

PolyU breakthroughs to help millions of children

理大科研突破 造福千萬兒童



The maintenance of childhood health is a critical measure of how a society looks after its own. PolyU is at the forefront of such efforts and has recently generated two breakthrough methods of dealing with childhood disease. A research team from the School of Optometry has developed a 'DISC' contact lens that takes advantage of the natural homeostasis in the eye to correct myopia, which is common among children in Hong Kong.

Another team, from the Department of Health Technology and Informatics, has developed a three-dimensional ultrasound imaging technology to overcome the limitations of conventional examinations for scoliosis, a condition that can lead to years of suffering for children and worry for their parents. Both award-winning advances have the potential to be used in other areas to benefit even more children both in Hong Kong and around the world.

一個社會如何保障兒童的健康，可以反映它怎樣平衡自身的健康發展。理大在照顧兒童健康方面走在前沿，最近更研發出兩個突破性方法處理兒童病症。眼科視光學院的研究團隊發明了「光學離焦」軟性隱形眼鏡，它利用眼睛的自然回饋機制，來糾正許多香港兒童患有的近視問題。

另一醫療科技及資訊學系的團隊，則研發出一項打破傳統脊柱側彎檢測限制的三維超聲波成像技術，惠及因患這病而長期受苦的兒童及其憂心的家長。這兩項獲獎發明都有可能應用於其他領域，造福更多香港及世界各地的兒童。



A student trying out the DISC lens in the clinical trial.
學童參與臨床研究中，試戴「光學離焦」軟性隱形眼鏡。

A Defocus Incorporated Soft Contact (DISC) lens to combat childhood myopia

Myopia, a major cause of ocular morbidity and blindness, could be affecting as many as 2 billion people worldwide. It has a particularly high prevalence amongst the world's youth. In Hong Kong around 17 per cent of Primary One students have myopia¹, and that figure rises to 80 per cent in the young adult population. Seven hundred million people in mainland China are expected to become myopic within the next 20 to 40 years². Yet until recently there was no clinically acceptable way of controlling the

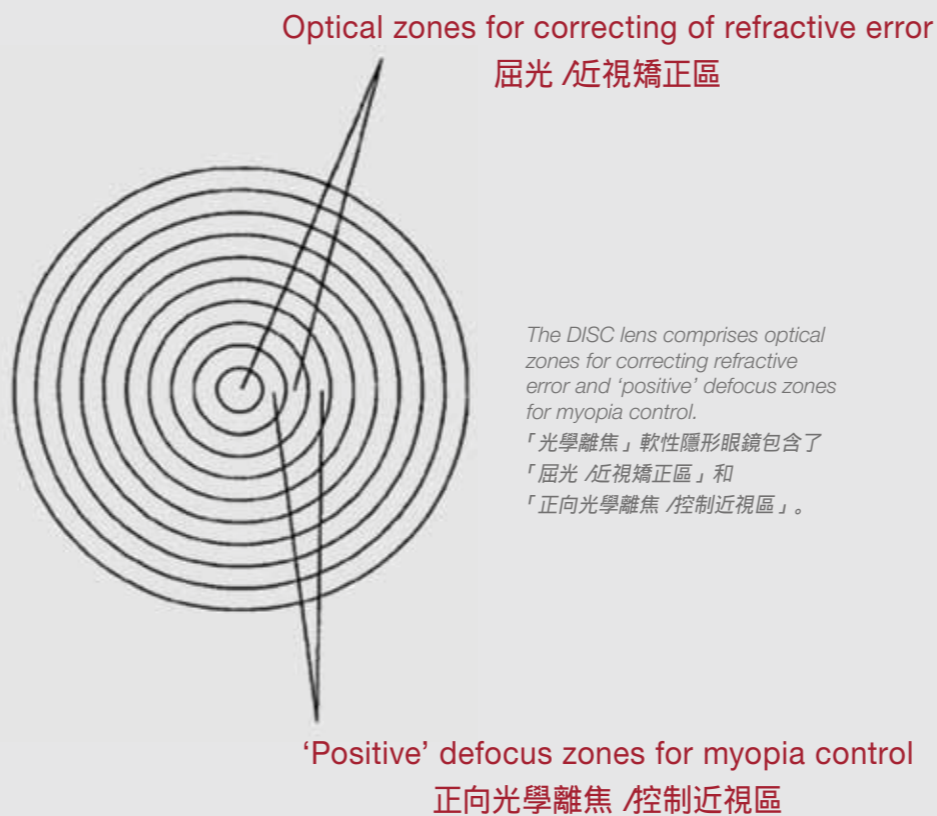
progression of myopia. A team from the Centre for Myopia Research under the School of Optometry of PolyU, consisting of Prof. To Chi-ho and Prof. Carly Lam, has now addressed that situation by developing the Defocus Incorporated Soft Contact (DISC) lens.

The patented method behind the multi-zone bifocal lens works on equalizing the physical and optical lengths of affected eyes. When a child has myopia, the light that enters the eye focuses in front of the retina rather than on it. Prof. To said, "The new method involves producing first an image on the retina and then a second image to generate a defocus. In doing so the DISC lens makes use the natural homeostatic mechanism known as 'emmetropization', whereby the eye tends toward a shape that allows it to receive focused images as it would

利用「光學離焦」軟性隱形眼鏡改善兒童近視情況

「近視」是其中一種可引起眼疾和導致失明的重要因素，它影響全球近二億人，在年青人中尤其普遍。在香港，大約百分之十七的小學一年級學生患有「近視」¹，而在年輕的成年人當中，該數字更躍升至百分之八十。據估計，在二十至四十年後，中國內地將有七億人患上「近視」²，可惜一直未有任何臨床可接受的方法來控制近視加深的速度。直至最近，理大眼科視光學院近視研究中心杜嗣河教授及林小燕教授組成的研究小組，成功研發了嶄新的「光學離焦」軟性隱形眼鏡，改變兒童近視情況。

這項技術的原理是利用一種多區域的雙光鏡片來平衡眼球的實際長度和光學長



The DISC lens comprises optical zones for correcting refractive error and 'positive' defocus zones for myopia control.
「光學離焦」軟性隱形眼鏡包含了「屈光 / 近視矯正區」和「正向光學離焦 / 控制近視區」。



The newly developed lens is made up of 10 layers of DISC and normal radians.
新設計的隱形眼鏡由十層「光學離焦」弧度和正常弧度組成。

do with normal vision, i.e. the size and shape of the eye is regulated by optical inputs from the environment."

The lens improves visual acuity, clearing the wearer's vision, and provides constant myopic defocus ("STOP" signal to myopia) at all viewing distances. Indeed, the defocus method is so effective that it can be incorporated into various commonly used forms of contact lens.

The major benefits of the new method are that it avoids the adverse effects of treatment with drugs or surgery and is effective in a high percentage of cases. The research team recently completed the world's first clinical double-blind control trial of DISC lenses. Spanning two years with a sample of 80 myopes, the trial showed that DISC lenses retarded the progression of

myopia by approximately 50 per cent in Hong Kong school children aged 8 to 13. More importantly, the children found the lenses comfortable to wear. The new lenses also provided clarity that was comparable to conventional single vision lenses, which deliver the same optical focal point over their entire area.

The team sees promise in these findings, but will need to assess the effects over a longer period to understand the lasting benefits of the new method. Such efforts will be very important regionally, given that myopia is widespread in cities such as Guangzhou, Shanghai, Beijing, Taipei, Tokyo, Seoul and Singapore. Around the world, the DISC lens has the potential to reduce myopia by 50% in 1.6 billion people and save the sight of up to 60 million people.

度，有關技術已獲得專利。當兒童患有「近視」，進入其眼睛的光線會聚焦在視網膜前方，而非視網膜上。杜教授表示：「戴上這嶄新鏡片後，首先一個影像會在視網膜上產生出來，繼而另一個離焦影像亦會出現。這樣，鏡片就是利用了眼睛的自然回饋機制——『正視化現象』，使眼睛傾向一個讓它能以最接近正常視力般聚焦的形狀，亦即是說，令眼球的大小和形狀因應在環境中所接收到的光學訊號而產生改變。」

這種鏡片既能提供清晰的視力，亦同時令佩戴者不斷接收各個視覺距離的「正向光學離焦」(即抑制近視形成)的訊號。該離焦方法非常有效，更可與各種常見的隱形眼鏡合併使用。

「此技術主要的效益在於佩戴者可以避免因藥物或手術造成的不良反應，而在很多試戴個案中亦有顯著成效。」杜教授說。最近，研究團隊以「光學離焦」隱形眼鏡完成了全球首次雙盲對照臨床

¹Student Health Service, Department of Health, HKSAR Government
香港特區政府衛生署學生健康服務
http://www.studenthealth.gov.hk/english/health/health_ev/health_ev_nea.html

²Centre for Myopia Research, PolyU School of Optometry
理大眼科視光學院近視研究中心
<http://www.polyu.edu.hk/so/asd1/hm/centre.htm>



Prof. Carly Lam (left) and Prof. To Chi-ho
林小燕教授(左)及杜嗣河教授

On a wider scale, the process of optical defocus put to work in the DISC lens could benefit the treatment of other forms of refractive error such as hyperopia, which is usually known as long-sightedness and involves a focus behind rather than in front of the retina.

In July last year, Prof. Carly Lam represented the team in giving an invited speech on the lens at the 13th International Myopia Conference in Tübingen, Germany. The invention also won the Gold Award with the Congratulations of the Jury and the Grand Prize of the Technical University of Cluj-Napoca, Romania at the 39th International Exhibition of Geneva in Switzerland during April this year.

This new technology has already been patented in Australia, the Chinese mainland, the US and various European countries. Hopefully, DISC lens will be introduced to the market very soon.

測試。為期兩年、八十位近視患者參與的測試顯示，「光學離焦」軟性隱形眼鏡能夠有效放緩香港學童（八至十三歲）的近視加深速度達百分之五十。參與測試的兒童更覺得佩戴此隱形眼鏡時感覺舒適。這新鏡片提供可媲美傳統單光鏡片的清晰程度，並在全塊鏡片上傳遞同樣的光學聚焦點。

研究結果令人鼓舞，但仍需進行更長時間的評估，以瞭解這新技術的持久效益。這「光學離焦」軟性隱形眼鏡對近視率偏高的區內城市尤其重要，如廣州、上海、台北、東京、首爾及新加坡。它有可能幫助減低全球一億六千萬人的近視深度達百分之五十，並拯救六千萬人的視力。

廣泛而言，此技術所用的「光學離焦」程序對治療遠視等其他屈光不正問題亦有幫助，因為遠視是因進入其眼睛的光線聚焦在視網膜後方，而非視網膜上。

去年七月，林小燕教授應邀出席在德國圖賓根舉行的第十三屆近視國際會議，並發表了演講，介紹有關研究。今年四月，這項發明在第三十九屆瑞士日內瓦國際發明展中奪得評審團特別嘉許金獎，以及羅馬尼亞克盧日納波卡科技大學 - 特別大獎。

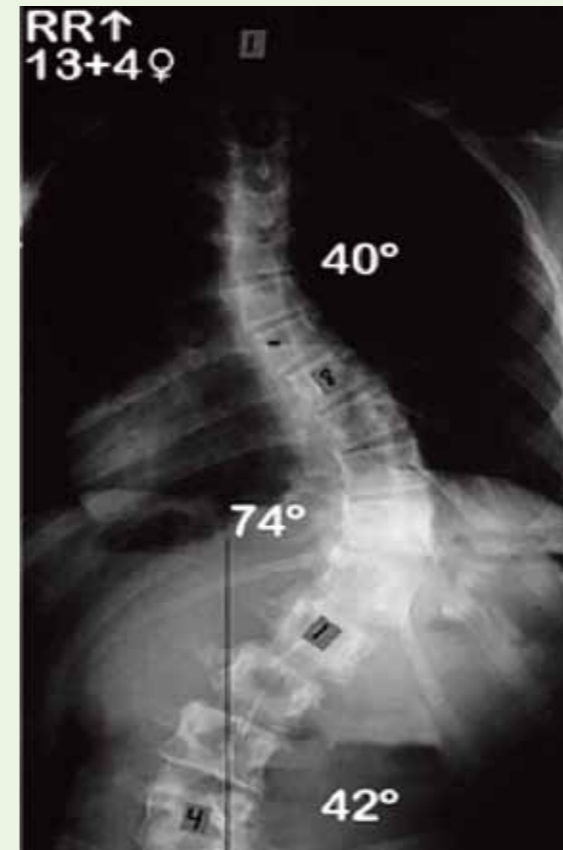
該新技術已取得澳洲、中國內地、美國及歐洲多個國家的專利。「光學離焦」軟性隱形眼鏡可望在不久的將來推出市場。

True scoliosis situation captured in radiation-free 3D ultrasound technology

Another significant burden carried by children worldwide is scoliosis, or curvature of the spine that may also involve rotation of spinal bones. This debilitating condition affects approximately 12 million people worldwide, including around 2 to 4 per cent of Hong Kong's population. In particular, adolescent idiopathic scoliosis pushes the spine sideways into an abnormal S or C shape. Children who suffer from the disease face years of repeated clinic visits, examinations and treatments, and parents share their anxiety and frustration.

無輻射三維超聲波技術 準確反映脊柱側彎實況

全球兒童面對的另一沉重負擔就是脊柱側彎問題（即脊柱彎曲），這亦有可能導致脊柱骨旋轉的情況。這嚴重的問題正影響全球一千二百萬人，在香港就有百分之二至四的人口受脊柱側彎的影響。當中，青少年特發性脊柱側凸的情況，更會把脊柱推側至異常的S或C形狀。患有這病的兒童要面對經年累月的覆診、檢查及治療，而家長亦同樣感到焦慮和沮喪。



A female subject with scoliosis and the X-ray image of her spine curvature
一位脊柱側彎的女病人及其脊柱彎曲情況的X光影像

Collection of 3D ultrasound images from that subject using an ultrasound probe with spatial sensor
以空間傳感器獲取該病人的三維超聲波影像



Prof. Zheng (second from right) and his research team
鄭教授(右二)及研究團隊

Scoliosis deformities can be halted, or even reversed in some cases, but that takes many years of treatment, therapy and x-ray examinations. For children, the recommended yearly limit of full-body x-rays is one, given the radiation involved. To consider this from a slightly different perspective, children with scoliosis can only be physically examined or have their treatment assessed once a year.

Clearly this limited observation regime is not beneficial for the timely treatment of scoliosis, which is why a group of researchers from PolyU's Department of Health Technology and Informatics turned to ultrasound imaging. Led by principal investigator Prof. Zheng Yongping, the researchers have developed a ground-breaking and cost-effective ultrasound technology that can produce a three-dimensional image of a deformed spine.

Ultrasound is rarely used in the imaging of bones because the waves do not pass well through their hard structures. However, the new technology uses

that weakness to its advantage. Ultrasound waves are mainly blocked by the spine, which shows up on a monitor as a bright region in B-mode images. During a scan the operator sweeps the ultrasound probe gently along the standing patient's spine, each time generating images that are two-dimensional (2D) slices of the body. A full three-dimensional (3D) model of the spine is then built up on a computer running customized software based on the spatial information of each 2D image.

"The resulting spine model can be rendered, manipulated, viewed in 3D, and even projected into a 2D image, similar to an X-ray image, for the patient's actual curve measurement," explained Prof. Zheng.

X-ray images only show bone density in their projection planes and the measurement for spinal deformity based on such images is not accurate enough and somehow subjective. Furthermore, the measurement based on X-ray images cannot provide the rotational deformity of spine. Although

其實，某些脊柱畸型的發展是可以停止甚至逆轉的，但需要經過長年的治療和X光檢查。由於輻射的原故，醫生建議小童最多每年只可以作一次全身的X光檢查，也就是說，患脊柱側彎的兒童每年只可作一次有關的檢查或治療評估。

以觀察病情來說，這限制明顯地不利於脊柱側彎的及時治療，有見及此，一群理大醫療科技及資訊學系的研究人員致力鑽研超聲波成像技術。這項目的首席研究員鄭永平教授領導的團隊，開發了具突破性和成本效益的超聲波技術，以擷取變形脊柱的三維影像。

一直以來，超聲波技術是很少用於骨骼檢查的，這是因為超聲波不容易穿透堅硬的骨骼。然而，這新技術就是把這弱點變成優勢。超聲波通常都會被脊柱阻擋，因而在顯示器上呈現一個有B模式影像的光亮區域。在進行掃描時，控制員以傳感器掃描站立病人的脊柱，每幅影像都是穿透身體的二維切片，繼而利用特別設計的電腦軟件，並基於每幅二維影像的空間信息，來組合成一個三維的脊柱模型。

鄭教授解釋道：「組合後的脊柱模型，可以三維或類似X光的二維影像展示，方便評估病人實際脊柱彎曲的情況。」

X-ray computed tomography (CT) and magnetic resonance imaging (MRI) can provide 3D images, they normally require subjects to lie down during scanning, which will affect the accuracy of the spinal deformity measurement. Both CT and MRI are expensive with complicated procedures. On the other hand, the new radiation-free ultrasound method is relatively low-cost and can generate a full 3D model of spine in standing posture that reveals lateral curvature with the sort of accuracy effective treatment relies on. This could even show the way forward for the imaging of bone surfaces by ultrasound.

"Because it is completely radiation free, the method allows scanning as often as needed, which means that examinations can be performed at any time," Prof. Zheng said. Physicians will be able to better personalize treatment, which will speed up recovery that would otherwise take several years. The unit is also highly mobile, comprising only the ultrasound device, a spatial sensor, the framework in which the patient stands and a computer. As it

can be installed almost anywhere, it will be ideal for the mass screening of scoliosis during regular body checks for children. Thus, it can help to detect scoliosis at a much earlier stage for more effective treatment.

The research group is now conducting clinical trials of the technology in collaboration with local clinics and hospitals. It holds three patents for the system and is in discussions with a local firm about licensing the technique used. Commercialization should be achieved within the next two years. In addition to this new technology, the research group owned some 20 patents related to medical and healthcare devices. For details, please visit <http://ultrasound.asia>.

In October last year, this novel invention won a Silver Medal at the 62nd International Trade Fair Ideas – Inventions – New Products in Nuremberg, Germany. With this important recognition and imminent commercialization, the invention will soon be benefiting thousands of young scoliosis patients.

X光片只能顯示有關骨骼密度的投影，基於這些影像而量度出的脊柱側彎情況並未夠準確，而且含有主觀因素。此外，以X光影像作測量，未能量度脊柱旋轉變形的情况。雖然X光電腦掃描(CT)和核磁共振成像(MRI)都可以提供三維立體影像，但由於在掃描過程中要求病人躺臥，因而會影響測量脊柱變形的準確性。X光電腦掃描和核磁共振成像檢驗都比較昂貴和操作複雜。然而，這全新無輻射超聲波技術則比較便宜，更可給出人體在站立姿勢的整個脊柱的三維模型，以準確顯示和測量側彎程度，並有利治療。它更有可能發展為以超聲波作骨骼表面成像的技術。

鄭教授表示：「這項新技術全無輻射，可按需要頻密地進行掃描，也就是說，任何時間都可進行檢查。」以前，有關治療可能需時數年，但有了這新技術，醫生就可為病人制訂更佳的治療方案，加快痊癒所需時間。另外，這儀器亦易於安裝，只包括超聲波裝置、空間傳感器、病人用以站立的框架、以及一台電腦。它可設置於任何地方，最適合用於兒童身體檢查中普查脊柱側彎的情況。如及早發現兒童患上脊柱側彎的毛病，就可迅即展開有效的治療。

研究小組正與本地診所和醫院合作，對該儀器進行臨床試驗。此外，小組現正與本地一家公司洽談授權製造該儀器，其中涉及三項專利，並有望在一至兩年內推出市場。除了這項新技術之外，該研究小組亦獲得約二十項有關醫療及護理儀器的專利權。詳情請瀏覽：<http://ultrasound.asia>。

去年十月，這新發明在德國紐倫堡市舉行的第六十二屆「國際創意、發明及新產品展」中奪得銀獎，備受推崇。該技術的商品化程序即將完成，相信很快便可為患有脊柱側彎毛病的年青人帶來福音。❖