ensuring that as products are packaged, they are being appropriately sorted and grouped into cases and pallets.

Inventory Management

Since Secure Digital Watermarks can be read simultaneously in real-time, inventory management applications can quickly identify and count packages on a store shelf, or in a warehouse location.

Retail Checkout

The covert nature of watermarks allows for a great deal of coverage over product packaging. This makes our Secure Digital Watermarks an ideal candidate for modern front of store systems to reduce the amount of time it takes to identify packages as they encounter checkout systems located at the front of store, mobile, or cart based.

Intelligent Package Routing

The Secure Digital Watermark can be read accurately at high speeds, which is perfect for automated warehouse environments where package routing occurs.

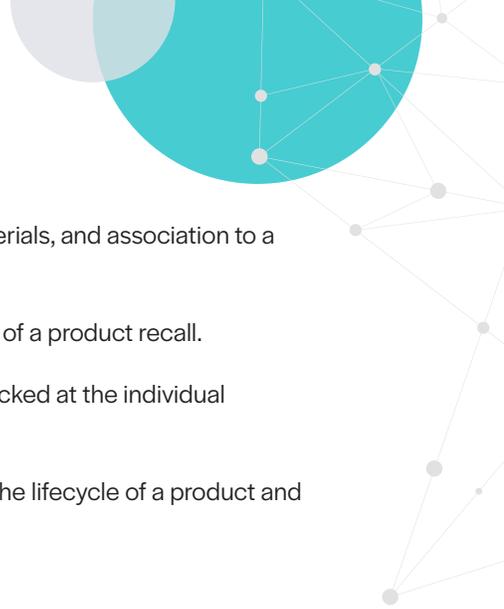
Digital Use Cases

Our Secure Digital Watermark is not just useful in the physical world. Secure Digital Watermarks can be associated to digital media which enables a myriad of use cases from digital media tracking to product authentication in e-commerce and social commerce applications.

Secure Digital Watermark Granularity

As previously mentioned, the watermark can be associated with a product, a batch of products, or serialized to the individual physical item. More granularity provides multiple benefits:

- Richer product intelligence. By capturing interactions with batches or serialized units, the data captured as a product encounters machines, devices, and applications becomes much richer. This richer intelligence can



be used for things such as product authentication, identification of gray market materials, and association to a consumer, among many others.

- Improved recall. A granular Secure Digital Watermark can be used to limit the scope of a product recall.
- Better traceability. For example, a serialized watermark can allow a product to be tracked at the individual physical item level.
- Lifecycle analysis. Granular Secure Digital Watermarks can provide rich insight into the lifecycle of a product and allow for analysis regarding package design and promotion.



See Everything, Achieve Anything™

Digimarc Corporation
8500 SW Creekside Place, Beaverton OR 97008 USA
www.digimarc.com

Digimarc is a global leader in product digitization, delivering business value across industries through unique identifiers and cloud-based solutions. A trusted partner in deterring digital counterfeiting of global currency for more than 20 years, Digimarc illuminates a product's journey to provide intelligence and promote a prosperous, safer, and more sustainable world. With Digimarc, you can finally see everything. And when you see everything, you can achieve anything. For more information, visit us at digimarc.com.

061622MF