產品可靠性暨系統安全研發中心
CENTRE FOR ADVANCES IN RELIABILITY AND SAFETY

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CAiRS NEWSLETTER

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哲學博士（悉尼大學），倫敦帝國理工學院文憑，
電機電子工程師學會高級會員，
英國特許工程師，香港工程師學會會員

Centre for Advances in Reliability and Safety (CAiRS) working on different research projects of the five research programs focusing on product reliability and system safety. In this issue, we invited Prof. Kenneth Lam, Associate Dean of Faculty of Engineering, Department of Electronic and Information Engineering at The Hong Kong Polytechnic University and he leads one of our research programs “Anomaly Detection and Syndromic Surveillances” to share his research experiences for the readers of CAiRS newsletter.

產品可靠性暨系統安全研發中心(CAiRS)經已與業界開展多項不同的研究項目，主要針對產品的可靠及系統安全作重點研究。今期，我們邀請協助CAiRS專項研究有關異常檢測和症狀監測項目的香港理工大學工程學院副院長、電子及資訊工程學系林健文教授為今期CAiRS通訊任專訪嘉賓。

DEVELOPING RELIABLE VISUAL DETECTION AT DIFFERENT TIMES OF THE DAY
發展可應用在全天候不同時間的可靠視覺檢測

A Conversation with Professor Kenneth Lam
與林健文教授的對話

Professor Kenneth Lam is the Associate Dean of Faulty of Engineering at The Hong Kong Polytechnic University. He has published more than 120 journal articles and 150 conference articles. More than half of his publications are on face-image analysis and recognition.

林健文教授是香港理工大學工程學院副院長。他發表了120餘篇期刊文章和150餘篇會議文章。他的著作中有一半以上是關於人臉分析和識別的。

INTERVIEW

Would you share your opinions on how computer vision can help with the reliability of systems?
請分享一下有關電腦視覺如何幫助提高系統可靠性?

Nowadays, we are surrounded by different machines and systems. Machines do not know the world by themselves unless connected with sensors. Sensors play an important role in the construction of a reliable visual system. One of the commonly used sensors is a camera. Through a camera, we can detect the size of an object and what it is about; this ability is known as computer vision. By using image processing and pattern recognition, we can understand more about the objects we have detected. The other technique we normally use is machine learning. It is based on data-driven methods, and we can use different machine-learning-based algorithms to classify the patterns, which provide more meaningful and accurate results. For example, RGB cameras and thermal cameras can be employed for anomaly detection in systems. RGB cameras and multispectral light sources under different directions can be used for defect detection or automatic inspection, which are applicable for inspecting PCBs, wafers, and semiconductor units.

現今社會，我們生活在一個擁有不同的機器和系統包圍的環境中。除非機器已連接感應器，否則它們亦不瞭解這個世界。感應器在構建可靠的系統中起着重要的作用，相機鏡頭是常用的感應器之一。通過相機鏡頭，我們可以檢測出物體的大小及其形態，通常稱之為電腦視覺。通過圖像處理和規律辨識等方法，我們可以瞭解更多關於檢測到的對象。另一種常用技術是機器學習。它基於數據主導的方法，我們可以利用不同機器學習的算法對模式進行分類，從而提供更有意義和準確的結果。例如，RGB相機鏡頭和熱能感應鏡頭可以用於系統的異常檢測。RGB相機鏡頭和不同方向的多光譜光源可用於電路版、晶圓和半導體零件等的缺陷檢測或自動檢查。

What are the opportunities as a result of reliable detection?
請分享一下在可靠檢測見到的一些發展機遇?

The availability of high-resolution cameras and advanced learning algorithms in recent years has provided high-quality videos for surveillance and achieved more accurate and reliable detection. For example, when applied to face recognition, advanced algorithms make age-invariant face recognition feasible, while high-resolution cameras generate high-quality face images, such that pore patterns in facial skin can be detected and used for high-accuracy face recognition.

近年來，高清相機鏡頭及高階學習算法提高了保安系統中視頻記錄的質量和較準確可靠的檢測。例如應用在人臉識別上，高階算法可幫助實踐不受年齡影響的人臉識別。高清相機鏡頭提供高質的人臉圖像可用作透過人體毛孔的高準確度的人臉識別。

Figure 1 Age-invariant face recognition.
圖1 因應年齡變化的人臉識別技術

Figure 2 Example of high-resolution face recognition through pore-scale feature matching
圖2 利用人體毛孔特徵配對的高清人臉識別技術的例子

How do you consider the consistency of performance of outdoor object detection through the whole day?
對於在不同時間檢測戶外物體的穩定度有何看法?

Most of the current detection systems perform satisfactorily, in general, in well-controlled environments. However, in real-world applications, there are different situations that may affect the reliability and consistency of a visual-based detection system. Lighting conditions have a significant effect on the images captured by traditional RGB sensors, especially in a dark environment or at night.

Below is one of projects we are exploring for object detection, under different lighting conditions. A deep neural model is used for detection and classification. Multiple modalities of an input are fused, and features are extracted for detection and classification. Faster R-CNN, with a segmentation-based auxiliary task and attention mechanisms, is employed. RGB images and thermal images are the input to the deep model, which can achieve reliable and accurate detection performance under different lighting conditions, even at night, with the use of cross-modal feature learning.

現時大多數的檢測系統特別是在控制良好的環境下的基本性能成熟，然而在實際應用中視覺檢測系統的可靠性和一致性會受到不同情况的影響。光度對傳統RGB感應器捕捉到的影像有顯著影響，尤其是在夜間黑暗的環境中。

以下是一個我們正在探索在不同光度下偵測物體的項目，該項目使用一個深度神經網絡模型，融合輸入的多種模態來選取特徵，並且使用具有基於分段的輔助任務和注意力機制的Faster R-CNN的方法，從而進行檢測和分類。該深度模型以RGB影像和熱影像作為輸入，通過跨模態特徵學習，期望在不同光照條件下即使在晚上獲得更穩定的檢測結果。

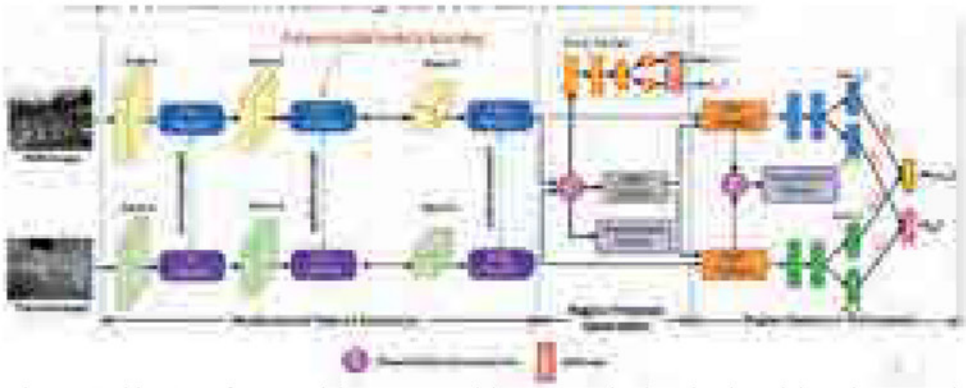


Figure 3 Architecture of proposed deep cross modal representation learning-based detection network
圖3 基於深度跨模態學習的檢測網絡架構

Would you share more about the next steps that can help with the practical application?
可否分享更多關於實際應用時的考量?

Cross-modal Representation Distillation is also employed for the design of a more efficient detector. As capturing multispectral data may be difficult or costly in some practical applications, knowledge distillation can be used. This is the process of transferring knowledge from a large model to a smaller one. Usually, a smaller deep neural network is trained. i.e. a “student” network, with a single RGB input is trained from a “teacher” network, with both RGB and thermal image inputs. After knowledge distillation, a simple student network is trained, as illustrated in Figure 4 below. The target is to use fewer inputs and simpler networks, which bring benefits in practical applications.

此系統還使用了跨模態的蒸餾作更有效的偵測。由於在某些實際應用中可能難以或較高成本去感測多光譜數據，因此可以使用知識蒸餾。這是將知識從大型模型轉移到小型模型的過程，通常會訓練一個較小的深度神經網絡。如下圖4所示，有一個RGB輸入的學生模型由包括在RGB和熱影像信息輸入的教師模型訓練。按此概念在實際應用中可使用更少輸入和更簡單的網絡從而帶來好處。

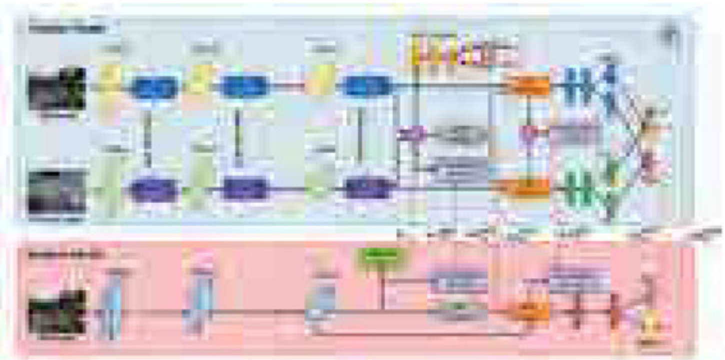


Figure 4 Illustration of cross-modal representation distillation
圖4 跨模態蒸餾的概念

All in all, there are lots of opportunities for computer vision to improve the reliability and consistency of visual detection and classification systems. Artificial Intelligence, machine learning and further analysis on different algorithms shall be the next steps to both reliability and safety enhancement in the coming years.

總括而言，在電腦視覺上有不同機會可以提高視覺檢測及分類的可靠性。未來幾年，人工智能、機器學習以及對不同算法的進一步分析將成為改善可靠性和安全性的其中一個發展方向。

COLOR CONTROL SYSTEM FOR RGB LED WITH APPLICATION TO LIGHT SOURCES SUFFERING FROM PROLONGED AGING

S. K. NG, K. H. LOO, MEMBER, IEEE, Y. M. LAI, SENIOR MEMBER, IEEE, AND CHI K. TSE, FELLOW, IEEE

Abstract—This paper presents a unified approach to controlling the white color point of the red/green/blue (RGB) light-emitting diode (LED) existing in all aging states. In contrast to conventional color control systems where the average driving currents of the primary-color LEDs can become saturated when the LEDs have undergone prolonged aging, which causes the resulting white color point to go out of regulation, the proposed method avoids this problem by adjusting the color set points when a predefined threshold current is reached by one or more of the primary-color LEDs. It is shown that the method can effectively maintain the white color point of RGB LED at the desired value when the primary-color LEDs are subjected to an accelerated aging through repetitive current stress cycles.

HIGH-BRIGHTNESS light-emitting diodes (LEDs) have been increasingly used for applications that require high luminosity and color accuracy, such as in the backlight system for liquid crystal display (LCD) monitors and LED projectors. These applications typically employ phosphor-coated white LEDs as the light source, and the drawback of using them is that the color temperature of the white light is predetermined by the chemical composition of the phosphor used and not directly controllable by external means. In addition, the color temperature of phosphor-coated white LEDs can vary significantly during their service lifetime mainly due to the aging of phosphor. This will lead to a degradation of color quality as a function of the service lifetime of the LED light source in these applications. To cope with these limitations of phosphor-coated white LEDs, for color-sensitive applications, an alternative method to produce white light that offers a better color control flexibility is obtained by mixing the light output of red, green, and blue (RGB) LED. Since these primary-color LEDs are individually controllable through their driver circuits, the color temperature of the white light produced by this method is also tunable to give different viewing moods or sensations to the users and to compensate for the aging effects of LED by means of feedback control. In general, two different approaches have been discussed in the literature for controlling the color point of RGB LED.

In the first approach, non-optical sensors such as thermal and electrical sensors are used in the feedback control. The forward voltages of the primary-color LEDs are measured in real time and correlated to their junction temperatures and luminous outputs according to a set of pre-calibrated curves. In this paper, the aging effect of the LEDs was not considered. A second feedback scheme based on the concept of photo power stabilization was proposed, where the electrical power consumption of the primary-color LEDs is adjusted according to a lookup table for compensating the effect of temperature variation on the luminous outputs of the primary-color LEDs. These methods, which are based on the measurement of electrical parameters and lookup tables, may lose their accuracy when the LEDs are aged and their electrical parameters have changed considerably from the initial values used in calibration, and this renders periodic calibrations necessary for maintaining color accuracy.

Fig. 1 shows the variations of the forward voltages of RGB as a function of the aging time in an accelerated lifetime test.

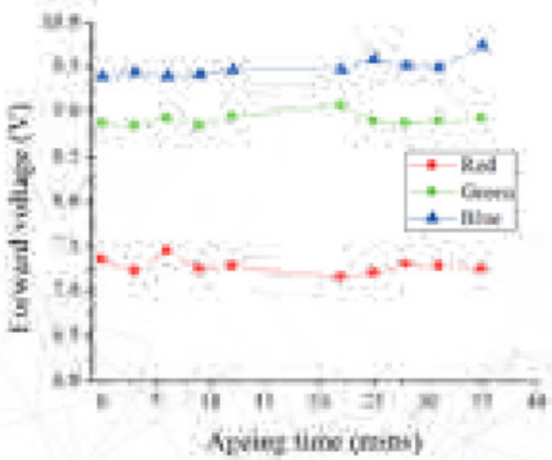
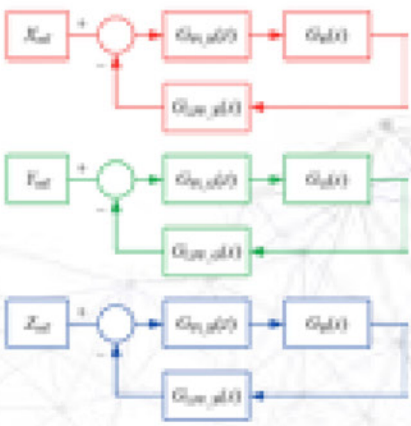
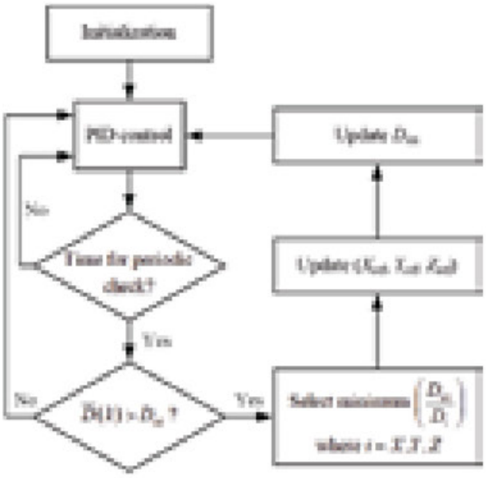


Fig. 2 shows the control block diagram of a conventional color control system for RGB LED based on optical sensing.



In the second approach, optical sensors are used to detect the luminous output of the primary-color LEDs and regulate it against some predefined references through PID controllers. When their luminous output deviates from the reference values, the changes are detected by optical sensors, and the controllers will restore their luminous output to the desired values in real time.

<u>**The proposed color feedback control**</u>



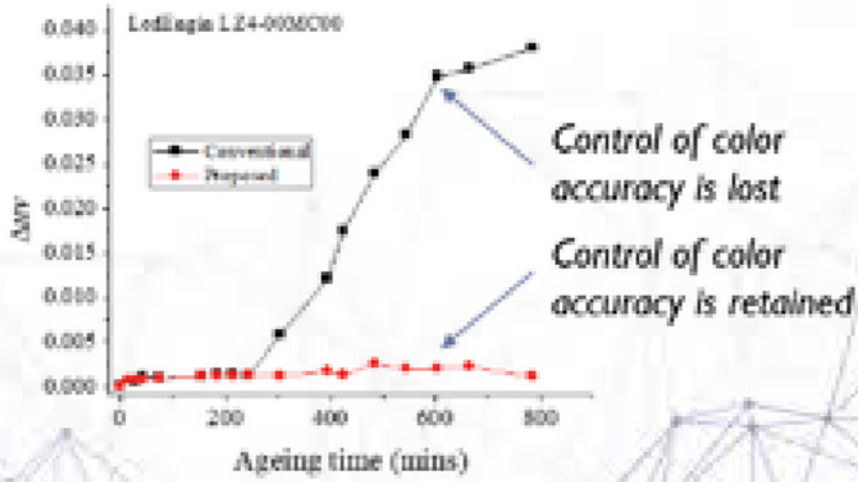
<u>**Experimental verification (LedEngin)**</u>

Conventional method:
Duty cycle for green LED saturated after 245 mins of ageing. No regulation of color point is possible after that. Hence, 245 mins can be regarded as the end-of-life of the RGB LED lighting system.

Significant color variation was resulted after 245 mins of ageing.

Proposed method:
No significant color variation

Luminous flux decayed to 70% (typical threshold used to indicate the end-of-life of LED) at 550 mins while the color point remains well regulated.



CAiRS HIGHLIGHTS

「系統可靠性及維護—企業成功關鍵」網上研討會

WEBINAR ON "SYSTEM RELIABILITY AND MAINTENANCE - KEY SUCCESS FACTORS FOR YOUR BUSINESS"

由產品可靠性暨系統安全研發中心主辦、香港電子業商會、香港電子業總會及香港科技園支持主辦『系統可靠性及維護—企業成功關鍵』網上研討會，已於2021年1月15日假「產品可靠性暨系統安全研發中心」舉行。

是次網上研討會邀請到海外及本地著名學者及業界代表出席，包括來自美國CALCE中心的兩位專家，分別是：Dr. Michael H. Azarian, Chair of the SAE G-19A Test Laboratory Standards Development Committee, Co-chairman of the Miscellaneous Techniques sub-group of the G-19A committee, Dr. Diganta Das, Vice chair of the standards group of IEEE Reliability Society, Sub group leader for the SAE G-19 counterfeit detection standards group，主要為我們分享預測系統穩定的可行性及對系統維護管理等方面研究。本地方面，我們邀請到香港電燈有限公司輸配電科技術服務主管—郭偉信工程師及香港理工大學電機工程學系副教授—卜思齊博士。兩位專家分別為業界分享有關應用人工智能技術提升電網穩定及安全；以及有關如何利用數據技術提升電力網絡的穩定及安全性。最後由"產品可靠性暨系統安全研發中心" (CAiRS)總監及執行董事 - 容錦泉教授為網上研討會作總結。

想了解更多關於CAiRS的最新消息及活動資訊，歡迎大家到CAiRS網站

www.cairs.hk 或關注CAiRS 臉書。

Organized by "Centre for Advances in Reliability and Safety" (CAiRS), supported by the Hong Kong Electronic Industries Association (HKEIA), Hong Kong Electronics Industry Council (HKEIC) and the Hong Kong Science & Technology Parks (HKSTP), Webinar on "System Reliability and Maintenance - Key Success Factors for your Business" was successfully completed on 15 Jan 2021.

In the Webinar, we have invited overseas and local professional experts, and renowned industrialist included Dr. Michael H. Azarian of CALCE, Chair of the SAE G-19A Test Laboratory Standards Development Committee, Co-chairman of the Miscellaneous Techniques sub-group of the G-19A committee, Dr. Diganta Das of CALCE, Vice chair of the standards group of IEEE Reliability Society, Sub group leader for the SAE G-19 counterfeit detection standards group, Ir Wilson Kwok, Head of Technical Services, Transmission & Distribution Division of the Hong Kong Electric Co., Ltd., and Dr. Siqi Bu, Associate Professor of the Hong Kong Polytechnic University. They shared their research, application and industrial experiences on system reliability and maintenance. Prof. Winco Yung, Executive Director and Centre Director of CAiRS delivered closing remarks for the webinar.

For more information and details of the webinar or upcoming activities, please visit our CAiRS website www.cairs.hk or follow our facebook #CAiRS.

網上研討會開始前合照
Guest speakers pose a group photo at the webinar.

與海外的專家直播時的情況
Live broadcasting with overseas experts at the webinar

香港電燈有限公司輸配電科技術服務主管–郭偉信工程師
Ir Wilson Kwok, Head of Technical Services, Transmission & Distribution Division of the Hong Kong Electric Co., Ltd.

香港理工大學電機工程學系副教授–卜思齊博士
Dr. Siqi Bu, Associate Professor of the Hong Kong Polytechnic University

(CAiRS)總監及執行董事 – 容錦泉教授為研討會致詞及作總結
Prof. Winco Yung, Executive Director and Centre Director of CAiRS delivered closing remarks for the webinar.

(CAiRS)項目經理–曾志煒博士為研討會擔任司儀
Dr. Dennis Tsang, Programme Manager of CAiRS, MC and moderator of the webinar

WEBINAR

RELIABILITY ENHANCEMENT OF ELECTRONIC PARTS, PRODUCTS AND SYSTEMS

This webinar is organized by "Centre for Advances in Reliability and Safety" (CAiRS). In the Webinar, local and overseas professional experts and renowned industrialist will share their industrial and research experiences on reliability of electronic parts, products and system.

Date 25 March 2021 (Thursday)
Time: 10:00 AM – 12:40 PM
Format: Webinar
Language: English

Register here:

25 Mar 21 **HK Time**	24 Mar 21 **US Time**	**Topics & Guest Speakers**
10:00 - 10:05	21:00 - 21:05	**Welcome Remarks**
10:05 - 10:35	21:05 - 21:35	**Section 1: Unsupervised Machine Learning Techniques in Prognostics of Power Electronics** Dr. Diganta Das, CALCE, Vice Chair of the standards group of IEEE Reliability Society, Sub group leader for the SAE G-19 counterfeit detection standards group
10:35 - 11:05	21:35 - 22:05	**Section 2: Reliability Prediction of Electrical Hardware** Dr. Michael Osterman, CALCE, Senior member of IEEE, Member of ASME, IMAPS and SMTA
11:05 - 11:20	22:05 - 22:20	**Part 1 Q & A**
11:20 - 11:50	22:20 - 22:50	**Section 3: Reliability, Intelligent Performance Monitoring and Lifetime Prediction of Thermal Imaging Sensors** Dr. Stanislav Markov, Data Scientist, Meridian Innovation Limited
11:50 - 12:20	22:50 - 23:20	**Section 4: Enabling High Reliability Power Module** Mr. Peter Ng, Vice President, Enabling Technology Group, ASM Pacific Technology Ltd.
12:20 - 12:35	23:20 - 23:35	**Part 2 Q & A**
12:35 - 12:40	23:35 - 23:40	**Closing Remarks** Prof. Winco Yung, Executive Director & Centre Director of CAiRS

TECHNICAL SEMINAR

CAiRS will organize a Technical Seminar on 20 April 2021, for updated information of both Webinar and Technical Seminar, please visit CAiRS website: www.cairs.hk.

CAiRS HIGHLIGHTS

我們非常榮幸經已有20間公司與我們協作，其中有12間是從事先進製造（以下的商標是按字母排名）。
We are honored that there are 20 collaborating companies working close with CAiRS, 12 of which are engaged in advanced manufacturing industries. (listed below in alphabetical order)

ASM | AMC SINCE 1966 Power for Excellence | Defond | GERMAN POOL 德國寶 | GP Batteries International Limited 金山電池國際有限公司 | LAMBDA SENSE | MERIDIAN Innovation | ProVista GROUP PROVISTA • PRECISION • PROTRONIC

*Names are listed in alphabetical order.

CAiRS將於三月份增添下列多款儀器設備:
CAiRS will install the following equipment in our lab:

Equipment	**Temperature and Humidity Chamber**	**Benchtop Vibration Tester**	**Interrogator**
			
Description	Durability testing of a package undergoing extreme temperature variations over a given period of time.	Reliability testing of compact products and electronics. The Multiple Degree of Freedom (MDoF) testing to enhance product reliability with the added benefit of possible test time compression.	Optical sensing equipment for FBG sensor
Industrial Applications	1. Electronic Products 2. Semiconductor 3. Automotive / Electric Vehicle 4. Machinery 5. Electrical Equipment	1. Machinery 2. Automotive / Electric Vehicle 3. Electronic Products	1. Machinery 2. Electrical Equipment

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