April, 2015　第16期

醫工學會 E-Newsletter

http://www.bmes.org.tw/

中華民國生物醫學工程學會

Taiwanese Society of Biomedical Engineering

更多醫工動態盡在醫工學會電子報，請即刻閱讀！
學會為了嘉惠醫工大家庭，100年4月回復電子報發行，預計每三個月出刊一期，敬請期待，對於本學會電子報，有任何意見，歡迎來電指教
(06) 2760665

目錄

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【張冠諒教授紀念獎學金】

本學會 104 年度張冠諒教授紀念獎學金開始接受申請，申請日期自即日起至 2015 年 5 月 31 日截止（以郵戳為憑），請有意願申請者儘速將報名文件寄至：701 台南市東區大學路一號國立成功大學醫工系轉醫工學會。
更多訊息以及相關表單敬請參閱醫工學會網站最新消息：
http://www.bmes.org.tw/notice_show.php?id=385

【2015 第四屆醫工盃】

2015 年第四屆全國大專院校醫工盃聯誼賽將於 104 年 7 月 11 日至 7 月 12 日假國立臺灣大學舉行，邀請各大專院校醫工相關系所踴躍報名參加進行交流。詳情請參閱「2015 醫工盃在台大」：https://www.facebook.com/bmecup2015

一、活動名稱：2015 第四屆全國大專院校醫工盃聯誼誼賽

二、主辦單位：國立台灣大學生醫電子與醫訊學研究所
國立台灣大學醫學工程研究所

三、活動時間：中華民國一零四年七月十一日（六）至七月十二日（日）

四、活動地點：國立台灣大學總區舊體育館、戶外籃球場（中央、新生）、
戶外排球場、網球場、總區新體育館桌球室、羽球室

五、參加對象：全國醫學工程相關科技之大學部（含雙主修，不含輔系）、碩士班、博士班學生。學生以一零三學年度第二學期正式註冊之再學生為限。一人可以報兩種項目，若遇時間衝突必須擇一棄權。體保生是否可參賽請見各球類章程規定。
※不含教職人員，這點與往年的不一樣請各校注意

六、比賽項目：7 月 11 日至 7 月 12 日：男女籃、男女排、網球團體賽
7 月 11 日：羽球團體賽、羽球個人賽、桌球團體賽、桌球個人賽

七、報名期限：2015 年 3 月 20 日（五）至 2015 年 4 月 30 日（五）11:59 截止

八、報名方式：以隊伍為單位，一律採線上報名，不接受紙本報名。
報名表連結 http://form.jotform.me/form/50718282520451

【2015 生物醫學工程科技研討會】

本年度的「2015 年中華民國生物醫學工程學會生物醫學工程科技研討會」，由國立臺灣大學生醫電子與資訊學研究所及醫學工程學研究所共同承辦，2015 年 11 月 13 至 14 日於國立臺灣大學博理館、電機二館、明達館舉辦。

除了擬聘請國內外生醫工程領域的專家學者外，也將廣邀產業界的相關人士前來分享，使與會者可藉如此難得的機會接觸到生醫工程領域的科學新知與發展趨勢。本次研討會將舉辦數場研究生物醫學及生物工程學術的學術講座、專題活動，希望增加生醫工程各領域間的跨領域合作，促進臺灣生醫工程科技的研究整合，以培養出兼具廣度及深度的跨領域人才來帶動臺灣生技產業的升級。

欲瞭解更多詳情，請見研討會網站：http://bmes2010.xwing.com.tw/2015

一、會議日期：2015 年 11 月 13 日（五）至 11 月 14 日（六）

二、會議地點：國立台灣大學校總區博理館、電機二館、明達館

三、主辦單位：國立台灣大學
中華民國生物醫學工程學會

四、承辦單位：國立台灣大學生醫電子與資訊學研究所
國立台灣大學醫學工程學研究所

五、協辦單位：國立台灣大學醫療器材研發中心

六、重要日程：

論文投稿

開放上傳論文	2015 年 08 月 01 日
論文截止收件	2015 年 09 月 15 日
論文審查截止	2015 年 10 月 06 日
論文接受通知	2015 年 10 月 12 日

註冊繳費

開放註冊繳費	2015 年 08 月 15 日
註冊優惠截止	2015 年 10 月 31 日
線上註冊截止	2015 年 11 月 06 日

國立交通大學生物醫學工程研究所—

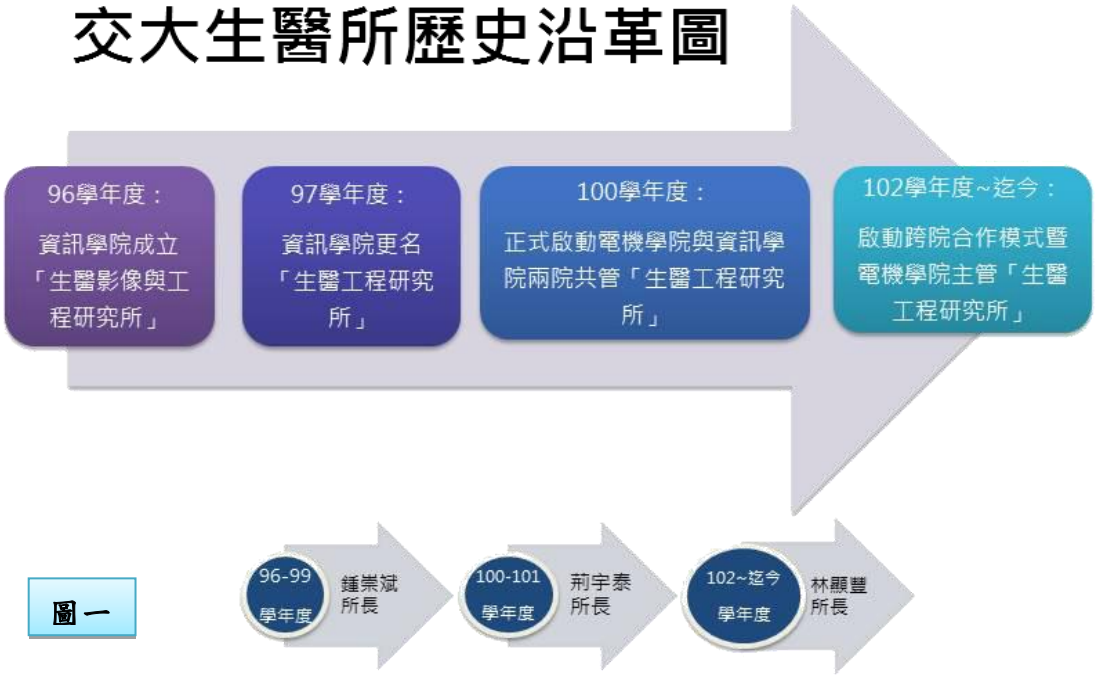
資通電生醫平台·產學研創新整合

從「生醫影像與工程所」到「生醫工程所」

本校於 96 學年起訂定持續發展生醫工程之目標，並以紮實的電子資訊科技與產業作為建構基礎，為此，由資訊學院成立生醫影像與工程研究所，而創所初期之揭立宗旨為：

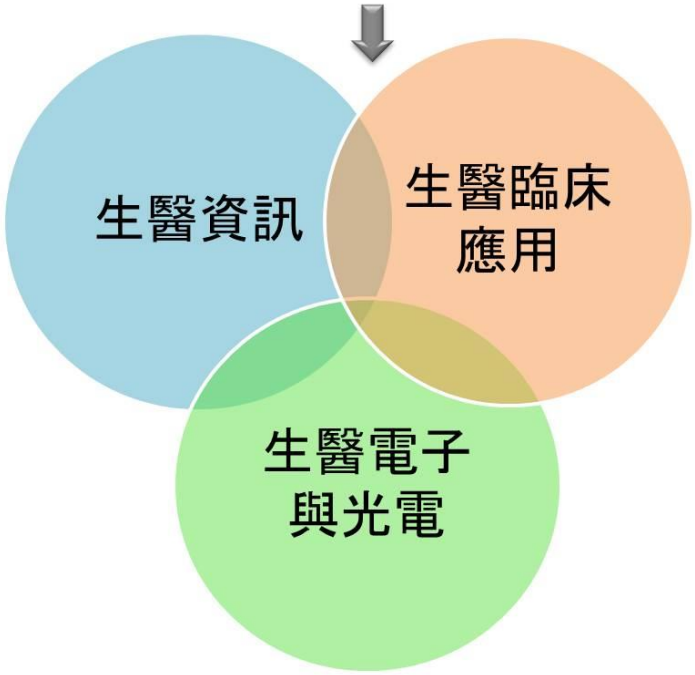
- 建立工程與科學之整合平台
- 培養具備生物、醫學與工程知識之研究人才
- 進行生醫工程相關跨領域與突破性的研究
- 開創未來的新科技產業

如圖一的歷史沿革圖所示，創所之時由鍾崇斌教授帶領生醫影像所，到了97學年度後則更名為生醫工程研究所。100學年正式啟動電機與資訊學院兩院共管生醫工程研究所，並由荊宇泰教授接棒擔任所長。至102學年上學期起再改成跨院合作模式經營，與資訊學院、理學院、工學院和生物科技院合作，並由林顯豐教授擔任所長至今，102學年度下學期奉教育部同意調整行政隸屬於電機學院，並於103學年度起定案，於電機學院下成立生醫工程研究所。



圖一

資通電生醫平台·產學研創新整合



圖二

杭學鳴院長

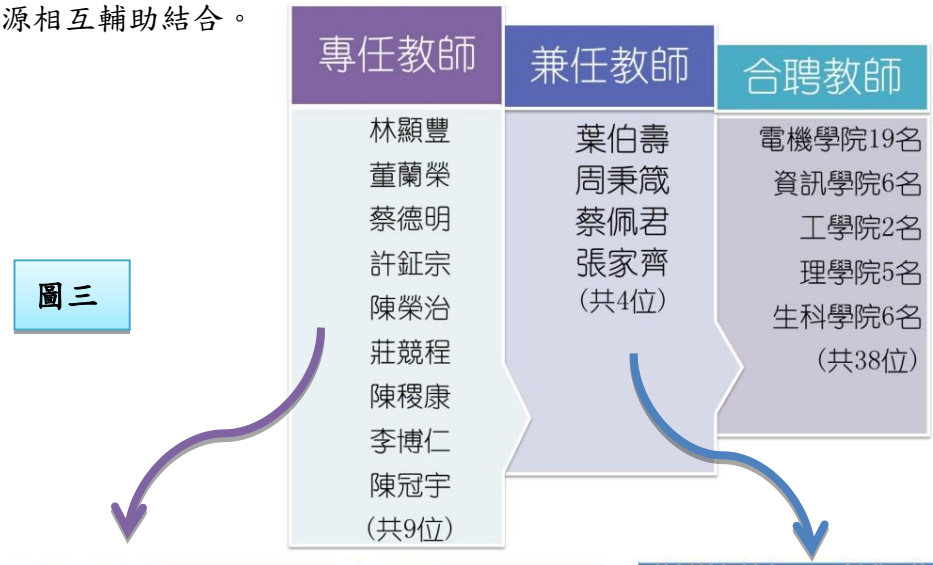
何謂「資通電生醫平台·產學研創新整合」？電機學院杭學鳴院長說：「(生醫所)若先結合本校的強項，在未來的發展將會越不同。」交通大學在民國四十七年就設立全台第一個電子研究所，到現在電機、資訊學院的教師人數約占全校教師人數的百分之四十，擁有極高比例的師資群。另外，在產業界裡，從電機與資訊學院畢業的校友也屢有傑出的成就。然而部分電機學院的老師早已有涉獵於生醫工程的研究領域，例如像是人工眼、偵測腦波異常訊號的裝置等。「若生醫工程能結合電機、資訊方面結合，在未來能夠重點研發在醫療器材、結合電子資訊的生醫設備。」這將是生醫所的一大優勢與特色。

如圖二所示，本所的主要特色著重 BioICT 之教學與研發，建立資通電生醫平台，並延伸至生醫資訊、生醫電子與光電、生醫臨床應用等專長領域，同時為促進產學發展，在學術研究上以臨床需求為起始，以解決臨床應用為主要導向，走向產學研創新整合。期待透過多元領域與生醫工程的整合，並結合交大 ICT 資產，帶領台灣電資通訊產業跨入生醫應用領域，推動交大邁向生醫與工程整合之新科技潮流。

多元化專業領域師資

如圖三所示，目前本所有 9 位專任教師，專長與學經歷均具備生醫工程或相關領域之專業知識，足以勝任開授本所規劃之各項課程。不僅研究計畫、論文發表屢獲肯定，也有獲獎之優良紀錄。另有 4 位兼任教師，1 位是生醫電子轉譯研究中心的研究員而另外 3 位是台大醫院新竹分院臨床醫學的醫師。還有 38 位隸屬於電機學院、資訊學院、工學院、理學院與生科學院之合聘支援教師。為了補足本校沒有醫學院的事實，廣泛與各大醫院合作進行研究，特別與榮總、台大新竹分院、馬偕新竹分院等建立長期共同合作研究關係，並與竹北生醫園區、科學園區、國衛院等資源相互輔助結合。

圖三



專任教師姓名	專長領域
林顯豐	心臟電生理、自律神經調控、生醫螢光測量分析、生醫電子與信號處理
董蘭榮	醫學影像處理晶片、腸胃道膠囊內視鏡、電化阻抗成像、數位X光影像處理
蔡德明	人工電子耳、神經手術導航、深層腦電刺激、穿顱磁刺激、電阻抗成像
許鉦宗	奈米電子、奈米生醫感測元件、量子元件、微電子工程
陳稷康	醫用超音波、奈米生醫應用
陳榮治	細菌與病毒感測技術、腫瘤診斷與治療技術、再生醫學與組織工程、醫療器材開發與轉譯醫學
莊競程	生醫光電工程技術、生醫光學模擬技術、神經光子學、光遺傳學
陳冠宇	分子生物技術、疫苗工程、生物材料與組織工程、基因治療、細胞死亡與自體吞噬和材料醫學應用
李博仁	奈米材料合成、感測元件製作、表面化學修飾、生物晶片整合、生醫樣品檢測

兼任教師姓名	任職單位	專長領域
葉伯壽	臺大醫院新竹分院神經部主任	神經科學、癲癇學、神經科學
周秉箴	臺大醫院新竹分院神經部醫師/癲癇科主任	腦中風、癲癇、眩暈、失眠、一般神經疾病
蔡佩君	臺大醫院新竹分院神經部認知行為科主任	巴金森氏症、腦中風、癲癇、頭痛、暈眩、不自主運動
張家齊	國立交通大學生醫電子轉譯研究中心助理研究員	生物醫學信號處理、虛擬生物醫學儀器、生物醫學系統

跨領域的課程


林顯豐所長

「我們有很多不同領域、不同背景的人在一起學習。」林顯豐所長強調本所欲培育能夠創新研究與跨領域整合、具獨立研發能力、擁有國際觀以及具團隊合作與溝通領導能力的人才。

「我們強調跨領域的課程與學習，希望未來學生能在各領域發展。」因此設置了許多跨領域課程，見圖四的課程地圖所示，首先分成「共用必修」與「共同專業選修」。共同專業選修的課程內容大致可分為「綜合分析」、「仿生發想」、「臨床需求」和「創新設計」四大類別，與基本素養及核心能力相對呼應、相輔相成。另再依各組專長分「生醫資訊組」、「生醫電子與光電組」和「生醫應用組」，除了各組的基礎能力課程與核心能力課程之安排外，還有適合專業能力發展的多元課程選擇。另外也設置英語授課課程，一方面能使國際生能迅速融入本校學習環境之外，一方面亦可增進本地學生之英文能力。

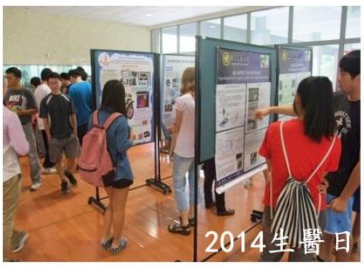
除了跨領域課程的學習之外，「希望未來能多與產業結合並創造產業，包含醫療器材、動物監視裝置、生醫農業、健康照護輔具(輪椅、機器人、遠端照護系統等)。」而目前所上老師在產學合作上有許多傑出的表現，也與地緣相近的醫院、他校研究中心進行具體研究計畫。

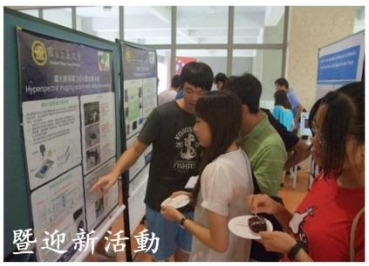
圖四

多元化的學習

本所學生除了課內的學習之外，在課外活動上也是非常積極參與。如圖五的照片中可見，從新生相見歡的迎新活動、 烤肉慶中秋晚會、刺激有趣的漆彈活動，到參與國內大型的生醫研討會，與他人互相學習專業學識、增廣見聞，這是交大生醫所學生多元化的學習過程，也是既豐富又充實的生活。

其中本所學生參與國內外的生醫研討會，無論是上台發表研究成果、與其他與會人員交流等，同學能汲取不同的學習經驗。碩一的雁翎說：「坦白說，第一次在這麼多專業人員面前用簡報發表自己的研究成果，其實很緊張！但是會後的感想是可以增加自己上台發表的經驗，並增強如何問別人問題的能力。」另外，同樣是碩一，從美國來的 Kyle 參與過在美國和台灣的研討會，他說：「我覺得台灣的生醫研討會較偏向學術上的研究討論，而美國的研討會之最大的不同，在於討論較偏向要如何研發出商業化的生醫產品。」在每次不同研討會的參與經驗裡，都能豐富同學們的學識與拓展自我的視野。


2014生醫日


暨迎新活動


2014THRS研討會


2014生醫漆投趣


2014期末餐會


2014慶中秋


2015生醫工程應用研討會(SEMBA)

圖五

朝向多元化整合發展

「雖然專任老師沒有這麼多，但是可與其他學院的老師密切合作，特別是與電資學院的互動能夠繼續延續，也與校方推動的 BioICT 方向發展。」杭院長期待本所能夠成為「小而美」的研究所，並從多領域的師資以跨學科(Interdisciplinary)整合。

生醫工程研究是本校長遠發展不可忽視之研究方向，未來應充分發揮電機與資訊領域之既有優勢，並與生醫領域相互結合，透過創新思維與作法，創造跨領域之整合性研究。學術研究上，透過多元課程與研究計畫等學術活動，促進不同背景學生交流，建立紮實基礎與目標，創造完善、優質之跨領域學習與研究環境。產學發展部分，除積極與各大醫院進行教學與研究合作，促進新興生醫科技之產學發展，更結合校內資源，整合細緻教學分工與學術研究力量，強化專業領域知識，以培育全方位生物醫學工程之人才。

如何找到我們？

- 我們的網站：http://www.bme.nctu.edu.tw/
- 我們的臉書：

- 我們的電話：(03)5712121 轉 31387 或 54048

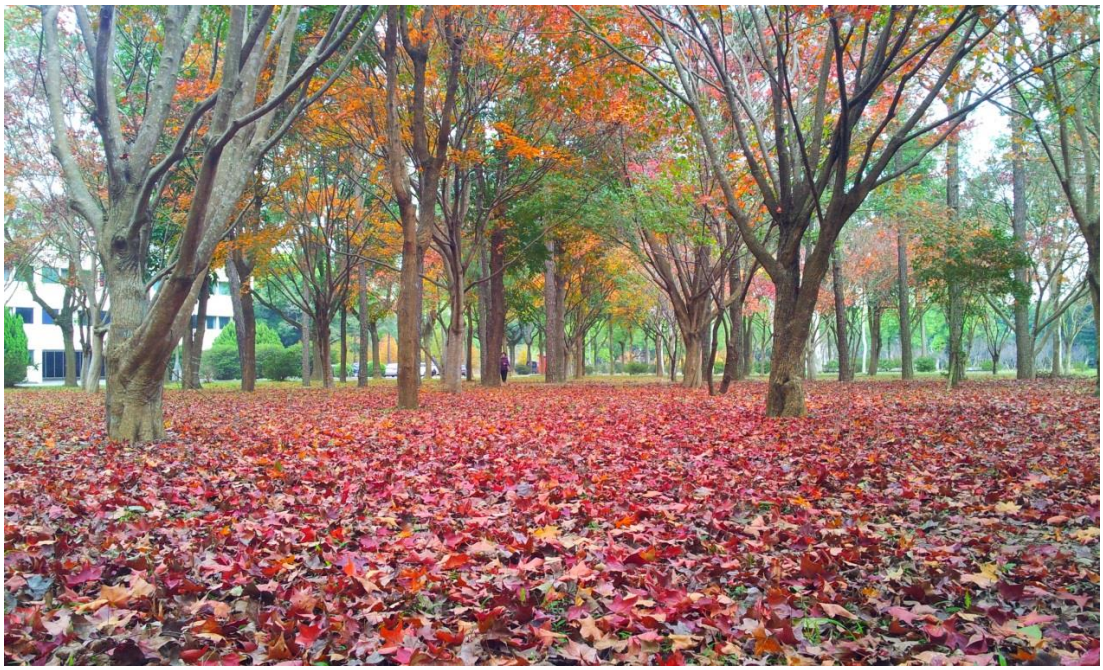
行政院原子能委員會核能研究所

核能研究所簡介

行政院原子能委員會核能研究所（以下簡稱本所）座落於風景優美、人文薈萃之桃園市龍潭區，佔地約一百二十英畝。龍潭地區早年是以天然湖－龍潭大池為主要地標，由於湖光山色秀麗，石門水庫及小人國等已在全國形成有名的旅遊景點。所區環境清幽、生態豐富，初春櫻花、仲春杜鵑盛開時蔚為奇景(圖一、圖二)，五色鳥、喜鵲、貓頭鷹等罕見禽鳥也不時可見蹤跡(圖三)。另因坐落於陸軍輕航隊附近，故能時常見到阿帕契、奇歐瓦等新式軍機翱翔天際，自然生態穿插著高科技產物的強烈對比景致，也算是本所一項特色了。

本所成立於民國五十七年七月，並於民國七十七年十月一日歸建原子能委員會，是我國從事原子能、能源開發與輻射應用的專責機構，現階段主要研發目標是針對國家能源安全、環境保護及國民健康，提供完整的技術解決方案。近年來除致力於核能相關技術研發與應用外，在新能源、再生能源及輻射應用領域之研發成果與產業應用成效大幅提升。在增進國民健康的目標上，即是應用輻射科技，研發各類造福國民健康之應用，包括核醫藥物、輻射類影像醫材、輻射照射改質等。本文將就輻射類影像儀器與醫材的部分做一簡要說明。

圖一、所區剪影



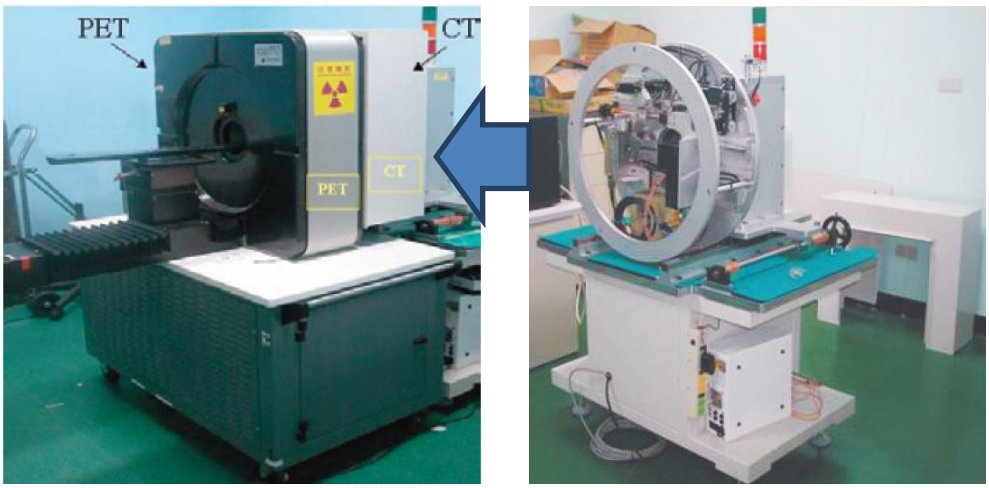
圖二、所區楓紅

圖三、所內棲息之領角鴞

放/輻射影像儀器技術

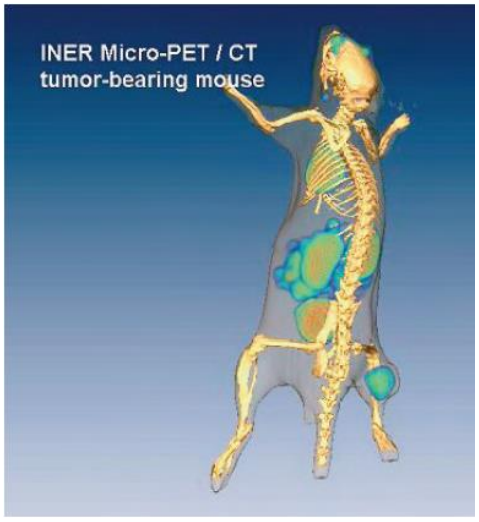
本所放/輻射影像儀器與醫材的開發是由放射成像研究團隊執行，現隸屬於保健物理組。草創之初是以配合本所核醫藥物研發、建立研究用(小動物用)正子斷層造影儀(Positron emission tomography, PET)為目標，以輻射量測技術為基礎，轉進成像偵檢、成像物理等應用領域技術開發，先後研製完成一部旋轉式(ARO-PET, 1999年)及一部靜環式(ASR-PET, 2002年)PET系統；同時另研發建立微型(錐狀射束)電腦斷層掃瞄儀(Computed tomography, CT)技術，於2003年完成一部研究用(小動物用)微型CT系統，並於2005/2006年建立三維影像融合、對位技術與硬體雙系統軟硬體整合，成功開發出世界第二部、亞洲第一部micro-PET/CT複合型機種(自製μCT與Concorde μPET R4結合，圖五)，成功帶領核醫藥物研發團隊進入雙功能(功能性影像+結構性影像)造影應用領域(次頁圖六為一例)，體驗其為研發帶來的強大威力，本團隊亦藉此建構雙功能造影系統之技術能力。

圖四、本所自製之 ASR-PET 系統

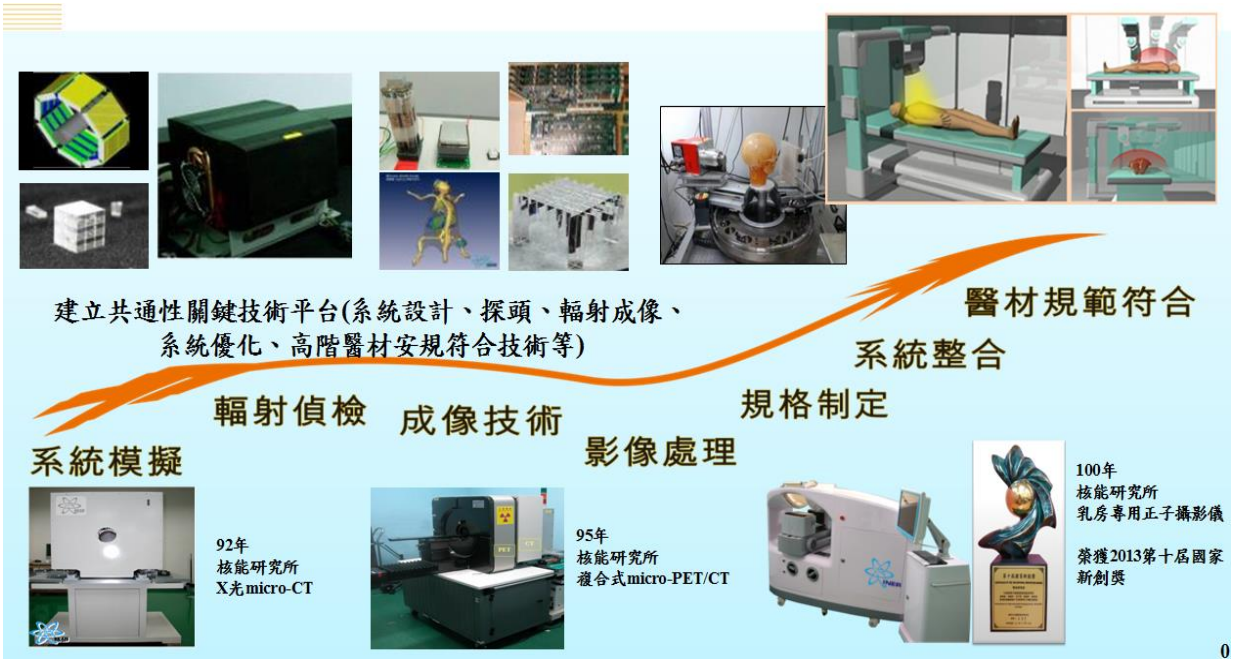


圖五、本所研製之 micro-PET/CT

其後因配合政府產業政策的轉向，技術的研發方向轉往人體/臨床診斷用的影像醫材系統開發所需之關鍵與基礎技術，並由核醫影像儀器逐漸往放射影像儀器領域拓展，近年來團隊所累積之技術能量大致整理如圖七所示，茲就較重要項目分述如下：



圖六、micro-PET/CT動物影像，小鼠腿部殖有結腸直腸癌腫瘤

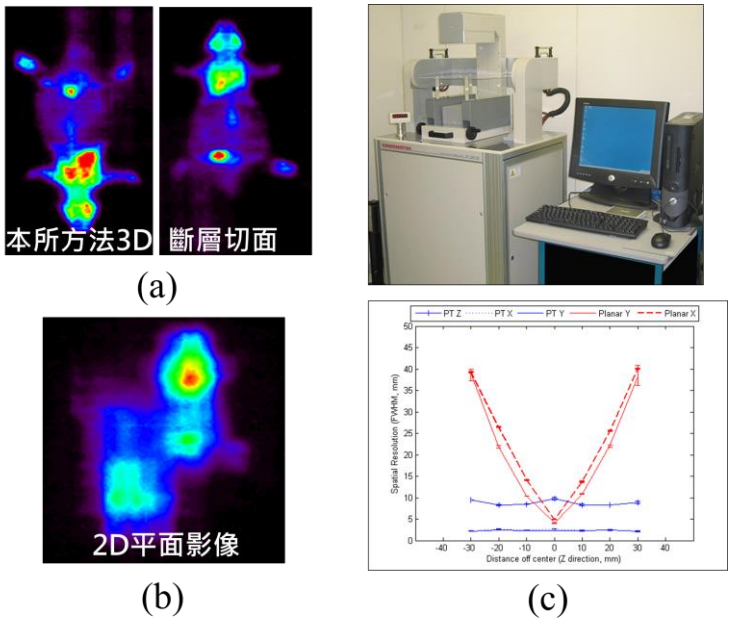


圖七、核研所放射成像團隊建立數位X光及(核醫)加馬射線偵檢成像通用技術，包含系統及軟硬體組件等

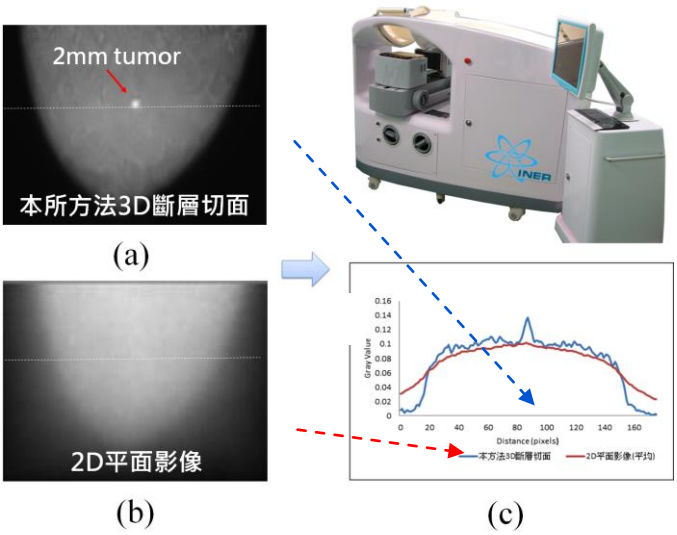
◆ **3D 影像重建技術—輻射類造影系統成像核心**

輻射類造影系統如 PET、SPECT 皆是以輻射成像探頭偵測輻射訊號，將該訊號經由影像重建之運算，再呈現出 3D 放射源/衰減係數之分布之影像。其中，影像重建技術即是輻射類造影系統能獲得 3D 斷層影像的關鍵。核能研究所具專利之 Planar Tomography 影像重建技術，無需完整 360 度拍攝，僅利用不旋轉之雙平面偵檢系統即獲得 3D 斷層影像。其優點為 1.攝影儀不受限環形設計 2.快速拍攝 3.降低成本(用少量偵檢器即可成像)。此技術克服偵檢涵蓋率較一般環型系統少 50%以上的限制，成功促成新型造影系統的開發，已應用於一部動物正子掃描系統(圖八)及本所自製之乳房專用正子攝影儀(圖九)。影像重建技術包含重建演算法與成像物理模型兩大部分，核能研究所在空間幾何的數值模型深耕多年，為精確快速逼近實體空間(連續)轉換至影像空間(數位取樣)，已有 Reduced dimensions、Separable method 等 know how 演算處理技術，技術能力與國際並駕齊驅，各有千秋。

近年影像品質精進多仰賴影像重建技術之提升，加上物理校正及精確系統物理成像模型已是趨勢，且依不同造影儀及臨床應用而處理技術不同。核能研究所將奠基於已有之影像重建 know how 技術，朝向精確模型建立與多樣新式幾何系統的重建技術精進研發，更致力於推廣至輻射類(核醫/放射)影像系統製造商的技轉與應用。



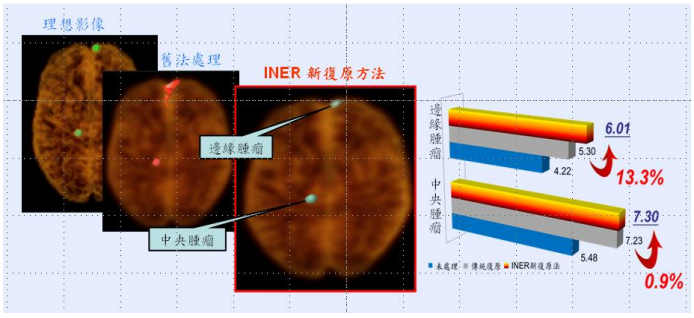
圖八、影像重建技術應用於 PPIS 動物造影系統(Hamamatsu photonics K.K.) (a)本所 Planar Tomography 重建影像之斷層切面， (b)傳統 2D 影像，(c)藍色線為本方法於 PPIS 系統上量測之系統解析度，不隨位置移動而改變較穩定，且解析度較優，紅色線為原系統解析度。



圖九、影像重建技術應用於乳房專用正子攝影儀
(a) 本所 Planar Tomography 重建影像之斷層切面， (b)傳統 2D 影像，
(c)影像虛線處剖面曲線，藍色為本所方法其對比度較高，腫瘤處突起較明顯。

◆ **影像復原技術—提升影像定量準確度**

核醫影像中的顏色與明暗除了幫助醫生診斷疾病，其影像上數值的高低更隱含生理意義，如妥善擷取其中資訊，對臨床應用上將有很大幫助。影像精確定量的應用範疇有藥物動力學模型、腫瘤分期、療效評估、劑量估算、體內放射治療計劃等。Boellaard *et al* 2009, J Nucl Med 中指出造影系統固有的參數對影像定量影響極大，例如:影像處理演算法影響可達 30%，而部份體積效應(partial volume effect)更可高達 80%的差異。核能研究所已建立具專利之影像復原技術，透過量測系統響應函數與考量受測物型態，可改善部份體積效應並有效提升影像定量的精準度。利用 Hoffman 腦部假體驗證，INER 新復原法較傳統方法對於腦邊緣腫瘤之還原準確率可提升 13.3%。影像復原技術可結合於影像重建內以獲得高成像品質，或結合其他影像處理應用。現仍持續精進技術，朝向高影像對比度、訊雜比與準確定量之目標努力。



圖十、利用 Hoffman 腦部假體驗證，INER 新復原法較傳統方法對於腦邊緣腫瘤之還原準確率可提升 13.3%。

◆ **高效能醫學影像運算技術**

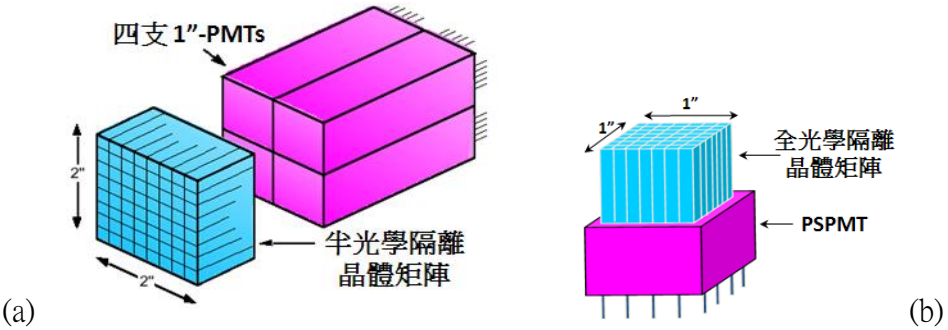
因應近年來醫學影像處理技術複雜度及運算量激增的現況，國際醫學影像會議(IEEE MIC)在 2009 年起新增了高效能醫學影像的論壇以發表最新加速運算之相關軟硬體技術為主。由此可見此領域之需求與扮演角色日漸重要。核研所放射成像團隊亦察覺此高效能運算技術之重要性，投入平行運算之資料結構、硬體操控、演算法區域分解等核心技術研究。在乳房專用正子攝影儀的影像重建運算加速成效卓越，原始空間幾何模型計算與迭代演算 1 次共需耗時 1.7 小時，經演算法流程最佳化與 GPU 加速處理後僅需 62 秒約加速 99 倍，大幅提升臨床上的實用性。另外，尚可應用於其他影像運算校正/處理，例如:為解決晶體間光訊號穿透造成影像解析度惡化的問題，所開發的高取樣率晶體穿透校正技術，結合運算加速技術後該校正運算時間大幅縮減，加速約 11 倍。另外，在影像定量精確度亦有明顯提升，乳房中央與邊緣腫瘤活度間誤差由 10.3%縮減為 1.6%。

近年利用 GPU 進行影像處理運算加速已蔚為風氣，核研所放射成像團隊除已掌握相關技術的開發使用，並持續關注多核心與叢集系統的發展趨勢，更著重於演算法流程最佳化的整合，累積足夠實戰經驗，以提高軟體技術的商品化與實用性。

◆ **輻射成像探頭技術**

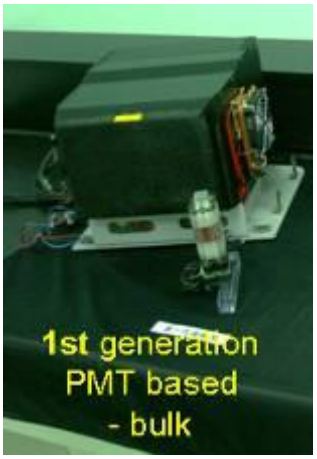
輻射成像探頭/偵檢器為醫學臨床上之分子影像儀器(如 PET, SPECT)的核心組件，亦是加馬攝影機(gamma camera)、掃瞄探針(gamma/positron probe)等產品所應用的關鍵技術，核能研究所具備豐富的輻射偵檢知能與實務經驗，放射成像團隊所發展的即是以閃爍偵檢器為基礎的輻射成像偵檢器技術。

本團隊所開發之成像偵檢技術，於規劃之初為建立技術競爭力，在架構上避開了大部分商用儀器採用的 PMT(普通光電管)-based 設計，直接切入具有高解析特性的 PSPMT(位敏光電管)-based 點陣式成像偵檢器技術，成功開發出較輕巧(厚度僅為傳統方法的 1/3)、解析度較高(可達 2mm 或更精細，而傳統 PMT 技術僅能達到 6~10mm)的成像偵檢器單體。

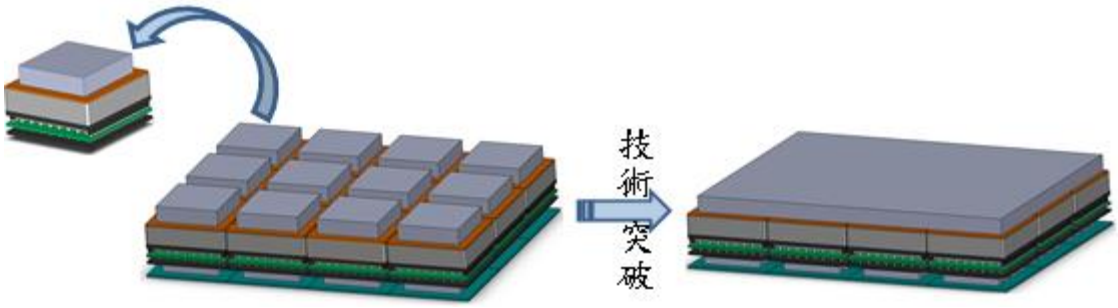


圖十一、(a)PMT-based 成像偵檢技術與(b)PSPMT-based 成像偵檢技術的架構示意

圖十一為二技術之架構示意，前者(PMT-based)雖可達成較大的單體面積，無感邊緣小，較容易合併單體擴展面積，為一般商用產品較常採用的設計，但卻具有笨重、發熱、解析力不易提升的缺點；相形之下 PSPMT-based 成像偵檢器具有較輕巧、較省電(低廢熱)、高解析力等優點，但其單體面積較小並具有一定比例之無感邊緣，使其合併單體擴展面積時遭遇無感縫隙問題，造成實用成像區域不連續，降低最終產品的實用性與市場性；為克服此技術不易擴展有效影像面積的瓶頸，本團隊初期由德州大學 M.D. Anderson cancer center (MDACC) 引進 PQS 成像偵檢器技術，應用於開發 BreastPET 系統所需的第一代成像探頭，實體照片如圖十二。但因上述的 PMT-based 技術缺點，本團隊精進自身技術能量，以 PSPMT-based 技術，完成專利性技術(非均勻光學分享矩陣)的開發，並應用於 BreastPET 系統第二代成像探頭開發。此技術順利達成無縫接軌的有效面積擴展(4.5x4.5 cm2　　9.9x7.4 cm2)，如圖十三所示，且同時保持原有的高解析優勢。

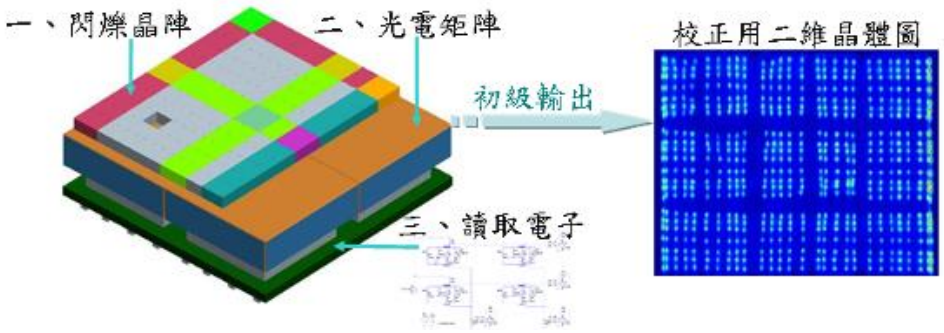


圖十二、第一代正子攝影儀用成像探頭，引進美國 MDACC 的 PQS 技術，安裝於第一代 INER BreastPET 上

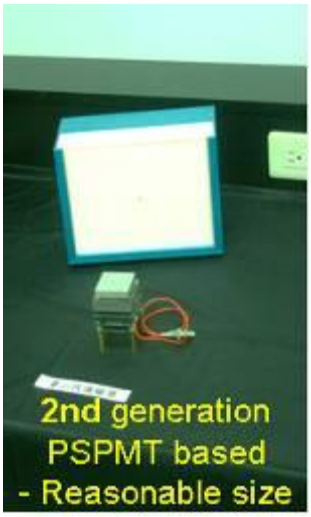


圖十三、PSPMT-based 成像偵檢器技術突破，完成無縫擴展有效影像面積

本所團隊的 PSPMT-based 成像偵檢器技術架構如圖十三所示，由閃爍晶陣、光電矩陣、與讀取電子三大部分所組成。由成像偵檢器初級輸出經資料擷取處理、儲存於電腦的原始資料，可轉換呈現二維晶體圖，此圖可定性展現探頭的成像性能，如圖中各晶體計數團清晰可辨、且顆粒清楚分離，說明此一探頭於該晶體尺寸(1.5 mm，亦可視為其解析能力)設定下，可達成優良的成像性能；相形之下，以 PMT-based 成像偵檢技術製作的探頭，即使在 6mm 的晶體尺寸設定下，仍無法達成計數團清晰分離的二維晶體圖，展現出二種技術的特性差異與本團隊的技術優勢所在，即本體輕薄，耗能(廢熱)低(僅第一代的 1/3~1/5)，光電元件成本雖較高，但性能穩定，造影系統的品質控管較簡易，耗費成本(人力、時間)較少。在上述三個部份上克服工程困難，進行嚴謹精密的實作，才可完成影像儀器所需的成像探頭組件，實體照片如圖十五。本技術套件現階段已完成與國內業者合作進行商用產品組件的開發，正進入技術移轉與儀器建置階段，未來更將以授權形式落實於我國影像醫材產業。



圖十四、PSPMT-based 成像偵檢技術開發之輻射成像探頭之架構示意



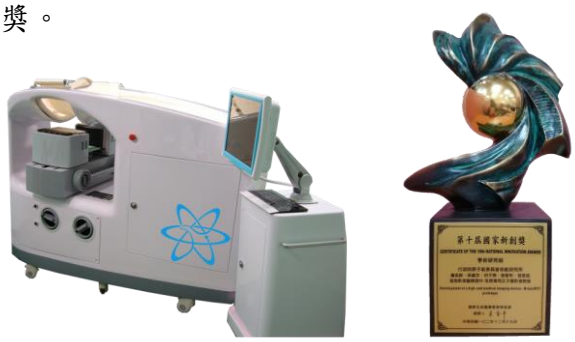
圖十五、第二代正子攝影儀用成像探頭技術現正技轉國內業者，
並協助其開發新一代 BreastPET 產品。

重要研發實績

◆ **乳房專用正子攝影儀（INER Breast PET）**

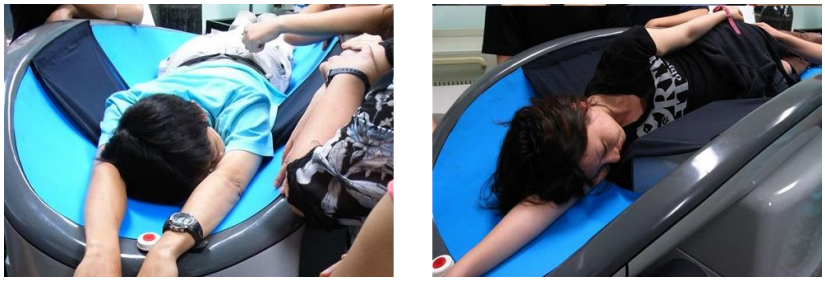
過去乳癌被視為歐美女性較易發生的癌症，但根據國民健康署最新統計，近 20 年來台灣女性乳癌的發生率增加了 4.8 倍，位居亞洲第二，僅次於新加坡。目前乳癌發生率及死亡率均高居我國女性癌症第一位，且有年輕化趨勢。國人年輕女性乳癌發生率比年長者高，乳癌好發年齡介於 41 至 50 歲間，較歐美平均年輕了 10 歲。隨著台灣青壯年女性乳癌發生率「超英趕美」，此族群女性的乳房檢查與乳癌防治是不容忽視的議題。乳癌若能及早發現提早治療，治癒機率相當高，但目前 X 光乳房攝影對於緻密型乳房較難發現存在的病變，而東方女性及年輕女性乳房緻密度通常較高，影像更不易判讀。而超音波適用>0.5 cm 以上腫瘤，較倚賴操作人員的經驗，早期乳癌容易誤診。磁共振造影(MRI)對於乳癌檢查的敏感度高，但價格昂貴，檢查時間較久，且因其過於敏感，偽陽性也偏高，不是惡性腫瘤的病灶也會顯影。在美國現行 MRI 乳癌檢查有 86%偽陽性，造成每年 24.5 億美元的健保系統資源耗費。

核能研究所以多年輻射偵測、放射成像經驗為基礎，切入輻射民生應用，以日益獲得重視之婦女健康照護(Women healthcare)議題為主軸，利用我國資通訊優勢技術，設計開發適合東方女性之乳房專用正子攝影儀（INER BreastPET），可望為上述問題提供解決方案。INER BreastPET 的高解析度和可分辨良惡性腫瘤的特性，提升了早期乳癌檢測能力，可輔助現行乳房攝影的不足，並可應用於治療前評估及治療後療效追蹤。INER BreastPET 系統為國人自主設計並獲得多項專利，具新創價值與市場競爭力，102 年榮獲國家生技醫療產業策進會主辦之第十屆國家新創獎，為我國生技醫藥技術創新研發的最高榮譽。至 103 年 2 月底前已獲美、日等國內外 9 件發明專利，8 件專利申請中。INER BreastPET 核心專利如獲多國專利之特殊有限角度二維造影三維成像技術，僅需來自兩個不旋轉之偵檢探頭偵測數據，充分利用斜角度數據成像獲得三維斷層影像，再配合精確物理模型與加速技術，可利用少量有限偵測數據，兼顧高準確性與運算效率，創造最佳的系統性能。該方法 102 年獲台北國際發明暨技術交易展之發明競賽區金牌獎。



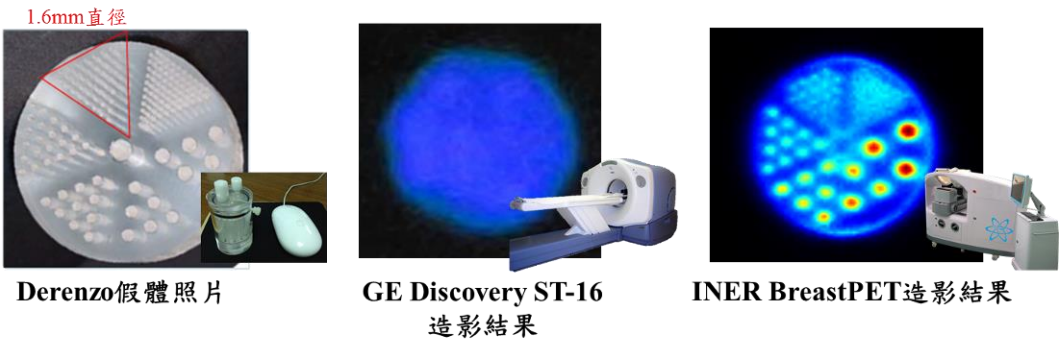
圖十六、核能研究所開發乳房專用正子攝影儀榮獲第十屆國家新創獎

INER BreastPET 造影病患以趴姿進行乳房檢測，特殊專利設計可有效減小胸壁(chest wall)檢測死角並增大偵檢範圍，提升儀器的乳癌偵檢能力；檢測時乳房自然下垂不擠壓，無疼痛與不適感，而腋下淋巴偵測模式可探知乳癌轉移可能性(如圖十七)。其他如效率校正、改良式幾何模型等專利，有效提升 INER BreastPET 影像品質，降低背景雜訊，為系統優化和未來產品性價比提升之重要技術，整體專利組合亦為提高廠商承接關鍵。



圖十七、INER BreastPET 之趴式與腋下檢測方式

INER BreastPET 於 101 年技術移轉國內業者，達成研發技術產業第二棒交接任務，為維護國人健康與產業經濟需求開拓新的道路，未來核能研究所更將戮力結合產業能量，共同打造醫療電子新未來。同年並開始推動 INER BreastPET 的人體臨床試驗。於台大醫院進行首例人體試驗前，利用高解析度假體先進行造影驗證並與全身正子造影儀比較，結果(圖十八)顯示 INER BreastPET 有相當好的解析能力。自 102 年 8 月起在台大醫院由核醫部曾凱元主任和乳房外科暨乳房醫學中心主任黃俊升教授主持人體造影試驗。相較傳統 X 光乳房攝影、超音波和正子斷層掃描(PET/CT)檢查，由迄 102 年底累積之 21 例統計，可多偵檢出 11.5%的小腫瘤，對婦女乳癌診療已展現初步影響力，有助於手術前及治療評估，為乳癌診斷治療新利器。

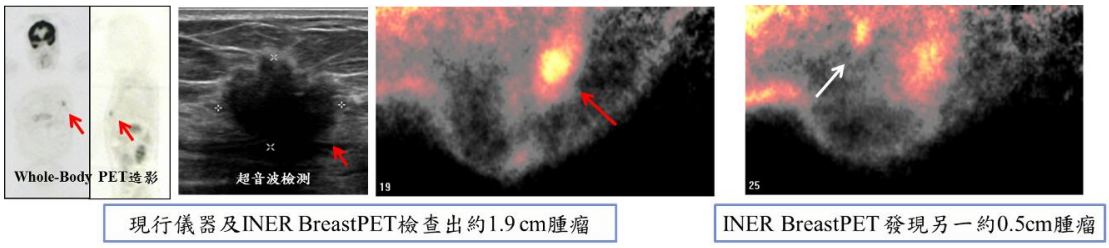


圖十八、於台大醫院進行之空間解析度造影實驗比較結果

INER BreastPET 開發過程及重要紀事：

- 98 年研發團隊在經濟部經費補助下完成雛型儀系統開發，之後繼續推展系統優化與臨床前測試如動物實驗、系統效能實驗等。
- 100 年 INER BreastPET 經台灣電子檢驗中心檢驗，通過醫療器材 IEC 電性安全驗證，獲 IEC 60601-1 電性安全、IEC 60601-1-2 電磁相容檢驗合格證書，為台灣高階大型醫療器材獲證首例。
- 101 年 INER BreastPET 與國內資通訊大廠簽署技術移轉合約，該公司並成立醫療器材專責之新創公司執行商品化上市業務。
- 101 年本所與台大醫院合作，INER BreastPET 臨床試驗計畫通過衛生署食品藥物管理局(TFDA)與台大醫院人體試驗委員會(IRB)審查。
- 102 年 8 月 7 日 INER BreastPET 於台大醫院由核醫部曾凱元主任和乳房外科暨乳房醫學中心主任黃俊升教授主持進行首例人體造影試驗，初步顯示可多發現 11.5%超音波和 PET/CT 未檢出的小腫瘤，降低乳癌檢測偽陽率，有助於手術治療評估。圖二十為一例。

圖十九、INER BreastPET 電性安全及電磁相容檢驗合格證書及
臨床試驗計畫通過衛生署和台大醫院 IRB 審查的證明文件



圖二十、INER BreastPET 人體造影功效驗證之一例

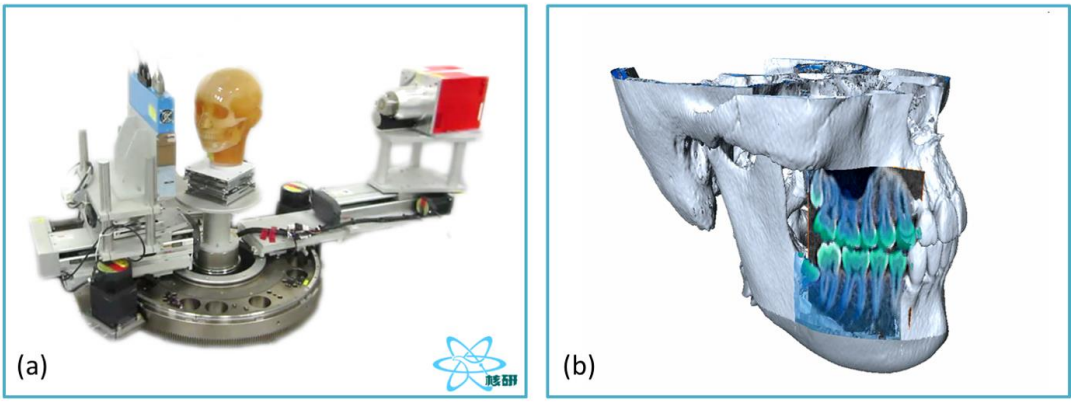
◆ **X 光造影系統技術開發**

核研所研發團隊因應臺灣X光影像產業需求缺口，設計建構多用途X光2D/3D造影模擬機技術平台(見圖二十一)，為X光造影系統/組件產品開發之最佳利器。此模擬機構具有多軸多軌獨立作動之高自由度與醫療級高精度設計，可真實地模擬多種2D、3D或不規則軌跡掃描模式，如牙科、乳房、胸腔、骨科與介入性手術透視等造影應用，可滿足實際臨床應用上多種不同的X光造影需求。X光多用途造影模擬機技術平台還可提供國內少見的偵檢訊號3D成像軟體，例如X光錐型射束(Cone-Beam) CT、高性價之擴大視野範圍(Extended Diameter Scan, EDS)成像、新數位斷層合成造影 (Digital Tomosynthesis)等，成像軟體是此技術平台發揮醫用/非醫用(例如工業用、獸醫用或其他非破壞性檢測、逆向工程用)多用途的核心關鍵。

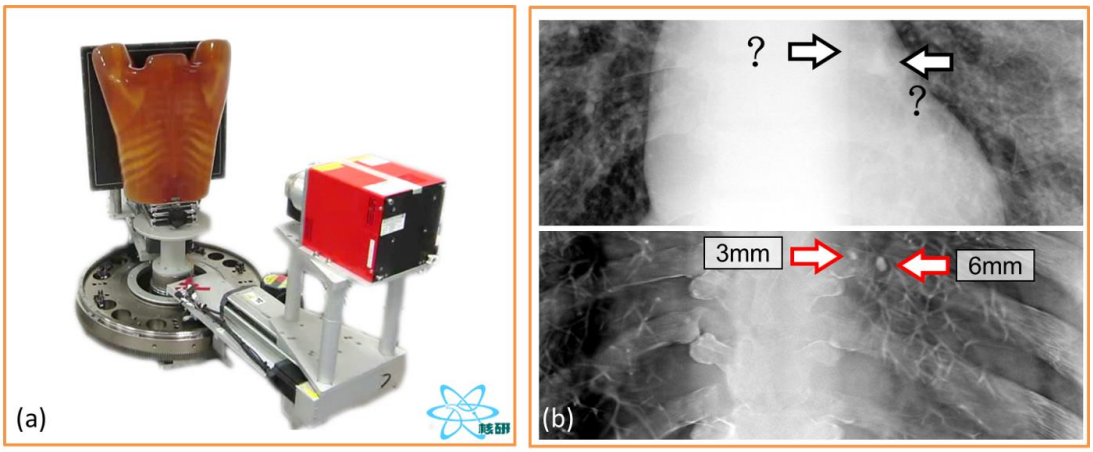
圖二十一、核研所開發之多用途 2D/3D 造影模擬機技術平台，可縮短我國 X 光產品設計開發、商品化時間與提升性價比

多用途X光2D/3D造影模擬機技術平台具有兩種主要用途，一為進行X光機系統開發的概念性驗證(Proof of Concept；POC)，此用途是在產品原型機完成前，就利用此模擬機進行先期實測，取得初步影像結果，及早徵詢醫師看法進行設計修正；在高階造影儀系統開發階段，整合複雜系統之第一步，必須掌握know how、know why的系統設計與規格制訂，包含各組件規格相互匹配連結等。相較於傳統作法，利用此模擬機輔以2D/3D輻射成像技術於新產品開發，在產品設計階段即可有全貌性架構並進行影像效能預測。全機系統組件匹配與最佳化模擬應用，使系統廠可及早了解設計中系統的性價比與組件選擇的關聯性，運用模擬機可以躍進方式快速產出可商品化產品設計，節省原型機製造、反覆測試修改等時程和經費，有效縮短我國X光機系統及組件業者的產品開發時間並提升系統產品的性價比。另一種用途是組件與系統之連結測試，使組件開發者對其產品於全機系統可發揮的效能有預先認知，若不如預期則實測數據可作為設計修改回饋。此功能可模擬系統廠的驗證，可協助關鍵組件商及早進行開發中產品測試與性能評估，加速使其產品與世界品質接軌。目前此模擬機已可提供至少6種以上X光造影功能，可服務X光醫材組件業者進行設計/製程最佳化及系統應用性能展示等。

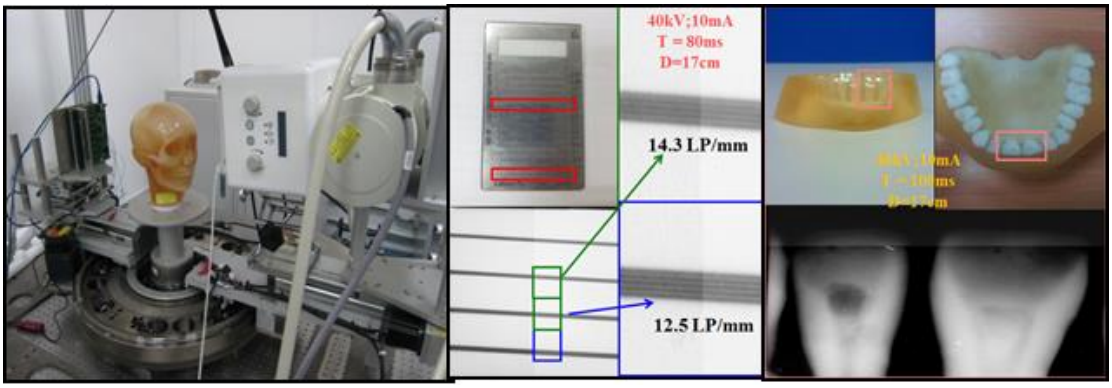
X光造影模擬機於醫用/非醫用技術應用性高，應用實例如圖二十二~圖二十五。目前核研所利用此套多用途X光2D/3D造影模擬機技術平台，已展開多項數位X光造影之關鍵技術研發，例如低劑量X光子計數成像偵檢器、工業用多能階CT、多X光源快速3D掃描儀、X光輻射曝露指標、3D輻射成像品質評估系統等。自2014年起，在行政院特別額度經費補助下，核研所更進一步整合各關鍵技術投入市場導向之新數位2D/3D X光造影儀系統(TomoDR)開發，計畫藉由統整合、介面連結成功經驗和自主輻射偵檢與成像技術掌握，結合醫療體系、研究單位及電子、資通訊、製造業的優勢，挑戰低劑量高品質的下世代高階影像醫材系統開發。除上述核研所主導之前瞻技術/系統開發外，研發團隊亦應用X光造影模擬機服務產研界技術升級。截至2014年底，核研所運用此模擬機技術平台已陸續協助國內7家廠商(包含國際大廠Swissray之在台研發中心)與1家法人進行技術驗證與產品開發，未來可望使我國X光業者迅速累積並掌握關鍵技術自主能力與成本控制能力，使高階醫療器材產業鏈和國內ICT產業獲得完整銜接，並提升MIT產品競爭力與加速進入國際市場。



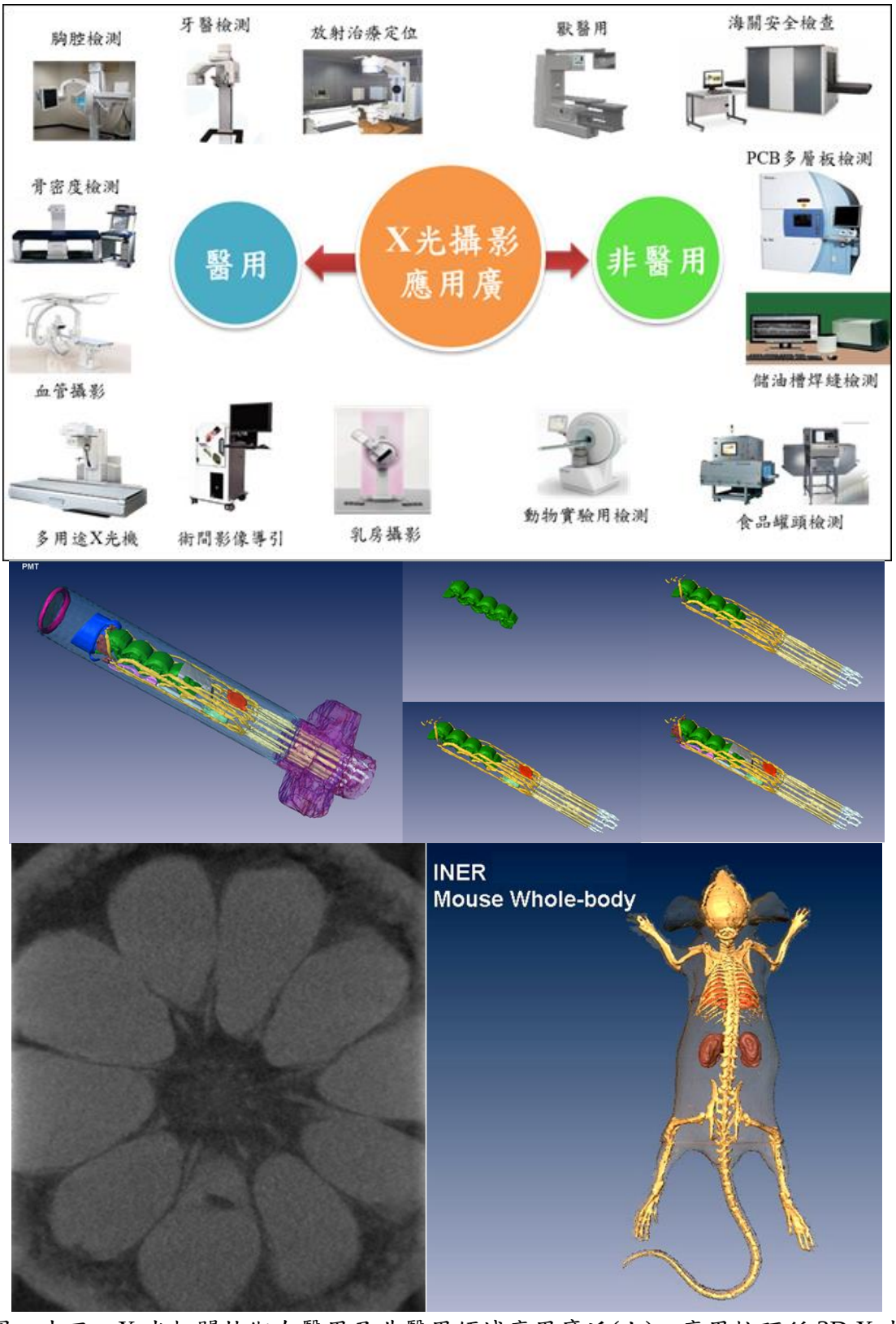
圖二十二、(a) 以核研所 X 光多用途造影模擬機進行牙科 CT 造影，
(b) 頭顱假體造影結果。



圖二十三、(a)以核研所 X 光多用途造影模擬機進行新數位斷層合成胸腔造影掃描，(b)上圖為傳統 2D 造影 X 光影像，因心臟、肋骨與腫瘤組織重疊，兩顆腫瘤不易被偵測出來；(b)下圖為新數位斷層合成造影成像處理後結果，可清楚分辨兩腫瘤



圖二十四、應用模擬機，配合中科院脈衝式數位 X 光偵檢器功能，進行組件測試和假體之 X 光牙科環口造影測試

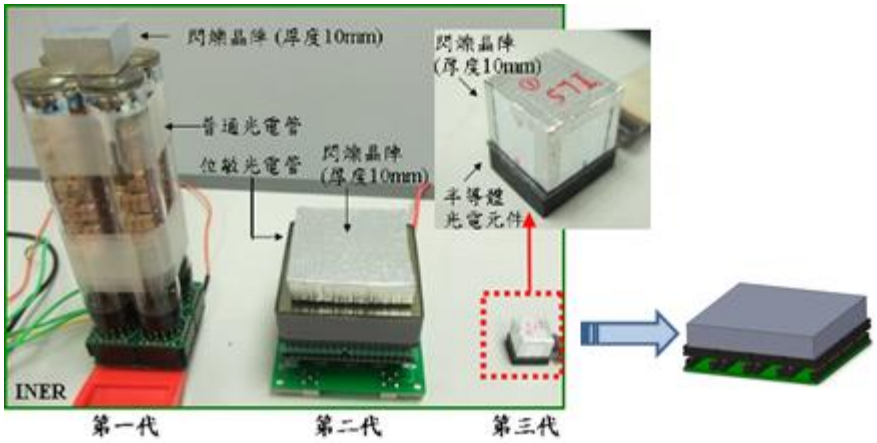


圖二十五、X 光相關技術在醫用及非醫用領域應用廣泛(上)，應用核研所 3D X 光成像技術於光電倍增管之非破壞性檢測(中)、實驗用小鼠及橘子的 CT 造影結果(下)

未來展望

在成像軟體技術方面，3D影像重建、精確影像定量、物理成像模型、高效能運算等核心技術研發已初具成果，未來將持續精進，以便在新系統之模擬設計階段，計算評估未來系統之成像品質，可作為下一代核醫影像儀器研製投資的保障。另透過專利佈局與know how保護，期成為國內輻射醫材製造商的R&D後盾，未來再放眼於更廣的其他輻射成像應用。

在輻射成像探頭方面，近年來半導體光電元件朝向蓋革慕勒(Geiger-Muller)運作模式發展，已可達到接近PMT的信號增幅倍率以及訊躁比(signal-to-noise ratio, SNR)，並展現同樣快速反應(~ns)的特性，與PMT相較半導體元件還具有輕薄、耗電量低、與抗磁場干擾的物理特性/優點，是取代PMT與PSPMT成為新一代成像探頭技術開發的最佳選擇。圖二十六說明了本所成像偵檢/探頭技術的演進，由左至右分別為PMT-based的第一代，PSPMT-based第二代，與應用固態光電元件的第三代(SSPM-based)，本團隊後續技術發展方向，將以應用於PSPMT-based成像探頭的技術為基礎，進一步進入半導體光電元件為基礎的成像偵檢器領域，此技術若開發成功，可使新一代的核醫分子影像儀器具有適形舒適、輕薄小體積、超低耗能、高影像性能等優點，且因其強磁相容特性，可進一步進入MRI整合型的複合式影像醫材領域。此一先進技術雖具備許多優勢，然其成熟產業化應用仍有諸多工程困難待克服，如固態元件光學操作、多通道平行處理電子、全數位成像電子等，將是本團隊後續努力的方向。



圖二十六、本所成像偵檢器/探頭技術演進

核能研究所擁有 40 餘年輻射偵檢及逾 15 年之輻射成像研究與應用經驗，已累積有深厚的高階影像研發能量，技術與能力在國內具獨特性。近年來配合國家生技政策及我國電子資通訊(ICT)產業之發展需求，本所擴展輻射技術應用於放/輻射影像醫療器材領域，並運用台灣資通訊產業與精密機械技術優勢，開發具高價值之放/輻射影像醫材產品技術，期望能與國內產學界合作共進，填補當前我國主導產業轉型醫療器材領域發展的缺口，期能促進我國醫療電子新興產業發展並創造就業機會。

104 年醫工證書考試相關訊息

本會將於 2015 年 8 月 1 日(六)舉行本年度之臨床工程師、醫療設備技師、醫學工程師之醫工證書考試，考試簡章將於 4 月底前公布於學會網站上，敬請有意報考者密切注意。非會員報考者，亦可參加考試。待考試通過後，必須完成入會手續，始頒予證書。

報名日期：2015 年 5 月 1 日至 2015 年 7 月 1 日

筆試日期：2015 年 8 月 1 日(六) 上午 09:30-11:30

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※最新證書考試訊息，請至醫工學會網站查詢。

※證書報考類別選擇說明：

為配合推動國家專業證書制度，本學會實施工程技術人員服務於醫學相關領域之專業認證，證書檢定要求與類別說明如下。

醫工證書之認證類別依工作環境區分為二類：

(1) 服務於醫療院所之醫工相關單位人員之證書：

考量其年資及工作內容，學會比照歐美先進國家及國際醫工聯盟(IFMBE)的規範，將證書分為兩大類：『臨床工程師』(Clinical Engineer) 、『醫療設備技師』(Biomedical Equipment Technician) ，證書檢定要求如下表一。

(2) 服務於醫療院所醫工相關單位以外之醫學工程人員：

如放射科、核子醫學科等學術研發單位以及業界之工程人員，可申請『醫學工程師』證書，其證書檢定要求如下表二。

表一、臨床工程師證書檢定要求

甄審資格	工作年資	甄審程序
本會之永久或個人會員且符合工作年資者	1.醫學工程相關研究所畢業，並有一年以上臨床工程之工作經歷。 2.醫學工程系（組）畢業，並有兩年以上臨床工程之工作經歷。 3.醫學工程科或大學相關系畢業，並有三年以上臨床工程之工作經歷。 4.專科相關科畢業，並有四年以上臨床工程之工作經歷。 5.實際從事臨床工程相關工作十年以上。 6.預計三年內符合以上任一資歷。 ※考試及格後三年內學歷及累積工作年資符合後方可領證。	1.填寫甄試申請書(至學會網站下載) 。 2.準備文件：學位證明影本、**工作年資證明正本**、甄試費繳交收據。 ※以上資料連同甄試申請書寄送本會。 ※甄審費由本會理事會另訂之。

醫療設備技師		
依工作領域分為一般醫療設備技師、放射醫療設備技師、臨床檢驗醫療設備技師		
甄審資格	**工作年資**	**甄審程序**
本會之永久或個人會員且符合工作年資者	1.醫學工程系（組）畢業，並有一年以上醫療設備之工作經歷。 2.醫學工程科或大學以上相關系畢業，並有兩年以上醫療設備工作之經歷。 3.專科相關科畢業，並有三年以上醫療設備工作之經歷。 4.實際從事臨床工程相關工作四年以上。 5.預計三年內符合以上任一資歷，考試及格後三年內學歷及累積工作年資符合後方可領證。 ※申請放射醫療設備技師及臨床檢驗醫療設備技師者必須在近兩年有 40%或近五年有 25%之工作與該領域有關(需提出實際工作項目證明，例如主管證明等)。	1.填寫甄試申請書(至學會網站下載) 。 2.準備下列文件：學位證明影本、**工作年資證明正本**、甄試費繳交收據。 ※以上資料連同甄試申請書寄送本會。 ※甄審費由本會理事會另訂之。

表二、醫學工程師		
甄審資格	**工作年資**	**甄審程序**
本會之永久或個人會員且符合工作年資者	1.大學院校之醫學工程(生物醫學工程)系、所、組、學程畢業。 2.大學院校之相關系、所畢業，並有一年以上醫學工程之工作經歷。 3.專科院校之相關科畢業，並有二年以上醫學工程之工作經歷。 4.實際從事醫療產業相關工作四年以上。 5.預計三年內符合以上任一資歷。 ※考試及格後三年內學歷及累積工作年資符合後方可領證。	1.填寫甄試申請書(至學會網站下載)。 2. 準備下列文件：學位證明影本、**工作年資證明正本**、甄試費繳交收據。 ※以上資料連同甄試申請書寄送本會。 ※甄審費由本會理事會另訂之。 ※醫學工程師筆試及格者，需符合下列規定之一，方可領證：(1)持有大專院校畢業證書者；(2)持有實際從事醫療產業相關工作四年以上之證明文件。

Index (2014 Vol. 34, No. 6)

Index (2015 Vol. 35, No. 1)

2014 Vol. 34, No. 6

Review: Progress Towards Automated Early Stage Detection of Diabetic Retinopathy: Image Analysis Systems and Potential

Vijay M. Mane, Dattatray V. Jadhav

Captured retina images enable important parts of the visual system to be analyzed. Automated retinal image processing is becoming a primary screening tool for the detection of diseases such as diabetic retinopathy (DR). An automated system reduces human error and also reduces the burden on ophthalmologists. The accurate detection of microaneurysms (MAs) is an important step for the early detection of DR. MAs appear as a first sign of DR and can be seen on retina images. This paper discusses some of the current techniques used to automatically detect MAs from retinal digital fundus images. This review outlines the general principle upon which retinal digital image analysis is based for the detection of MAs. The algorithms are categorized according to four processing steps (preprocessing, candidate MA detection, feature extraction, and classification). Various gold standard or ground truth databases, data sample size, and the use of image databases are discussed. The variety of outcome measures and flaws in the literature are discussed. The challenges and future potential for research are discussed to provide guidance to algorithm designers of the early detection of DR.

Coherence Validation of Alternative Sleep EEG Electrode Placements Using Wavelet Transform

Shih-Chung Chen, Aaron Raymond See, Chun-Ju Hou, Yeou-Jiunn Chen, Chih-Kuo Liang, Po-Yang Hou, Wen-Kuei Lin

Recent studies on automated sleep stage classification have started to adopt alternative sleep encephalography (EEG) electrode placements on the forehead as opposed to the traditional C3-C4 placement. The current study determines the validity of adopting the prefrontal EEG electrode placement. First, EEG signals were decomposed into four harmonic bands using the discrete wavelet transform and their power spectrum densities were extracted for comparison. The correlation coefficients of both signals were calculated and jackknifed to determine an unbiased statistical value. The signal and its power spectrum displayed moderate to very strong values of the correlation coefficient, respectively, with minute standard errors and biases. A strong coherence is exhibited between both electrode placements as viewed from the power spectra of different sleep stages. The magnitude-squared coherence values indicate that the reduction in the coefficient values for the beta band was due to a low correlation in a certain frequency band. Manual sleep stage classification was also conducted by a sleep technician and sleep stage classification software, with consistent results obtained. Sleep stage scoring using both methods indicated substantial agreement for the standard and alternative electrode placements. In conclusion, this work shows a strong coherence for the prefrontal and standard electrode placements and corroborates the hypothesis of using the alternative placements for performing quick, convenient, and efficient measurement and analysis of EEG signals.

Scale-Invariant Behavior of Epileptic ECoG

Suparerk Janjarasjitt, Kenneth A. Loparo

There is evidence that some biological systems, including the brain, can exhibit scale-invariance, a hallmark of a complex system. Scale-invariant behavior reflects the tendency of a complex system to develop organized complexity with both temporal and spatial long-range correlation structures. This study investigates the scale-invariant characteristics of the dynamics of the brain of subjects with epilepsy. Electrocorticogram (ECoG) recordings obtained during different pathological brain states and from different regions of the brain are examined in terms of the spectral exponent using computational analysis based on the wavelet-based representation for 1/f processes. The spectral exponent is moreover validated and compared to the Hurst exponent. Computational results show that the brain of subjects with epilepsy exhibits considerably different scale-invariant characteristics corresponding to the pathological state of the brain. Particularly, the behavior of the brain during seizure activity tends to have shorter-range correlation than that during non-seizure periods.

Segmentation-based Image Compression Using Modified Competitive Network

Wei-Yen Hsu, Kuei-Wan Chen

A method that combines watershed segmentation with a modified competitive learning network (MCLN) is proposed for segmentation-based image compression. The watershed algorithm is used to segment a gradient image into several closed regions via region growing. The mean intensity for each region is then calculated for subsequent classification. After classification, vector quantization with MCLN is applied to these regions with different compression rates according to the importance of the regions to simultaneously preserve important features and reduce the size of images. The results indicate that the proposed method is promising in comparison with the generalized Lloyd algorithm and the MCLN algorithm.

Framework for Automatic Delineation of Second Derivative of Photoplethysmogram: A Knowledge-based Approach

Dae-Geun Jang, Seung-Hun Park, Minsoo Hahn

Knowledge-based rules for delineating the second derivative of photoplethysmogram (SDPTG), which is widely used as an indicator of arterial stiffness, are proposed in this study. The SDPTG facilitates the distinction of five sequential waves, namely the initial positive wave (IPW), the early negative wave (ENW), the late upsloping wave (LUW), the late downsloping wave (LDW), and the diastolic positive wave (DPW). An analysis of these waves indicates that the SDPTG is a slowly time-varying signal and that the difference between two adjacent pulses cannot go beyond a certain range. It also indicates that the diastolic positive wave can be accurately estimated from the envelope of the SDPTG signal even with a noisy signal. To delineate the SDPTG, pulse waveforms are first divided into pulse segments, each of which contains one period of the SDPTG signal, using the slope sum function with an adaptive thresholding scheme, which simplifies detecting pulse onsets by enhancing the upslope of the pulse signal and suppressing the remainder of the signal. After pulse segmentation, IPW is first identified by picking the maximum positive peak in the segment. DPW is then extracted using a knowledge-based rule that uses the envelope of the SDPTG signal. In the range from IPW to DPW, ENW, LUW, and LDW are sequentially determined using knowledge-based rules. The proposed method is evaluated using the HIMS database, which includes 1,386 pulses. A positive predictive value of 99.71% and a false negative rate of 1.02% are obtained, and thus the proposed rules are expected to facilitate pulse diagnosis using SDPTG signals.

Hemodynamic Effects of Endoleak Formation in Abdominal Aortic Aneurysm Patients with Stent-Graft Implants

Yueh-Hsun Lu, Chia-Yuan Chen, Prahlad G. Menon, Kuan-Ting Liu, Hsing-Hung Lin

Endoleaks may evolve and become severe post-surgical complications in patients with abdominal aortic aneurysms (AAAs). After endovascular aortic aneurysm repair (EVAR), endoleaks may induce EVAR failure. Therefore, the early detection and management of endoleak development could help reduce the need for reoperation. An endoleak is characterized by blood flow that leaks into the cavity between the stent-graft (SG) and aneurysm sac. Comprehensive hemodynamic analysis can identify the relationship of flow-induced wall stress and endoleak formation. Given this hypothesis, a numerical analysis of fluid-structure interaction was performed in this study. SG geometry and AAA flow dynamics were incorporated using the physiological conditions of three patient-specific models of AAA after EVAR. Endoleak locations were well matched to the local peak locations of von Mises stress in the aneurysm bulges of these patients. Further investigation on the associated blood flow structures could provide insights on the physical relationship between hemodynamic force and endoleak formation. The presented analytical procedure offers a reliable alternative for endoleak prediction and detection. This method may be used for post-EVAR patient care with sophisticated imaging techniques such as magnetic resonance, computed tomography, and digital subtraction angiography.

Monte Carlo Study on Dose Enhancement Effect of Various Paramagnetic Nanoshells in Brachytherapy

Toktam Ahmadi Moghaddas, Mahdi Ghorbani, Abbas Haghparast, Ryan Thomas Flynn, Mohammad Taghi Eivazi

The dose enhancement effect of various paramagnetic nanoshells irradiated with various brachytherapy sources was calculated. 125I, 103Pd, hypothetical 169Yb, and 192Ir brachytherapy sources were simulated using the MCNPX Monte Carlo code. The dose rate constants and radial dose functions of the sources were calculated and compared with previously published data. Au/Gd, Au/Fe2O3, Ag/Dy, and Ag/Mn nanoshells with concentrations of 10, 20, and 30 mg/ml in tumor tissue were simulated. A soft-tissue phantom containing a 1 cm × 1 cm × 1 cm tumor was loaded with nanoshells. The dose enhancement factor (DEF) was calculated in voxels inside and outside the tumor. The highest average DEFs in tumor tissue were observed with the 125I source for the 30 mg/ml tumor concentration, with DEF values for Au/Gd, Au/Fe2O3, Ag/Dy, and Ag/Mn nanoshells of 3.25, 2.82, 2.86, and 2.77, respectively. The calculated dose rate constant and radial dose function of the sources were in good agreement with previously published data. Based on our results, nanoshells can be utilized in brachytherapy to enhance the tumor dose and because of their biocompatible shells, their toxic effects can be avoided. The nanoshells are paramagnetic and can be applied simultaneously in brachytherapy and magnetic resonance imaging. However, clinical application of nanoshells in brachytherapy requires more preclinical studies.

A Combination Method of Artificial Potential Field and Improved Conjugate Gradient for Trajectory Planning for Needle Insertion into Soft Tissue

Pan Li, Shan Jiang, Jun Yang, Zhiyong Yang

To reduce postoperative complications and unwanted side-effects, injury to vital tissues and/or nerves should be avoided in minimally invasive surgery. In this paper, a combined trajectory planning algorithm that uses an artificial potential field (APF) method in conjunction with an improved conjugate gradient algorithm (ICGA) is proposed. Fascial tissues create local minima (LM) when the APF method is applied, which may lead to needle oscillation. The proposed method finds sub-goal points using ICGA to escape from LM. Thus, a complete smooth trajectory passing through anatomical obstacles is obtained. Needle guidance and steering can be performed through a unicycle model. The optimal APF function is obtained by adjusting parameter n. When n=6, the distance between LM and the target reached its minimum (1.0198), which shows that Point 6 is closest to the target and n=6 performs higher search efficiency. The experimental simulation shows combination method has higher efficiency (13.45% higher) compared to APF method, which requires just a few tenths of a second on a standard PC.

Three-dimensional Reconstruction System for Automatic Recognition of Nasal Vestibule and Nasal Septum in CT Images

Chung-Feng Jeffrey Kuo, Yueng-Hsiang Chu, Chin-Liang Liu, Fang Tzu Yeh, Han-Cheng Wu, Wei Chu

At present, computed tomography (CT) images of interest for medical diagnosis are manually selected among a series of images by physicians. This study uses image processing to automatically select the regions of the nasal vestibule and nasal septum using a back-propagation neural network. Three-dimensional (3D) image reconstructions of the nasal regions are conducted to obtain the 3D spatial information. 3D images of the nasal cavity, nasopharynx, and paranasal sinuses are also reconstructed. The representative points are labeled in three surgically risky locations, namely the anterior cranial fossa of the brain and the inferior and medial edges of the orbital rim. The nasal and paranasal sinus conformation and marked points are presented to assist surgeons in the preoperative evaluation. The overall recognition rate of the system for the nasal vestibule and nasal septum is 99.7%. The 3D images are considered to be beneficial by an otolaryngologist from Tri-Service General Hospital in Taiwan. The proposed method can facilitate the preoperative evaluation and improve the quality of medical care.

Classification of Four Eye Directions from EEG Signals for Eye-Movement-Based Communication Systems

Abdelkader Nasreddine Belkacem, Hideaki Hirose, Natsue Yoshimura, Duk Shin, Yasuharu Koike

Many classification algorithms have been developed to distinguish brain activity states during different mental tasks. Although these algorithms achieve good results, they require many training loops to make a decision. As the complexity of an algorithm grows, it becomes more and more difficult to execute commands in real time. The detection of eye movement from brain activity data provides a new means of communication and device control for disabled and healthy people. This paper proposes a simple algorithm for offline recognition of four directions of eye movement from electroencephalographic (EEG) signals. A hierarchical classification algorithm is developed using a thresholding method. A strategy without a prior model is used to distinguish the four cardinal directions and a single trial is used to make a decision. Using a visual angle of 5°, the results suggest that EEG signals are feasible and useful for detecting eye movements. The proposed algorithm was efficient in the classification phase with an obtained accuracy of 50-85% for twenty subjects.

Support-vector-machine-based Meditation Experience Evaluation Using Electroencephalography Signals

Yu-Hao Lee, Sharon Chia-Ju Chen, Yung-Jong Shiah, Shih-Feng Wang, Ming-Shing Young, Chung-Yao Hsu, Geng Qiu Jia Cheng, Chih-Lung Lin

Meditation is used to improve psychological well-being, but there is no scientific quantitative evidence to prove the relation between them. Therefore, in this study, an effective classifier, namely a support vector machine (SVM), is applied to classify meditation experiences and help validate the interaction between emotional stability and a meditation experience. Three groups (10 subjects in each), created based on practice experience in meditation (S group with 10-30 years, J group with 1-7 years, and N group with 0 years of experience in Tibetan Nyingmapa meditation), were recruited to receive visual stimuli in the form of affective pictures. The images shown were selected from the International Affective Pictures System (IAPS), a confidential database. The response signals were acquired through physiological examination via electroencephalography (EEG). The subjects' data were entered into two classification systems, namely those based on the classification and regression tree (CART) method and the SVM method, respectively, and the outcomes were compared. From the classification results, SVM had a higher accuracy rate (98%) than that of CART (79%). The stability and robustness of SVM are higher than those of CART, as determined by performing over 100 repetitions and using various variable numbers. An evaluator based on SVM can thus assess a meditation experience through visual emotional stimulation. The results can help explain emotional stability during meditation.

Experimental Study of Dielectric Properties of Human Lung Tissue in Vitro

Jie-Ran Wang, Ben-Yuan Sun, Hua-Xiang Wang, Shan Pang, Xiao Xu, Qing Sun

The present study investigates the differences in the dielectric properties of normal and cancerous tissues of human lungs in vitro to extract the characteristic parameters from impedance spectra and provide some reference data for the impedance measurement of human lung cancer in vitro. Specimens were obtained from operation patients with lung cancer. The impedance spectra of the specimens were measured from 100 Hz to 100 MHz. The air filling factor F is defined for describing pulmonary air content. The results show that the dielectric properties of normal tissue decrease with increasing F. The relative permittivity of cancerous tissue is 1.2-3 times larger than that of normal tissue with F = 0.1781. The conductivity of cancerous tissue is 1.6-2 times larger than that of normal tissue and there is a significant difference in their impedance spectra. The results show that the differences in the dielectric properties and impedance spectra of normal and cancerous tissues are significant, providing basic data for the impedance measurement of human lung cancer in vitro.

Tracheal Opening Discrimination During Intubation Using Acoustic Features and Gaussian Mixture Model

Wei-Hao Chen, Yu-Hsien Chiu, Hsien-Chang Wang, Yu-Wei Hung, Hao-Po Su, Kuo-Sheng Cheng

Correct identification of glottic opening is crucial during endotracheal tube intubation for airway management. Direct glottis visualization by the physician is considered best standard practice, but it is dependent on conditions, skill, and experience. This study proposes an improved oxygen insufflation system that applies an acoustic modeling approach to discriminate glottic and non-glottic areas utilizing the acoustic response from a steady directional airflow at the hypopharynx. An electric stethoscope is placed at the suprasternal notch to record sound produced by insufflation during intubation. The Gaussian mixture model with mel-frequency cepstral coefficients (MFCCs) is used to determine differences between glottic and non-glottic areas. A dataset containing 56.567 seconds of non-glottic sound and 46.472 seconds of glottic sound was recorded from 8 anesthetized adults receiving intubation. Short-time analysis and several objective evaluations were performed to investigate system performance. The evaluation results show that the system achieved a high classification accuracy of 93.24%. The proposed approach outperformed a baseline linear discriminant analysis method with various configurations of linear prediction coding coefficients and MFCCs, and shows potential in improving glottic identification during endotracheal tube intubation.

Examination of Breast Asymmetry Associated with Adolescent Idiopathic Scoliosis Using Surface Topography Methods

Alexandra Trovato, Amin Komeili, Lindsey Westover, Eric Parent, Marc Moreau, Samer Adeeb

Surface topography (ST) is a tool used to assess adolescent idiopathic scoliosis (AIS), which affects females more severely than males. However, current ST techniques fail to measure breast asymmetry related to torso deformity. Cosmetic deformity is important to patients because poor body appearance can cause psychological distress. Breast asymmetry is especially important to adolescent females. This study develops a method for assessing breast asymmetry using ST in patients with AIS, and proposes a reliable breast asymmetry classification for such patients. To achieve this, ST torso scans of 25 females (age: 15.4 ± 1.3 years; range: 13.5 - 17.5 years) with AIS were obtained. Scans were analyzed using a method that finds a rotoinversion matrix to minimize the distance between the torso scan and its reflected image about the sagittal plane. The mirrored torso was then fitted to the original torso using an iterative least- squares method, such that the average deviation between the observed and reflected torsos was minimized. The relative deviation between the two torsos was measured and displayed as a deviation colour map (DCM). Each patient's DCM was visually appraised by two of the authors and a breast asymmetry classification system was created based on this appraisal. Good intra- and inter-rater reliability was found for the classification decisions by five observers. All of the patients presented breast asymmetry that could be reliably categorized into the proposed five-group classification with all patients exhibiting deviations exceeding the threshold of 3 mm between sides routinely observed in healthy teenagers without scoliosis.

3D Finite-Element Modelling of Drilling Cortical Bone: Temperature Analysis

Khurshid Alam, Mushtaq Khan, Vadim V. Silberschmidt

Bone drilling is a key part of major orthopaedic surgeries for fixing fractured bones and replacing damaged joints. One of the main problems in bone drilling is thermal necrosis of tissue, which can occur due to elevated temperatures in the drilling zone. Investigation of the temperatures arising in bone drilling is necessary to analyse the extent of bone necrosis. This paper presents a three-dimensional thermo-mechanical finite-element model of a bone-drilling process to study the effect of drilling parameters (cutting speed and feed rate) and cooling conditions (air and saline solution) on the temperature in drilled bone. The drilling speed was found to have a higher effect compared to that of the feed rate in inducing thermal necrosis in bone for the tested cooling environments. The level of necrosis penetration into bone was strongly affected by the drilling speed and the application of saline cooling (irrigation) in the drilling zone. A considerable extent of necrosis was predicted even at lower drilling speeds when no cooling was used. Drilling experiments were performed on real cortical bone to measure temperatures near the immediate vicinity of the drill. Calculated temperatures were compared with experimental values and were found to be in good agreement with them.

2015 Vol. 35, No. 1

Mechanical Impedance and Its Relations to Motor Control, Limb Dynamics, and Motion Biomechanics

Joseph Mizrahi

The concept of mechanical impedance represents the interactive relationship between deformation kinematics and the resulting dynamics in human joints or limbs. A major component of impedance, stiffness, is defined as the ratio between the force change to the displacement change and is strongly related to muscle activation. The set of impedance components, including effective mass, inertia, damping, and stiffness, is important in determining the performance of the many tasks assigned to the limbs and in counteracting undesired effects of applied loads and disturbances. Specifically for the upper limb, impedance enables controlling manual tasks and reaching motions. In the lower limb, impedance is responsible for the transmission and attenuation of impact forces in tasks of repulsive loadings. This review presents an updated account of the works on mechanical impedance and its relations with motor control, limb dynamics, and motion biomechanics. Basic questions related to the linearity and nonlinearity of impedance and to the factors that affect mechanical impedance are treated with relevance to upper and lower limb functions, joint performance, trunk stability, and seating under dynamic conditions. Methods for the derivation of mechanical impedance, both those for within the system and material–structural approaches, are reviewed. For system approaches, special attention is given to methods aimed at revealing the correct and sufficient degree of nonlinearity of impedance. This is particularly relevant in the design of spring-based artificial legs and robotic arms. Finally, due to the intricate relation between impedance and muscle activity, methods for the explicit expression of impedance of contractile tissue are reviewed.

Feasibility Study of High-Frequency Ultrasonic Blood Imaging in Human Radial Artery

Tae-Hoon Bok, Ying Li, Kweon-Ho Nam, Jay Chol Choi, Dong-Guk Paeng

The present study investigates cyclic variation in blood echogenicity (CVBE) in vivo using high-frequency ultrasound (HFUS). Blood echogenicity (BE) and vessel diameter (VD) were obtained from cross-sectional B-mode images of the radial artery of six volunteers (three young and three old volunteers) acquired at a frequency of 20 MHz. The magnitudes of the cyclic variations in BE and VD were 0.83 ± 0.18 dB and 0.29 ± 0.05 mm, respectively. CVBE was observed to be out of phase with the cyclic variation in VD, which is known to be in phase with blood flow velocity. This result is different from those in previous studies, which were performed in the carotid artery at lower frequencies. In addition, the magnitude of CVBE in the older group (0.96 ± 0.05 dB) was higher than that in the younger group (0.63 ± 0.06 dB, $p < 0.005$), whereas the magnitude of variation in VD was not significantly different between the two groups ($p = 0.119$). This feasibility study suggests that HFUS B-mode blood imaging of human small vessels is useful for the noninvasive measurement or monitoring of the dynamic variation of hemorheological properties in human blood.

Effect of Concussion on Inter-joint Coordination During Divided-Attention Gait

Hao-Ling Chen, Tung-Wu Lu, Li-Shan Chou

This study investigates the effect of concussion on the inter-joint coordination of the lower extremities during walking. Gait analyses were performed on 15 young adults who had suffered a concussion and 15 matched controls while walking on level ground with and without a concurrent cognitive task. The continuous relative phase (CRP), derived from phase planes of two adjacent joints, was used to assess the inter-joint coordination. Variability of coordination was assessed using the average value of all standard deviations calculated for each data point over the stance or swing phases from all CRP curves, namely the deviation phase. The results show that subjects who had had a concussion achieved a level of performance on the concurrent cognitive task similar to that of their matched controls, but had altered gait performance. The temporal–spatial gait control and the kinematic control of each individual joint were found to be altered immediately following a concussion. Patterns of the inter-joint coordination were similar to those of normal individuals. However, greater variability of inter-joint coordination patterns was found in swing phase hip–knee coordination. Examination of the inter-joint coordination could explain the observed deviations in gait performance and joint motion of individuals who had suffered a concussion.

Comparative Study of Fuzzy PID Control Algorithms for Enhanced Position Control in Laparoscopic Surgery Robot

Seung Joon Song, Youngjin Moon, Duck Hee Lee, Chi Bum Ahn, Youngho Jo, Jaesoon Choi

This paper proposes intelligent fuzzy proportional–integral–derivative (PID) controllers for the position control of a master–slave configuration laparoscopic surgery robot system. For the slave robot controller, two fuzzy PID control algorithms are implemented: a rule-based fuzzy control algorithm for online PID gain tuning and a learning fuzzy controller to tune the rules in the rule buffer automatically online. The two fuzzy controllers are tested using sinusoidal reference motions with various periods and the test results are compared with those of a conventional PID controller in terms of position control performance. Various performance indices are used for the comparison, including root mean square error, steady-state error, integral of average error, integral squared error, integral time-weighted absolute error, and integral of time multiplied by the squared error. The evaluation shows that the learning fuzzy controller yields the best performance among the three algorithms. Furthermore, the relationship between the scaling gains and the performance can be deduced to construct a comparative tuning algorithm, which enables the scaling gains to be optimally tuned with less trial and error. Further refinement of the algorithm for enhancing control performance is under way.

Network Analysis of Functional Brain Connectivity Driven by Gamma-Band Auditory Steady-State Response in Auditory Hallucinations

Jun Ying, Dan Zhou, Ke Lin, Xiaorong Gao

The auditory steady-state response (ASSR) may reflect activity from different regions of the brain. Particularly, it was reported that the gamma-band ASSR plays an important role in working memory, speech understanding, and recognition. Traditionally, the ASSR has been determined by power spectral density analysis, which cannot detect the exact overall distributed properties of the ASSR. Functional network analysis has recently been applied in electroencephalography studies. Previous studies on resting or working state found a small-world organization of the brain network. Some researchers have studied dysfunctional networks caused by diseases. The present study investigates the brain connection networks of schizophrenia patients with auditory hallucinations during an ASSR task. A directed transfer function is utilized to estimate the brain connectivity patterns. Moreover, the structures of brain networks are analyzed by converting the connectivity matrices into graphs. It is found that for normal subjects, network connections are mainly distributed at the central and frontal–temporal regions. This indicates that the central regions act as transmission hubs of information under ASSR stimulation. For patients, network connections seem unordered. The finding that the path length was larger in patients compared to that in normal subjects under most thresholds provides insight into the structures of connectivity patterns. The results suggest that there are more synchronous oscillations that cover a long distance on the cortex but a less efficient network for patients with auditory hallucinations.

Effective Anatomical Priors for Emission Tomographic Reconstruction

Yu-Jung Tsai, Hsuan-Ming Huang, Cheng-Ying Chou, Weichung Wang, Ing-Tsung Hsiao

Bayesian tomographic reconstruction with anatomical side information from other imaging modalities can improve both image quality and quantitation in emission tomography for both single-photon emission computed tomography and positron emission tomography. However, the complexity and sensitivity to registration error between function and anatomical images often limit its clinical applications. To alleviate these challenges, this study proposes two priors, anatomical median root prior (AMRP) and anatomical mean prior (AMP), with a simple scheme of incorporating anatomical information. The priors are based on a simple edge-preserving prior that aims to retain the true intensity edges without blurring, median root prior (MRP), by replacing the median value among neighboring pixels with the median or mean value in a corresponding predefined anatomical region. Digital simulations and Monte Carlo simulations were conducted to evaluate the performance of the proposed methods. As compared to MRP, the proposed priors both showed sharper edges, better uniformity, and more accurate activity recovery with well-aligned anatomical and functional images. In addition, a tolerance study in terms of the misregistration between anatomical and functional images was also performed. Acceptable results were obtained for both priors when misalignment was less than 2 pixels, which can be easily achieved in real applications. The proposed anatomical priors for emission tomographic reconstruction can improve both visual and quantitative performance, and are not sensitive to misregistration errors between anatomical and functional images.

Novel Use of Theta Burst Cortical Electrical Stimulation for Modulating Motor Plasticity in Rats

Tsung-Hsun Hsieh, Ying-Zu Huang, Jia-Jin J. Chen, Alexander Rotenberg, Yung-Hsiao Chiang, Wan-Shan Chang Chien, Vincent Chang, Jia-Yi Wang, Chih-Wei Peng

Various forms of cortical stimulation are capable of modulating motor cortical excitability through plasticity-like mechanisms and thus might have therapeutic potential for neurological diseases. To better understand the neural mechanism underlying the cortical neuromodulation effects and to enable translational research in rodent disease models, we developed a focused brain stimulation method using cortical electrical stimulation (CES) on the motor cortex in anesthetized rats. A specific stimulation scheme using theta burst stimulation (TBS) was then adopted to observe the facilitatory and inhibitory effects in motor cortical excitability. Adult male Sprague–Dawley rats were used for all experiments. Under urethane anesthesia, two epidural stainless steel screw electrodes were unilaterally implanted over the primary motor cortex targeting the forelimb area. Brachioradialis motor evoked potentials (MEPs) were obtained by single-pulse CES. Acute MEP changes were measured before and after intermittent and continuous TBS (iTBS and cTBS). For sham intervention, electrodes were implanted, but no TBS was delivered. To examine TBS-elicited plasticity responses, MEP amplitude was measured at baseline and for 30 min after iTBS or cTBS. The MEPs were significantly enhanced immediately after iTBS ($p = 0.001$) and remained enhanced for 30 min ($p < 0.001$) compared to the baseline MEP. Similarly, the MEPs were suppressed in 5 min ($p = 0.035$) and lasted for 30 min or more ($p < 0.001$) after cTBS. No effect was noted on the MEP magnitude in rats under sham stimulation ($p > 0.05$). The developed TBS scheme uses the focused CES method to produce consistent, rapid, and controllable electrophysiological changes in the motor cortex. In particular, the cortical plasticity can be modulated in rat models via the CES–TBS protocols. These findings may have translational relevance for establishing new therapeutic CES applications in neurological disorders.

Effects of Ankle Eversion, Limb Laterality, and Ankle Stabilizers on Transient Postural Stability During Unipedal Standing

Wen-Xin Niu, Jie Yao, Zhao-Wei Chu, Cheng-Hua Jiang, Ming Zhang, Yu-Bo Fan

Transient postural stability (TPS) is an individual's ability to keep postural balance for a short duration. It is particularly useful for evaluating the danger situation faced by persons. This study examines the effects of an inclined surface on TPS during unipedal standing with ankle eversion. Ten male and nine female healthy adults were requested to unipedally stand with dominant and non-dominant leg respectively on a platform. The platform was manually regulated to three inclination angles (0°, 10°, and 20°) for the subjects to stand with ankle eversion. Three ankle stabilizer conditions were investigated, namely barefoot control, elastic ankle tape, and a semi-rigid brace. The plantar pressure distributions were measured and analyzed for 18 conditions (two laterals, three ankle inversions, and three stabilizers) for each subject. The anterior/posterior (A/P-FR) and medial/lateral force rates were used to evaluate TPS in two directions, respectively. The results show that the A/P-FR was significantly higher for the non-dominant side compared with that for the dominant side when subjects stood with ankle eversion, indicating that the anterior/posterior TPS of the non-dominant foot is higher. Ankle eversion mainly destroys the medial/lateral TPS during unipedal standing with the dominant foot. Compared with the semi-rigid ankle brace, the elastic tape was more helpful in maintaining medial/lateral TPS during unipedal standing with ankle eversion.

Computer-Assisted Auscultation: Patent Ductus Arteriosus Detection Based on Auditory Time–frequency Analysis

Po-Hsun Sung, William Reid Thompson, Jieh-Neng Wang, Jhing-Fa Wang, Ling-Sheng Jang

This study presents a computer-assisted auscultation approach for patent ductus arteriosus (PDA) detection. PDA is a frequent congenital heart disease in neonates. The early detection of the PDA murmur from a neonate's heart sound is important to avoid the development of severe respiratory diseases in newborns. Computer-assisted auscultation has the potential to become a heart disease screening tool because it can improve the sensitivity and specificity of heart murmur detection. This study proposes an auditory time–frequency representation method (auditory spectrogram) to demonstrate the dynamic and non-stationary characteristics of heart murmurs. The auditory spectrogram is obtained using the proposed cochlear wavelet transform, which mimics the auditory response of the cochlea in the human auditory system. The auditory spectrogram can represent the heart sounds in the time–frequency domain to assist cardiac auscultation. Furthermore, the spectrum flux and spectrum centroid are used to characterize the configuration of the auditory spectrogram. The phonocardiogram data of 18 patients, including normal heart sounds, innocent murmurs, and PDA murmurs, are used in the blind test for algorithm effectiveness assessment. The results demonstrate that the proposed computer-assisted auscultation method can achieve a high sensitivity of 100 % and a specificity of 91.67 % for PDA detection. The developed method is robust, cost-effective, and convenient, making it effective for the enhancement of the accuracy of PDA detection.

Age-related Changes in Dynamic Postural Control Ability in the Presence of Sensory Perturbation

Yusuke Maeda, Toshiaki Tanaka, Yasuhiro Nakajima, Tomoya Miyasaka, Takashi Izumi, Norio Kato

For the development of fall prevention programs, the dynamic postural control of elderly persons under conditions when their senses are perturbed needs to be investigated. The present study investigates the manner in which elderly persons respond to external perturbations when their visual and somatic senses are disturbed. The subjects included 4 healthy older adults and 6 young adults. In the experiment, external perturbation was introduced through a platform that was movable in four directions (forward, backward, right, and left). The effects of sensory disturbance created by wearing translucent goggles and standing on a soft floor were examined. The responses were measured in terms of the center of pressure (COP) on the force plate, the electromyographic (EMG) activity, and the joint angle from video analysis. The COP analysis showed that the older group, especially in the presence of sensory disturbances, required a longer time than that for the younger group to return to an erect standing position after external perturbations (recovery time). The EMG indicated that the older group used the articular muscles of the knee to respond to postural perturbations involving up-and-down movements. The recovery time is a characteristic parameter of the response to external perturbations in the presence of sensory disturbances, and thus a potentially useful indicator in evaluating balance ability. The increases in knee muscle' activities were due to reduced ankle joint torque, which is presumably one of the causes of the prolonged recovery time. These findings could be applied to the development of fall prevention training.

Scapular Motion Tracking Using Acromion Skin Marker Cluster: In Vitro Accuracy Assessment

Andrea Cereatti, Claudio Rosso, Ara Nazarian, Joseph P. DeAngelis, Arun J. Ramappa, Ugo Della Croce

Several studies have recently investigated how the implementations of acromion marker clusters (AMCs) method and stereo-photogrammetry affect the estimates of scapula kinematics. However, in the large majority of these studies, the accuracy assessment of the scapular kinematics obtained with AMCs was carried out through a comparative evaluation using a scapula locator that is prone to error. The present study assesses AMC accuracy based on best practice recommendations, both with single and double anatomical calibration implementations, during several passive shoulder movements. Experiments were carried out on three cadaveric specimens. The scapula motion was acquired with a stereo-photogrammetric system using intra-cortical pins. When the scapula kinematics was estimated using an AMC combined with a single anatomical calibration, the accuracy was highly dependent on the specimen and the type of motion (maximum errors between –6.2° and 44.8°) and the scapular motion was generally overestimated. Moreover, with this implementation, scapular orientation errors increased for shoulder configurations distant from the reference shoulder configuration chosen for the calibration procedure. The double calibration implementation greatly improved the estimate of the scapular kinematics for all specimens and types of motion (maximum errors between –1.0° and 14.2°). The double anatomical calibration implementation should be preferred since it reduces the kinematics errors to levels which are acceptable in most clinical applications.

Effect of Congenital Anomalies of the Papillary Muscles on Mitral Valve Function

Yonghoon Rim, David D. McPherson, Hyunggun Kim

Parachute mitral valves (PMVs) and parachute-like asymmetric mitral valves (PLAMVs) are associated with congenital anomalies of the papillary muscles. Current imaging modalities cannot provide detailed biomechanical information. This study describes computational evaluation techniques based on three-dimensional (3D) echocardiographic data to determine the biomechanical and physiologic characteristics of PMVs and PLAMVs. The closing and opening mechanics of a normal mitral valve (MV), two types of PLAMV with different degrees of asymmetry, and a true PMV were investigated. MV geometric data in a patient with a normal MV was acquired from 3D echocardiography. The pathologic MVs were modeled by altering the configuration of the papillary muscles in the normal MV model. Dynamic finite element simulations of the normal MV, PLAMVs, and true PMV were performed. There was a strong correlation between the reduction of mitral orifice size and the degree of asymmetry of the papillary muscle location. The PLAMVs demonstrated decreased leaflet coaptation and tenting height. The true PMV revealed severely wrinkled leaflet deformation and narrowed interchordal spaces, leading to uneven leaflet coaptation. There were considerable decreases in leaflet coaptation and abnormal leaflet deformation corresponding to the anomalous location of the papillary muscle tips. This computational MV evaluation strategy provides a powerful tool to better understand biomechanical and pathophysiologic MV abnormalities.

Time Course of Change in Movement Structure During Learning of Goal-Directed Movement

Makoto Suzuki, Hikari Kirimoto, Kazuhiro Sugawara, Yusuke Kasahara, Takayuki Kawaguchi, Ikuyo Ishizaka, Sumio Yamada, Atsuhiko Matsunaga, Michinari Fukuda, Hideaki Onishi

Primary and secondary submovements are important in human movements. The purpose of this study was to examine the time course of changes in kinematics and electromyography (EMG) parameters for primary and secondary submovements associated with the learning of a goal-directed aiming movement task. The subjects comprised 9 neurologically normal adults. They were instructed to make horizontal planar movements of elbow flexion that were both fast and accurate. The learning session comprised 20 blocks of 10 movements. Our research found that the kinematics- and EMG-related parameters of the antagonistic triceps brachii muscle gradually changed over the course of the learning period and reached a plateau that fitted an exponential function. However, the EMG parameters of the agonistic biceps brachii muscle did not markedly change. Moreover, the kinematics- and EMG-related parameters for the primary and secondary submovements varied at different rates during the motor learning. Our findings may facilitate the understanding of the learning of a goal-directed aiming movement in sports and rehabilitation settings.

Impact of Haemodialysis on Insulin Kinetics of Acute Kidney Injury Patients in Critical Care

Ummu K. Jamaludin, Paul D. Docherty, J. Geoffrey Chase, Geoffrey M. Shaw

Critically ill patients are occasionally associated with an abrupt decline in renal function secondary to their primary diagnosis. The effect and impact of haemodialysis (HD) on insulin kinetics and endogenous insulin secretion in critically ill patients remains unclear. This study investigates the insulin kinetics of patients with severe acute kidney injury (AKI) who required HD treatment and glycaemic control (GC). Evidence shows that tight GC benefits the onset and progression of renal involvement in precocious phases of diabetic nephropathy for type 2 diabetes. The main objective of GC is to reduce hyperglycaemia while determining insulin sensitivity. Insulin sensitivity (S_I) is defined as the body response to the effects of insulin by lowering blood glucose levels. Particularly, this study used S_I to track changes in insulin levels during HD therapy. Model-based insulin sensitivity profiles were identified for 51 critically ill patients with severe AKI on specialized relative insulin nutrition titration GC during intervals on HD (OFF/ON) and after HD (ON/OFF). The metabolic effects of HD were observed through changes in S_I over the ON/OFF and OFF/ON transitions. Changes in model-based S_I at the OFF/ON and ON/OFF transitions indicate changes in endogenous insulin secretion and/or changes in effective insulin clearance. Patients exhibited a median reduction of −29 % (interquartile range (IQR): [−58, 6 %], $p = 0.02$) in measured S_I after the OFF/ON dialysis transition, and a median increase of +9 % (IQR −15 to 28 %, $p = 0.7$) after the ON/OFF transition. Almost 90 % of patients exhibited decreased S_I at the OFF/ON transition, and 55 % exhibited increased S_I at the ON/OFF transition. Results indicate that HD commencement has a significant effect on insulin pharmacokinetics at a cohort and per-patient level. These changes in metabolic behaviour are most likely caused by changes in insulin clearance or/and endogenous insulin secretion.

Effect of Immunocompromising Therapy on In Vivo Cell Survival in Musculoskeletal Tissue Engineering

Sebastian E. Dunda, Laura K. Krings, Markus F. Ranker, Christoph Wruck, Sabien G. van Neerven, Ahmet Bozkurt, Norbert Pallua

Replacing soft tissue after trauma or tumor surgery remains a major challenge in reconstructive surgery. A promising alternative is the possibility of using bioartificial musculoskeletal tissue created out of primary muscle cells. However, poor survival of transplanted cells and suboptimal matrix qualities limit the development of bioartificial tissues (BATs). Furthermore, granulocyte infiltration into BATs also appears to impair cell survival. Therefore, this study investigates how immunocompromising therapy affects the survival of transplanted myoblasts in a three-dimensional vascularized BAT. Myoblasts(4×10^6) were transfected with a luciferase-reporter sequence and then transplanted into an in vivo bioreactor placed within the abdominal wall of Wistar rats. Bioluminescence was used to monitor the myoblasts in vivo. The rats were either not treated (group 1, control) or subjected to immunocompromising therapy that involved daily administration of cyclosporine A (group 2), prednisolone (group 3), or both (group 4). Bioluminescence monitoring showed that luminescence signals on day 7 were significantly higher in all immunocompromised animals than those in the animals in the control group (group 2:$p < 0.0001$; group 3: $p = 0.0073$; group 4: $p = 0.0053$). Moreover,TUNEL analysis revealed that the apoptosis rate was significantly lower in the cyclosporine-A-treated group than that in the control group ($p = 0.037$). Our results indicate that cyclosporine A and prednisolone enhance the in vivo survival of transplanted myoblasts and thus they can be considered as a supportive medical treatment for increasing cell survival after cell transplantation in tissue engineering.

國內研討會：

- 第四次 TREATS 學會暨第五次 TSICF 學會聯合學術研討暨論文發表大會
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- 台灣私立醫療院所協會 104 年度醫學工程研討會
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  網址：http://www.taipei-cma.org/news.html

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國際研討會：

- IUPESM 2015 - World Congress on Medical Physics & Biomedical Engineering
  Toronto, Canada. June 7 - 12, 2015.
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- Montreal'2015 AES-ATEMA 22nd International Conference
  Montreal, Canada. June 15 - 19, 2015.
  https://montreal2015aesatema.wordpress.com/

- Quebec City'2015 AES-ATEMA 23rd International Conference
  Quebec City, Canada. June 22 - 26, 2015.
  https://quebec2015aesatema.wordpress.com/

- ICMBSE 2015 : XIII International Conference on Medical and Biological Systems Engineering
  Singapore, SG. July 4 - 5, 2015
  https://www.waset.org/conference/2015/07/singapore/ICMBSE

- 7th WACBE World Congress on Bioengineering
  Singapore, SG. July 6 - 8, 2015
  http://www.wacbe2015.org/

- Prince Edward Island'2015 AES-ATEMA 24th International Conference
  PEI, Canada. July 6 - 10, 2015.
  https://pei2015aesatema.wordpress.com/

- Toronto'2015 AES-ATEMA 25th International Conference
  Montreal, Canada. August 10 - 14, 2015.
  https://toronto2015aesatema.wordpress.com/

- The 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC'15)
  MiCo - Milano Conference Centor - Milan, Italy. August 25 - 29, 2015.
  http://embc.embs.org/2015/

- 13th International Conference of Numerical Analysis and Applied Mathematics (ICNAAM 2015)
  Rodos Palace Hotel, Rhodes, Greece. September 23 - 29, 2015.
  http://www.icnaam.org/

- Ottawa'2015 AES-ATEMA 26th International Conference
  Ottawa, Canada. October 12 - 16, 2015.
  https://astaa2015.wordpress.com

- The 17th IEEE International Conference on E-health Networking, Application & Services (IEEE Healthcom 2015)
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