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On-Product and On-Advertisement Encoding for Visual Product Identification

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TITLE

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ABSTRACT

This disclosure describes a method for on-product and on-advertisement encoding for visual product identification. Visual search technologies can have difficulty distinguishing between product models that are highly similar or visually identical, which may lead to incorrect identifications and a suboptimal user experience. The described method involves embedding a unique product identifier, like a Global Trade Item Number (GTIN), onto a physical product or into its advertisements through an invisible watermark. This watermark is composed of subtle, algorithmically detectable variations in color or pattern that are imperceptible to the human eye, such as stripes of nearly identical shades on a fabric. This encoding can enable visual search systems to more reliably identify the exact product version being scanned, which can improve product discovery accuracy and provide a way to measure ad effectiveness.

KEYWORDS

Invisible watermarking, on-product encoding, visual product identification, computer vision shopping, product disambiguation, algorithmic pattern recognition, imperceptible optical codes, physical object watermarking, augmented reality product recognition, machine-readable surface patterns, ad effectiveness measurement, GTIN embedding, subtle color variation encoding, scan-to-identify.

BACKGROUND

Visual search technologies, such as those that allow users to identify real-world objects with a device's camera, are often used for product identification in e-commerce. A user can scan an item or an advertisement to find and purchase it online or offline. While these systems may be effective at recognizing a product's brand and general category, they face a challenge in differentiating specific models, particularly if they are visually identical. For example, different generations of apparel or electronics may look the same externally but have significant internal differences. This can lead to misidentification and a frustrating shopping experience by directing users to the wrong or outdated products. Existing technologies like QR codes can link products to digital information but are visually obtrusive and can detract from the product's or ad's aesthetic design. Invisible watermarking is another technology, primarily used for copyright data in digital images, and is not typically designed for direct application onto physical products in a way that is both imperceptible and robustly decodable by a consumer camera for model identification. Thus, a method is described to enable accurate product identification without compromising the visual integrity of the item or its marketing materials.

DETAILED DESCRIPTION

Overview

The disclosed technique proposes embedding a unique product identifier directly onto a physical item or within its advertising using an invisible watermark. This is based on creating subtle, algorithmically-detectable variations in pattern or color that the human eye does not perceive. This encoded data allows a visual search system to distinguish between product models that appear identical. The encoding is achieved by modifying the product's surface or the ad's image in a controlled way. For instance, a fabric that seems to be a single color could be made with stripes of two very similar shades. A human would see one color, but a computer vision algorithm can detect these variations and read them as a code. This approach is designed for easy algorithmic discovery and avoids visually obtrusive markings like QR codes. It can be applied during manufacturing or to images used in various ads. Manufacturers can create specific encodings for ads placed at different places to measure effectiveness, and the like. The watermark can also include additional data, such as unique codes for different ad placements, to provide advertisers with analytics on ad effectiveness.

System Architecture Overview

The system architecture includes an encoding subsystem for manufacturers and advertisers and a decoding subsystem for integration into consumer-side applications, like a visual search tool. The process starts with the encoding subsystem generating a visually imperceptible pattern representing data (e.g., a GTIN) and applying it to a product or ad. A consumer then uses a device with the decoding subsystem to capture an image of the item. The decoding algorithm on the device searches for the pattern's signature, decodes it to extract the data, and initiates an action like displaying the correct product page.

Encoding Process and Principles

The encoding process generates a machine-readable pattern that is imperceptible to the human eye to avoid the aesthetic issues of codes like QR codes. The technique uses subtle variations on a product's surface or in an ad's image. The information payload is intentionally kept low, similar to a one-dimensional barcode, which allows for a simple and robust encoding scheme for a GTIN. A primary encoding mechanism involves precise color manipulation, using two or more very similar shades to create a pattern. For example, a fabric could be woven with threads of two slightly different shades of blue that appear as a solid color to a person but are distinguishable to a digital sensor and algorithm. By arranging these shades in a sequence, like thin stripes, a binary code can be formed to represent data. This can also be applied to variations in luminance, saturation, or micro-patterns.

Application to Physical Products and Advertisements

When applied to physical products, the encoding is integrated into the manufacturing process. For textiles, looms can be programmed to weave threads of nearly identical colors into a data-carrying pattern, making it an intrinsic part of the fabric. Alternatively, the patterns can be applied to the finalized product, in a post-manufacturing printing process that introduces the color variations. For hard surfaces, the pattern can be applied with high-precision printing or molded as a micro-texture. This makes the on-product encoding persistent and inseparable from the item. For advertisements, the application is often digital, with an algorithm altering pixel values in an image or video file. For print ads, the source file is encoded, and it may be desirable for the printing process to be calibrated to faithfully reproduce the subtle color differences. This may utilize high-fidelity printing technologies to help ensure the watermark is detectable.

Decoding Process and Algorithm

The decoding process starts with image acquisition on a user's device. Software analyzes the video stream or still image. A first step may be pre-processing to normalize the image, correcting for distortions, lighting, and scale. The pattern may include features like imperceptible fiducial markers to aid the algorithm. A specialized pattern detection algorithm then scans the image, optimized to find the specific signature of the encoding scheme. This could involve using a Fast Fourier Transform (FFT) to find the pattern's spatial frequency or analyzing local color histograms. This targeted search can be computationally efficient and performed in near real-time. Once a pattern is found, the data is extracted by analyzing the sequence of variations. In the case of color stripes, each stripe is classified to reconstruct the binary data stream. The payload could incorporate error-detection and correction mechanisms like a checksum or CRC to guard against read errors. The decoder validates the data by comparing checksums; if successful, the valid payload is passed to the host application.

Use Cases and Data Payload Expansion

The data payload's flexibility allows for several applications beyond simple product identification. A primary use case is disambiguating visually identical products. However, the payload can be expanded for analytics and marketing. For advertisements, a unique identifier can be encoded for each specific ad placement. An ad on a billboard could have a different ID than the same ad in a social media feed. When users scan these ads, the decoded ID allows advertisers to measure the engagement and conversion rate of each specific ad instance. This can also be used for tracking individual physical items. A promotional item given to an influencer can have a unique "personalized" watermark printed on it. Every time a consumer scans the item, the unique ID is captured, allowing the brand to measure the downstream engagement generated by that specific item. The payload can also include interactive elements like coupon codes.

IMPLEMENTATION EXAMPLES

Example 1: On-Product Encoding for Apparel

A denim manufacturer can use this to distinguish between visually identical jeans. The loom can be programmed to weave the denim with threads of two slightly different shades of blue, creating a pattern of thin stripes that appears as a solid color. A visual search app can analyze an image of the jeans, detect the subtle color variations in the stripe pattern, and decode the product's GTIN. The data could also include size and colorway to direct the user to the exact product page.

Example 2: Ad-Specific Encoding for Performance Measurement

An advertiser for a new watch can measure ad effectiveness by encoding a unique identifier into identical-looking ads, one for a billboard and one for a magazine. Scans of the billboard would register the billboard identifier, while scans of the magazine would register magazine identifier, allowing the advertiser to track interactions from each specific ad. Additionally, if multiple billboards in different physical locations are used, the system can also be used to tell them apart.

Example 3: Instance-Specific Encoding for Influencer Marketing

A footwear brand applies a unique watermark, such as a micro-texture on the sole, to a promotional pair of shoes given to a celebrity. This personalized watermark encodes an ID specific to that influencer. The brand can then measure the engagement every time a consumer scans that specific pair of shoes, whether in person or from a photo, providing granular data on the return on investment for that marketing activity.

Features and Potential Applications

This technology may provide an improvement in the accuracy of visual product identification by embedding a machine-readable identifier directly onto a product or its advertisement, which can reduce ambiguity between visually similar models. This can address the problem of directing users to incorrect products and lead to a more reliable shopping experience. An advantage is the preservation of aesthetics, as the imperceptible encoding does not alter the product's design, unlike solutions such as QR codes. The technique also offers a tool for marketing analytics, allowing advertisers to gain precise data on which ad placements are driving engagement by encoding unique identifiers into different ad instances. This can also be extended to track individual physical items, like a promotional product given to an influencer, to measure the engagement generated by that single item. The system is designed for robustness, using a low-information-density payload that allows for a simple, redundant encoding scheme, which may enhance decoding reliability under various real-world conditions.

Certain features of the technology may include the use of imperceptible, machine-readable encoding to embed data through subtle, controlled variations in a product's physical surface or its ad imagery. This may preserve aesthetic integrity. Another feature is the use of a low-density and/or high redundancy data structure optimized for robust algorithmic detection rather than secrecy. This approach, analogous to a barcode, may improve decoding reliability. The technique also allows for direct and intrinsic encoding onto physical products during manufacturing, making the code an inseparable part of the item. Finally, the data payload can be expanded to include ad-specific and instance-specific information for analytics, such as personalizing a watermark on an individual item to track its specific engagement.

CONCLUSION

In conclusion, the described method of on-product and on-advertisement encoding presents a significant advancement in visual product identification by addressing the critical issue of disambiguating visually similar items. By embedding imperceptible, machine-readable identifiers, such as a GTIN, directly onto a product's surface or within its advertising, this technology provides a reliable mechanism for computer vision systems to achieve precise identification. This approach not only enhances the consumer experience by eliminating the frustration of incorrect product matches but also preserves the aesthetic integrity of the product and its marketing materials, a distinct advantage over visually intrusive solutions like QR codes. Furthermore, the capability to encode unique identifiers for specific advertisements or individual items opens up new frontiers in marketing analytics, enabling granular measurement of ad effectiveness and influencer campaign reach. The robustness of the simple, low-density encoding, combined with its direct integration into the manufacturing and digital design process, makes this a commercially viable and powerful tool for bridging the gap between physical products and their digital identities.