Depth Perception – An Important Authentication Tool for Security Features

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Authentication in the field of document security continues to be a major concern. There are many features in the market that provide security; each have strengths and weaknesses but, with some, the underlying technology has now been used for a significant period.

There is always a demand for new technology platforms that can provide secure, memorable and fast visual authentication. One approach is non-print based visual effects such as 3D stereo-depth and movement with multiple colours and high contrast, that reach the mechanical robustness and durability required in a banknote and that are difficult to reverse engineer or simulate due to their complexity.

Depth perception as an authentication tool

As human beings, we use all our five senses to perceive and understand the outside world. When it comes to banknote security, we are heavily dependent on our visual perceptions and, to a smaller extent, on tactile cues.

Secure documents and banknotes use multiple visual authentication indicators. Among them are 'colour' and 'shape', which are visually easy to recognise but which, unless they incorporate additional security features, are the easiest to duplicate or simulate via printing, embossing or modern digital copiers. Adding a 'movement' feature typically makes it more secure but requires either tilting or turning by the user to see the specific effect, which can make it less user-friendly.

For these reasons, 'stereo-depth' is a formidable visual effect. The 3D parallax effect stemming from stereo-depth can be immediately seen. It does not require any auxiliary tools for authentication such as flashlights, UV lights, magnifying lenses, or any prior knowledge or specific skills.

In general, people differentiate between banknote denominations easily and quite accurately, irrespective of the duration of inspection, due to non-secure features such as size, colour and the subject matter. Authentication is less easy.

However, for most people, an exposure of 3D features for a mere 100 milliseconds is adequate for their brains to create signals to confirm authenticity, while exposure of half a second increases the rate of correct authentication significantly. (J Raymond et al, '3D Micro-Optics Enable Fast Banknote Authentication by Non-Expert Users', Optical Document Security Conference 2020, S5P2, San Francisco USA).

3D stereo-depth

Understanding how humans see objects in 3D is important in understanding how stereo-depth images appear on thin and small security features. Each eye acts as an independent receiver of light. We live in a 3D world, but human eyes can perceive only two dimensions. The depth that humans think they can see is a computational mechanism the brain has learned. 3D depth perception comes from the brain's ability to combine two 2D images in such a way that it extrapolates depth. This is called stereoscopic vision.

Because human eyes are distinctly separated by a short distance, each retina produces a somewhat different picture, which is a direct result of the depth of the objects that are viewed. When those two images are combined and computed in the brain point by point, they are interpreted as depth, which is known as the stereo-depth perception. An ordinary 2D paper surface does not enable the brain to produce stereoscopic images.

One option for creating secure 3D stereo depth features is to use complex nanoscale structures, tailor-made such that each eye can see a slightly different image from a slightly different perspective and be assembled in the brain to create a 'real world' stereo-depth effect.

3D security features leveraging stereo-depth effects are an ideal authentication tool due to the brief viewing time required to authenticate and the difficulty to simulate or otherwise counterfeit the feature. Additionally, a 3D stereo-depth feature should perform well even under low illumination conditions. (NB for the small percentage of the population who is stereo-blind, 3D effects will not be visible).

Nanotech's KolourDepth

Nanotech has developed a security feature that incorporates multiple effects in a single feature, which is thin and represents significant challenges to counterfeiters. The result of this work is a product called *KolourDepth*™.

KolourDepth is exclusive to the high security government documents and banknote industry. This security foil combines 'always on' multicolour, 3D depth, and motion, creating a secure solution with a significant number of design alternatives for banknote security stripes, threads, and patches.

Recent efforts in software development and nanofabrication processes have enabled precise engineering and patterning of nanostructured pixels on top of microstructures to obtain a wide gamut of authentication content in a single optical feature. We believe this feature addresses many shortcomings of other technologies and sets a new bar for authentication in the process.

KolourDepth offers some benefits over conventional gratings and lens-based technologies, including thin feature sizes, flexible design, multiple substrate application options, multi-colour, omni-directional movement, and ease of viewing in low lighting environments.

Conclusion

Our software algorithm, proprietary nano-optic design and nanofabrication techniques significantly increase the security of banknotes. Moreover, we are confident that KolourDepth's overall durability and ultrathin form factor (<10 um) are compatible with the large number of manufacturing processes and substrates involved in producing security documents, especially for banknote applications.

Nanotech's access to a new class of direct-write based lithographic systems, including in-house electron beam lithography (EBL), provides a method of constructing structures well below the diffraction limit, embedding billions of precisely engineered nanostructured pixels to create large authentication patterns.

Depth perception is an important authentication tool for security features as it supports excellent authentication within a brief viewing period, performs well under low illumination and is readily visible when the banknote is static, and 3D depth holds great promise as a security feature for banknotes.

This article is a summary of a new white paper from Nanotech Corporation, which can be downloaded from their website.
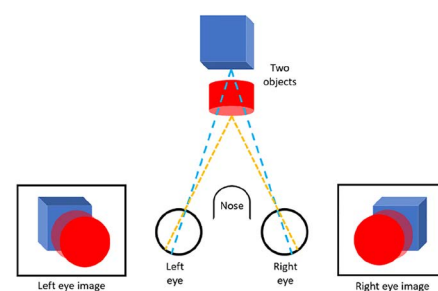
How human eyes see images individually and collectively, creating a stereo-depth effect.