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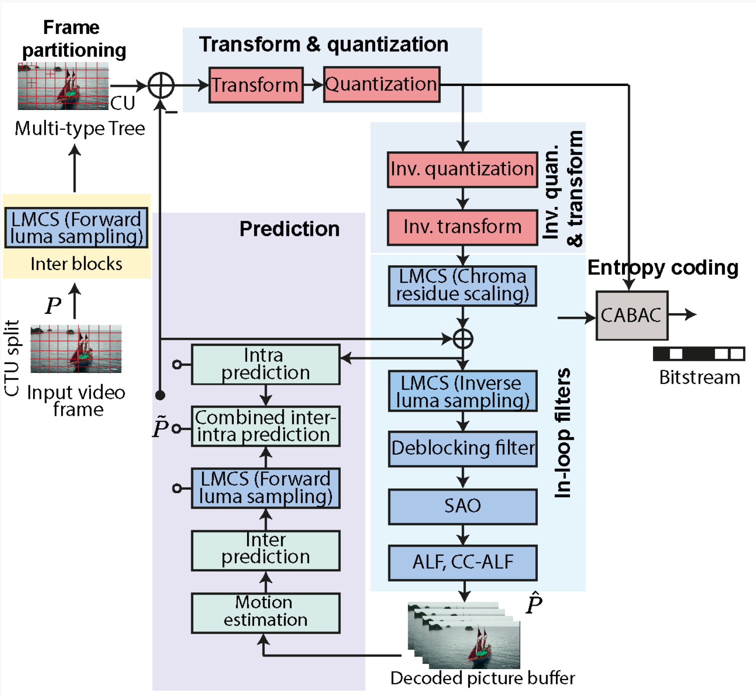

The encoder block diagram of versatile video coding

TABLE OF CONTENTS

EDITOR'S NOTE

On behalf of the Editorial Board of IEEE CTSoc News on Consumer Technology (NCT) editor-in-chief Wen-Huang Cheng, and fellow co-editors, Yafei Hou, Luca Romeo, Jianlong Fu, I am pleased to introduce the October issue of the News on Consumer Technology (NCT).

For this issue, we begin with a cover story regarding the development of video coding standards and the challenges involved. We present an article from our IEEE Consumer Technology Magazine which provides an overview of consumer electronic use cases of the versatile video coding standard MPEG-I Part 3 that was finalize relatively recently in July 2020, as well as video compression tools, available real-time implementations, and first industrial trials done with this new standard.

This is followed by an interview with Prof. Chuan-Yu Chang from the National Yunlin University of Science and Technology, Taiwan. Prof. Chang established the Intelligent Recognition Industry Service (IRIS) Research Center with a convention of 22 professors in the field of Artificial Intelligence in the year 2018. In this featured interview, he shares about the various technologies he had developed over the years together with the IRIS center as well as his goals and visions for the future.

Finally, this issue ends with a feature article by Dr. Simying Ong from Universiti Malaya, Malaysia who is an expert in the area of Data Hiding in Digital Images. In the article she shares her perspectives and rethinking of the conventional framework for data hiding in images including the stakes, challenges and preliminary works towards future solutions.

Have a nice read!

Yuen Peng Loh
Editor of NCT

Editor: Yafei Hou

ARTICLE TITLE
Versatile Video Coding Standard: A Review From Coding Tools to Consumers Deployment

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- In the framework of consumer electronics applications, the multimedia applications, and more specifically those in charge of video encoding, broadcasting, storage and decoding, play a key role. Therefore, the development of new video coding standards is a challenge to increase the compression rate and other important features with a reasonable increase in the computational load.
- The Joint Video Experts Team of the ITU-T Video Coding Experts Group and the ISO/IEC Moving Picture Experts Group (MPEG) have worked together to develop the versatile video coding standard, finalized in July 2020 as the International Standard 23090-3 (MPEG-I Part 3).
- For cover story in this issue, we would like to recommend this highly-cited article overviews some interesting consumer electronic use cases, the compression tools described in the standard, the current available real-time implementations, and the first industrial trials done with this standard. It also reports in further sections some efficient implementations and trials done recently in real scenarios.

INTERVIEW WITH DR. CHUAN-YU CHANG

Dr. Chuan-Yu Chang is with the National Yunlin University of Science and Technology as a distinguished professor at the Department of Computer Science and Information Engineering and the director of the intelligent Recognition Industry Service (IRIS) Research Center. He is concurrently the Deputy General Director of the Service System Technology Center at the Industrial Technology Research Institute (ITRI). At the same time, he is the chairman (2021-2022) of the Chinese Image Processing and Pattern Recognition Society, which is the most indicative and largest academic society in the field of artificial intelligence. In the past, he also served as the Dean of Research and Development, Director of the Incubation Center for Academia-Industry Collaboration and Intellectual Property, Director of the Department of Computer Science and Information Engineering, and the division director of the Systems Section of the Information Technology Services Center at the National Yunlin University of Science and Technology. He has comprehensive experience in administrative and industrial services. Dr. Chuan-Yu Chang has actively participated in various international academic organizations and is highly reputable in the academic fields. He is a Fellow of the Institution of Engineering and Technology (IET) and a senior member of the Institute of Electrical and Electronics Engineers (IEEE).

In 2021, Dr. Chuan-Yu Chang received the National Award for Distinguished Contribution to Industry-Academic Cooperation from the Ministry of Education in Taiwan for his outstanding industry-academia research results. The award is the most prestigious in technical and vocational education. Additionally, he received numerous other awards, including the National Science Council's Future Tech award, the Chinese Institute of Electrical Engineering's Outstanding Professor Award, ITRI's Outstanding Research Award, and the IEEE's Outstanding Technical Achievement Award.

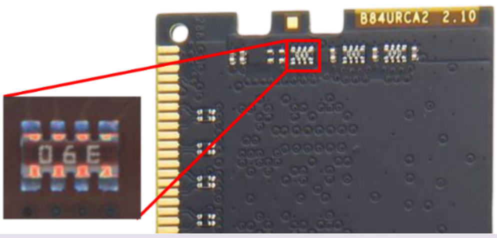
In 2018, Dr. Chuan-Yu Chang convened 22 professors in the Artificial Intelligence field from the National Yunlin University of Science and Technology and established the lntelligent Recognition Industry Service (IRIS) Research Center. The Ministry of Education's Higher Education Sprout Project selected the center as Global Taiwan's Featured Areas Research Center. The center explores the actual requirements of the industries to develop forward-looking AI intelligent recognition technologies and emphasizes on intelligent detection, intelligent healthcare and intelligent living.

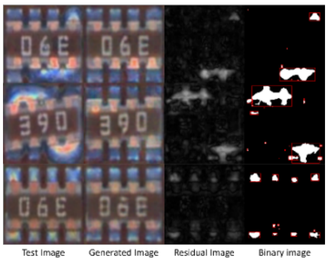
Dr. Chang, you have developed many innovative technologies. Is there one you are most proud of?

Dr. Chuan-Yu Chang has served in academia for around 20 years. Since 2003, he has served at the National Yunlin University of Science and Technology and established the Medical Image Processing Laboratory (MIPL). He has been involved in machine learning, medical image processing and related research for a long time. The MIPL's objectives are to develop technologies that solve industrial difficulties, involve student teams in medical and industrial facilities to thoroughly understand industrial issues, and provide intelligent solutions for various industries. The center has provided services to over one hundred enterprises and supported one hundred students to complete their postgraduate degrees. The most representative research is the globally-renowned Infant Crying Translator. In 2013, Dr. Szu-Tah Chen from the National Taiwan University Hospital Yun-Lin Branch consulted Dr. Chang regarding the possibility of interpreting infant cries via computers to provide suggestions to the parents, which started the long-term collaboration between Dr. Chang and the National Taiwan University Hospital. After three years of research, the team has collected over three million samples of infant cries (the largest database globally) and developed the first infant cry recognition application in the world in 2016, namely, the Infant Crying Translator. The application utilizes machine learning to determine the infant's needs based on the infant's cry (hungry, sleepy, wet diaper, or seeking comfort).

The application can also customize an individual infant's cry model (the only one in the world). The application's recognition accuracy is 92% for cries from babies less than one week old, which helps to reduce confusion for new parents. Furthermore, Dr. Chang leads the team of MIPL students in entrepreneurship to commercialize infant cry recognition technology. The technology has received the Ministry of Science and Technology's Entrepreneur potential award (top 10) in the From IP to IPO (FITI) project and has been selected as an entrepreneurial team by the Taiwan Innovation and Entrepreneurship Center (TIEC) for the Silicon Valley Startup Accelerator. The team has been reported by hundreds of international media (including Reuters from the US and the Sankei newspaper from Japan), and the technology has been transferred to several renowned international companies (Japan, The Netherlands and China). The team also facilitated Taiwanese brands to enter the European and American markets. To provide comprehensive infant care service, the team has also developed technologies to detect other infantile events such as milk spitting, mouth and nose obstruction, face monitoring, heart and respiration monitoring, and more. The target is to implement an all-around intelligent baby monitor which contributes significantly to the industry.

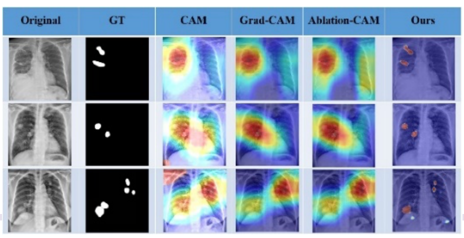
Since its establishment four years ago, the IRIS center (directed by Dr. Chang) has developed 81 AI recognition technologies. Can you please share the industrial contributions of the developed technologies?





The IRIS center is focused on implementing industrial technologies for the industries. So far, 81 novel technologies have been developed and integrated into the industries. In the following, we will introduce the center's results and highlights with regard to three main areas.

In intelligent detection, the target is to integrate computer vision detection technologies into the industries towards the Industry 4.0 concept. The main research goals are to improve the detection rate and reduce misdetections due to staff fatigue and lack of experience. Research outcomes include defect detections for tires, solar power EL, memory modules, electronic components, copper foil, precision glass, textiles, and so on. Among the developed technologies, "The application of deep learning in the detection of soldering points of DRAM modules" used the Generative Adversarial Network (GAN) for defective image classification of DRAM modules and achieved an overall accuracy rate of 99% with a defect misdetection rate lower than 0.3%. The technology effectively solves problems such as high misdetection rates and large manual rechecks in the conventional AOI detection setup. The technology is successfully integrated into the largest memory module manufacturing plant in the center of Taiwan. Furthermore, the work also received a gold medal in the 2020 International Innovation and Invention Competition Award (IIIC), as well as a first prize and best innovation prize in the 2020 Pan-Pearl River Delta and undergraduate computer competition. The technology has a profound contribution in the advancement of AOI industrial technologies.



In intelligent medicine, various AI-aided diagnosis systems have been developed to assist medical practitioners in clinical diagnoses by reducing diagnosis difficulties, shortening examination time, and increasing treatment quality. The technologies have been extended to telemedicine. Some research highlights are computer-aided diagnosis systems for glaucoma, lung lesions, thyroid nodules, breast cancer, rheumatoid arthritis, pancreatic cancer, endotracheal tube, and pneumothorax, developed in collaboration with the Dalin Tzu Chi Hospital, National Taiwan University Hospital Yunlin Branch and the National Cheng Kung University Hospital. A major highlight is the world's first non-contact facial symmetry, heart rate and respiration detection technology. The technology utilizes facial asymmetry with the eyes and mouth to evaluate the risk of a stroke from facial features and observes the micro-vibrations of the head due to heart contractions. The technology uses a standard camera to overcome existing image measurement issues such as lighting variations and provide simultaneous, instantaneous and continuous measurement for several people. The error rate for heart rate detection is around four beats per minute, and the respiration error rate is one breath per minute. The accuracies are close to medical-grade physiological signal monitoring machines, indicating high clinical application values. The technology is commercialized and marketed with the National Taiwan University Hospital Yunlin Branch and Insight Vision. It was awarded the 2020 MOST Future Tech award for its uniqueness and innovation and obtained five patents in the US and Taiwan.

Intelligent life includes various technologies associated with intelligent living, behavior recognition, hyperspectral identification, infant cry recognition, intelligent automotive electronics, and so on. These technologies can be applied to historical artifacts, sports technology, environmental monitoring, agriculture, and other fields to improve the quality of life. Research outcomes include the baby monitor, human face and emotion recognition, artifact and artwork preservation and recognition and agricultural produce examination. Apart from the Infant Cry Translator App, a major highlight is the AI artifact preservation monitoring system developed in collaboration with a national antiquities appraiser in the IRIS team. The system integrates AI, environment sensing and the Internet of Things to determine the authenticity of artifacts, monitor artifact degradation conditions and provide warnings. The technology is applied to the idols and artifacts in the Taisheng Temple in Budai Township, Chiayi County and Beiji Temple in Dapi, Yunlin County, and the Chien-lung stele in Chiayi Park. The technology aims to solve artifact restoration difficulties with AI technology, alleviate the lack of artifact restorers and improve artifact preservation.

What are the goals and vision for the IRIS center?

The IRIS center is focused on developing AI recognition technologies and aims to develop practical technologies to solve actual industry issues. In addition to industrial collaborations, the center seeks to cultivate industrial application talents to connect with enterprises. In four years, the center has cultivated 303 outstanding graduates, provided industrial work experience for 42 students, received 35 international awards and published 89 SCI journal papers, including 56 Q1 rank papers, establishing the center's status internationally. With regard to industrial collaborations, 81 AI recognition technologies have been integrated into various industries to service over 400 enterprises, and the total enterprise collaboration amount is 135 million NTD.

The IRIS center aims to be Asia's first-class and Taiwan's number one intelligent recognition benchmarking center. I hope that our technologies will not only help to upgrade Taiwan industries but to establish our brand and take place in the global market so that the world knows about the strong AI potential in Taiwan.

RETHINKING CONVENTIONAL DATA HIDING RESEARCH IN DIGITAL IMAGES: THE CHALLENGES AND THE PROPOSED SOLUTIONS

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When we take a step back and rethink about the current state and framework of data hiding research, what's the problem and what's left to be done here?

I. The Introduction

Data Hiding is the art and science of concealing the existence of data for various purposes and needs in different application domains. It can be known as steganography, for achieving the purpose of covert communication, or it can also be known as watermark, for claiming the ownership of created digital content, or it can also be called as metadata insertion, for inserting metadata into the digital medium for management and retrieval purposes, just to name a few. Different purpose and need require diverse levels of concealment (security), processing complexity and time, output quality, and hiding capacity. For many years, countless research in data hiding have been done to either focus on certain quality depending on the application domain or trying to strike a trade-off balance between these qualities. Novel techniques or improved techniques are constantly invented to be crowned as the winner of the quality game.

However, when we take a step back and rethink about the current state and framework of data hiding research, what's the problem and what's left to be done here? In this article, the stake and challenges of the current data hiding research are discussed from the technical framework and usability perspectives. Then some preliminary works done in the research group are also shared in this article hoping to get nearer to the mature solution in the future.

II. Must we follow the "Conventional Framework"?

A standard data hiding encoding framework is as shown in Fig. 1, consist of four compulsory components, namely the cover image, the hidden data, the data hiding technique and the output image. The cover image will be modified using the data hiding technique, to accommodate the data and generate an output image with hidden data. In most cases, maintaining the output image quality is utmost important, because the output image will be stored, displayed, or transferred to the intended user or location for further usage and application.

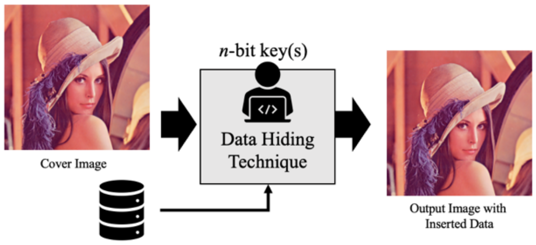

Figure 1: The Conventional Data Hiding Framework.

At the same time, malicious actions can also be performed on the output image to identify the data hiding technique, detect any hidden data, or even crack to obtain the hidden data. These attacks including analyzing its statistical properties such as the signal or histogram distribution against the usual natural image distribution, comparing the output image with its original counterpart, etc. There are many possible attacks centered around the "output image" by trying to find out the trace of modification due to the hiding gesture.

To combat the attacks, there are also researches which proposing data hiding technique that focus on maintaining the natural image statistical distribution or minimizing the modification on the cover image. However, there is no easy way out for this too due to the needs in achieving better results in other qualities and constrained by the cover image. In fact, the cover image acts as a container that creates a boundary to data hiding technique, including the hiding capacity, the distribution, etc. For instance, some data hiding techniques failed to conceal data or only able to achieve very low hiding capacity in certain image type or image components, and it is impossible to hide "outside" of the cover image

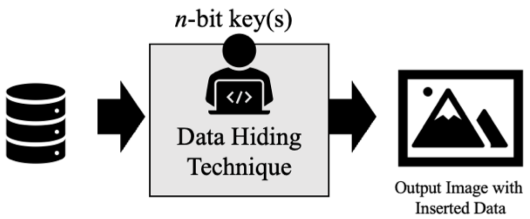

Figure 2: The Coverless Data Hiding Framework.

Hence, is there any other option? Must we use "cover image" and the standard "output image" production method in conventional encoding framework? In year 2007, Otori and Kuriyama [1] proposed a data hiding technique using texture synthesis method by encoding secrets into Local Binary Pattern dots and placed onto a blank image, which later camouflaged as a random texture image. Following this research, several synthesis-based methods have been proposed to generate output image without using "cover image" [2-3]. Here, we started to coin these methods as the "coverless data hiding methods" [4]. For more information about the evolutions and reviews of coverless data hiding methods, kindly refer to [4] for further reading.

There are two categories of coverless data hiding methods, namely the constructive/ synthesis-based, and the non-constructive-based. Data hiding methods fall under the coverless range are of those which do not modify the cover image to conceal data. Therefore, for non-constructive-based methods [5-6], input image(s) will still be needed, but only to select suitable images to represent the hidden data. These methods need a large image pool, then using certain calculation technique, such as the average pixel intensity, grayscale gradient co-occurrence matrix, to calculate the represented value of each image. A group of images will be selected in sequence by matching the represented value with the hidden data. The non-constructive-based methods can retain the image quality, but the hiding capacity is very low, and the sequence of the images must be maintained to correctly decode the hidden data.

As for constructive/synthesis-based data hiding methods, no "cover image" or "input image" is required. The "output image" is constructed by representing the data using points [1], patterns [7-8], features [3], or generated images [9]. In 2021, Ng et al. [9] proposed a coverless constructive-based data hiding framework (refer to Fig. 3), which generates art images using ACGAN (Auxiliary Classifier Generative Adversarial Network), mapping each art class to represent specific hidden binary value, then collage the art images and mask it to generate the final image as shown in Fig. 4 with hidden data.

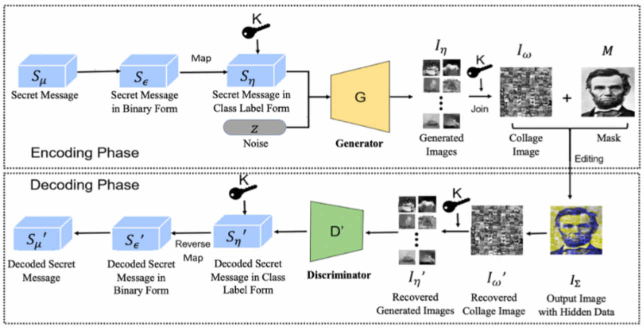

Figure 3: The coverless data hiding method using collage image [9].

Figure 4: Output image using collage image and mask [9].

All these coverless methods are proposed and tested with various experiments to evaluate them with the conventional data hiding methods. At the current stage of work and advancement of technology, it is found that coverless data hiding methods are much more possible and feasible as compared to decade ago. Using coverless approach shows that these methods not only able to avoid the attacks and limitations that applied to the conventional approaches, but it also opens another possible path in achieving various qualities in data hiding.

III The Usability

The usability is an important requirement when research is put into action and use in real life. For data hiding research, one of the biggest challenges now is to fill the real-world gap by encouraging the use of data hiding methods in the actual world. In every day, new data hiding techniques are proposed to improve the technical qualities, but these methods are simply proposed, experimented, and ended up just being archived in the publisher's database.

A preliminary study was performed on a group of university students to understand the possible causes of this gap [10-11]. In this study, it is observed that the user agreed that the importance of data hiding in protecting their digital images but feels cumbersome to perform additional steps in applying data hiding methods on their digital images

Let's imagine the user routine from capturing the image to uploading the final image to social networking site (SNS) in a mobile phone setting. First, user capture the image using camera, the light signal will be captured and processed to the required image format, enhanced to increase the image clarity and features. Then, user apply photo effects such as filter, border, text or adding objects to customize and personalize the image. Lastly, the image is uploaded to SNS and reformat or compressed to be stored in the database.

Considering the user routine, many image processing steps are performed in the process (refer to the italic words in the routine). Therefore, it is certainly possible to integrate data hiding into these image processing step(s) to reduce the hassle of doing additional steps to achieve data hiding. In our research group, several preliminary works have been proposed to test the feasibility of the proposed integration, and these works are broadly divided into two categories, data hiding in image enhancement techniques [13] and data hiding in photo effects [10-12].

In year 2020, we proposed integrating data hiding using Median Filter image enhancement technique [13]. Instead of choosing the median value to be replaced with the targeted pixel, the pixels in the pre-defined sized region are grouped into multiple partitions to carry distinctive binary values. The hidden data will decide which pixel partition that will be used for replacing targeted pixel. In 2020, William et al. [12] proposed to use Sketch, Halftone and Vintage effects, as shown in Fig. 5, to hide data. Later in 2021, Gong [10] and Tan [11] proposed to embed data using Mosaic filter, pencil drawing, pixel extension and collage effects. In addition, these new data hiding methods are put into a mobile application (refer to Fig. 6) as a proof of concept. Currently, these are the on-going works which later will be put into the feasibility and usability experiments to verify their performances. More detailed results will be reported in the future.

Figure 5: Data hiding using photo effects [12].

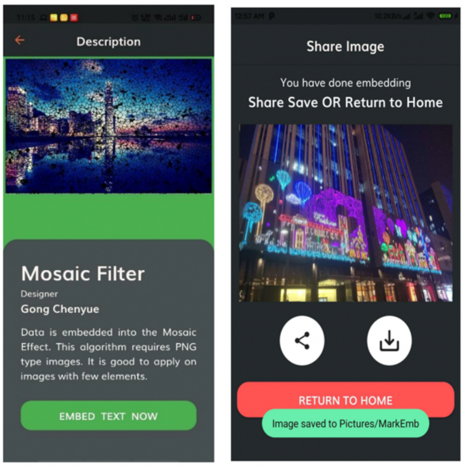

Figure 6: Mobile App prototype for Data Hiding using Photo Effects [10-11].

IV The Conclusion

In this article, two challenges in current data hiding research, viz., the limitation of using "cover image" in conventional framework, and the usability gap within data hiding research and real-world, are briefly explained. For the first challenge, some existing coverless data hiding methods are brought forward as possible solutions, because the coverless approach can avoid leaving modification traces on the cover image. As for the second challenge, data hiding techniques are proposed to integrate the hiding capability with the image processing step in user routine, including image enhancement and photo filters, to eliminate the extra steps required in using data hiding in real life scenario.

IV Acknowledgement

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