多了一層的守護力量，讓我們能更安心地欣賞山岳景致 / 呂理雍攝
With more protection, we will feel more at ease getting into the mountains. / by Li-yong Lyu

把行蹤傳出去

科技 讓愛山更無礙

Technology Makes Enjoying Landscape of Mountains Easier

Passing on the Last Whereabouts

很多愛山的人之所以喜歡登山，是想要享受那份與世隔絕、寧靜致遠的感覺。不過，身處在原始山林之中，如果未做好完全準備，也會讓自己陷入危難之中。而善用日新月異的先進技術，更能經常深入山林的山友或研究人員「無後顧之憂」，像是前期報導過的紅外線自動相機，就可安裝在動物出沒的熱點，運用熱能感應原理，拍攝動物的畫面，免去研究人員在山裡餐風露宿等候還可能撲空的窘況，也能節省研究經費；而針對山難事件，台灣亦研發出協助搜救的利器——「山難黑盒子」。它可以記錄登山者足跡，又像病毒傳播一樣，可以讓登山客變成「帶原者」，擦肩而過時交叉傳染散播登山足跡。如此一旦山難發生，只要找出任一帶原者，就能定位待援登山客行蹤，搜救人員就能抓緊黃金救援時間，待援者不再就不用在山上枯等無助，家屬毋須在山下心急如焚。

而在了解「山難黑盒子」研發過程前，先看看下面這段山難故事……

2009年1月，心臟內科醫師蘇文政在台東嘉明湖附近墜崖身亡。入山申請資料顯示，他上山是為了尋找2008年10月在該處失蹤、可能早他一步罹難的山友江秋萍。

蘇醫師擁有數十年登山資歷，一向熱心探勘山難搜救的緊急下撤路線。據友人說，蘇醫師認為江秋萍如果不幸罹難，也要幫忙找到遺體讓往生者安息。他將搜救路線圖留給太太，約好當晚就回家，但——沒能兌現。

Many mountain lovers like mountaineering for the feeling of seclusion and peace. But to avoid getting into trouble, we have to be prepared, say applying state-of-the-art technology ,when in the pristine mountains. The camera trappers reported in the previous issue, for instance, detect animals' body temperature and take pictures of them, saving not only the trouble for researchers but also the money. As for mountain accidents, a device called “The Mountain Accident Black Box” was developed by Taiwan to assist rescue work. Recording the mountaineers' footprints, the box is just like a virus that turns every mountaineer into a carrier, who in turn spreads the virus when running into others. Thus if an accident happens, the whereabouts of the mountaineer can be located as long as a carrier is identified. Thus the rescue work can be done in time and precious lives can be saved.

Before we get to know how the box was developed, let's read about this mountain accident:

In January 2009, a cardiology doctor named Wen-zheng Su fell off a cliff and lost his life at Jiaming Lake in Taitung when looking for another mountain hiker, presumably dead, Qiu-ping Jiang.

A mountaineering veteran, Su had been enthusiastic about exploring emergency retreat routes. He is trying to at least find Jiang's body to help her soul rest in peace. Su had promised his wife his safe return but he failed to keep his word.

高山上的氣候變化無常，登山者需格外留意。 / 鄭真義攝
The climate in the mountains is capricious, so mountain hikers should always take extra caution. / by Jhen-yi Jheng

採訪撰文 Interview & Text ／張碧慧 Joyce Chang
特別感謝 Special thanks to ／中央研究院資訊科學研究所助研究員陳伶志 Ling-jyh Chen Assistant Research Fellow of Academia Sinica、黃致豪博士 Jyh-how Huang, Ph.D.、林政翰先生 Mr. Zheng-han Lin
翻譯 Translator ／歐冠宇 Kuan-yu Ou

多山的台灣，有許多單位從事山難救援工作。圖為消防局救難訓練過程。/ 歐陽台生提供
In the mountainous Taiwan, many people are engaged in the rescue work. The picture is taken during a rescue training held by the fire bureau. / Photo provided/ Tai-sheng O'Young

台灣在登山救援技術上經常與國外交流。圖為美國救難專家來台訓練畫面 / 歐陽台生提供
Taiwan often makes exchanges with other countries on mountain rescue skills. The photo was taken when an U.S. rescue expert came to Taiwan to offer a training session. / Photo provided/ Tai-sheng O'Young

米亞桑戶外中心負責人、受過美國 WMA 專業野外急救訓練的林政翰1月13日一早加入搜救蘇醫師的行列。他和南搜搜救隊員才開始搜索兩小時，就聽到無線電傳來尋獲遺體的噩耗。

根據蘇醫師的姿勢研判，他是從身旁落差達100多公尺的山崖墜落。為什麼他會走上如此危險的陡坡？友人猜想，為了找出山友下落，他似乎刻意尋找危險地形……。

直昇機也幫不上忙

遺體在酷寒荒野中又等了一夜才不得已用人力背負下山。林政翰回憶，找到蘇醫師當天他們將附近樹木砍除，升起狼煙。沒想到氣流將狼煙下壓，直昇機盤旋兩小時就是看不見他們的蹤影。

是的，山難搜救最難就難在確認待援者方位。別說人力地毯式搜索彷如大海撈針，可能錯過黃金救援時間；就連直昇機速度快，台灣山區普遍林木茂密、氣候多變的情況下也常無功而返。

為了解決山難搜救的瓶頸，今年成功攀登聖母峰、目前在台大電機所進行博士後研究的黃致豪，五、六年前突發奇想：為什麼不把個人所學的網路通訊技術，應用在自身熱愛的登山領域呢？

Two days after Su went missing, a rescue team started a mission. Among the rescuers was Zheng-han Lin, who had been trained by Wilderness Medical Associates (WMA). Two hours later, he heard through radio Su's body was found.

His idea has now been realized in the form of a mountain rescue black box: Cenwits Search and Rescue System. Co-director of the project, Ling-jyh Chen, Assistant Research Fellow of Academia Sinica, says this system will be in use this Nov. in Yushan National Park to facilitate timely rescue to hikers in need.

Not Even a Chopper Could Help

The rescue team had to spend the night in the wild and carry Su's body down on back the next day because the smoke signals were suppressed by the strong air currents, and the chopper just couldn't see them after hovering for two hours.

Yes. The most difficult part of mountain rescue is to locate those waiting to be rescued. Aside from the time-consuming on-foot search, even choppers may be of little help in dense forests with whimsical weather in mountains in Taiwan.

To solve this problem, Jyh-How Huang, who just climbed Mt. Everest and now doing his postdoc in NTU, had found 5 or 6 years ago that network communication technology had a great potential.

他的想法已經落實成真正的山難黑盒子——山文誌登山資訊系統。據主導這項無線搜救系統研發的中央研究院資訊科學研究所助研究員陳伶志表示，這套系統已在玉山國家公園實地測試成功，預定今年11月將正式啓用。玉管處希望將來結合入山管理制度，申證同時提供黑盒子讓山友配戴，一旦發生意外就能快速鎖定搜救範圍，提供待援者即時協助。

擦身而過，瞬間交換行蹤

所謂的山難黑盒子，在小小黑盒內裝了 GPS 接收機、無線傳輸器、軌跡記錄器及記憶體。它可以記錄登山者的行蹤(軌跡)，當途中與人相遇，也會自動交換相遇時間、地點，以及兩人更早前各自與其他登山客相遇的所有記錄。換句話說，就像陳伶志形容的，這套系統很像學校的接力賽跑，登山客會接力傳輸行蹤資料，最後只要有一個人抵達系統中繼站，所有資料就可以回傳基地台。當山難發生，馬上就能查出待援者行蹤。

和目前的山難搜救相比，這套系統最大的貢獻是每個擦身而過的人都可以提供正確訊息。黃致豪解釋，現行山難搜救依賴目擊者提供待援者行蹤的蛛絲馬跡。且不說口耳相傳的資料準確度存疑，有時反而誤導延誤搜救；更大的麻煩是，山難發生後上哪裡尋找目擊者？特別是迷路大多在上山途中發生。上山比較累，累就容易影響判斷力、注意力，容易迷路或失足墜崖。因此，和上山失蹤者錯身而過的人，通常正在下山。這些人下山後各奔東西，很難找來詢問，有了山難黑盒子，就可以改善這問題。

相對於現行搜救，山文誌系統的另一優勢是成本較低。搜救直昇機出勤一趟，估計花費二、三十萬油錢。而黑盒子量產後約可降到每只1,000元，中繼站架設成本每座約一、兩萬，3G 網路傳輸費用每站每月375元。以玉山主峰登山線為例，每日容納80人上山約需購置100只黑盒子，外加架設4至5個中繼站，換算最大購置成本約為22萬元。

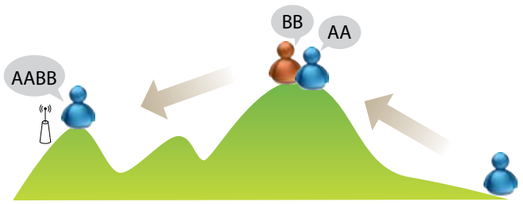
His idea has now been realized in the form of a mountain rescue black box: Cenwits Search and Rescue System. Co-director of the project, Ling-Jyh Chen, Assistant Research Fellow of Academia Sinica, says this system will be in use this Nov. in Yushan National Park to facilitate timely rescue to hikers in need.

Exchanging Whereabouts upon Encounters

The black box contains a GPS receiver, a wireless transmitter, a track recorder, and a memory device. It records the whereabouts (tracks) of a hiker, and exchanges all the information with another black box carried by another hiker. The on-going process, Chen says, acts like a relay race, with hikers passing on all the accumulated information, which will be transmitted to a relay station and may help find those waiting to be rescued.

Compared to the current rescue methods, Cenwits may collect accurate information exchanged at each encounter. Huang explains that traditionally, words passed on by witnesses could be fragmented and misleading. Also, hikers get lost mostly on their way uphill as they tend to feel tired and lose focus, and witnesses meet those missing mostly on their way downhill, and are hard to find afterwards. With the help of this black box, information can be easily gathered.

Another advantage of Cenwits system is its low cost. A tour of chopper search would cost NT$200,000 to 300,000. In contrast, each black box costs NT$1,000, each relay station NT$10,000 to NT$20,000, 3G network transmission fee NT$375 per month per station. Take the hiking route of Mt. Jade Main Peak, which requires 100 black boxes for a daily maximum of 80 hikers, and 4 to 5 relay stations, for example. The total annual cost would be NT$222,500, equaling the cost of one single tour of chopper rescue.



交錯而過的登山客互相交換軌跡資料，先一步下山的人便可將紀錄資料帶下山。
Mountain hikers who encounter one another exchange track data, so that the first to get off the mountains can bring the data down.

有高科技產品輔助，人們愛山更無憂 / 賴宛靖攝
With the aid of high-tech products, mountain lovers can feel more assured when going into the mountains. / Photo taken by Wan-ching Lai

不過，陳伶志強調，這套系統絕不能取代現行搜救。這套系統可以保證提供的必定是正確訊息，但不能擔保百分百的登山安全。系統在最佳情況下，只能提供出事山友最後一次和人相遇的正確地點，倘若山友從頭到尾未與人相遇，或最後相遇後又走失很遠，都必須仰賴專業搜救人員判斷後續行蹤，再行搜索。

先鋒部隊，一定要專業

搜救人力專業與否，對救援成功機率影響很大。黃致豪表示，如果第一個上山搜救的人很有經驗，救援成功機率就大。專業搜救人員不僅熟悉當地地形，知道哪些路段容易迷路，還會從腳印、折斷樹枝等判斷出事者行蹤。由他們做先鋒，可以排除類似不戴手套、腳套就進入犯罪現場搜索，足跡雜沓反而破壞寶貴線索的情況。

曾連續四年協助美國山區救難協會來台救難訓練的林政翰也表示，美國山區救難，第一批上山的通常少於12人。這一批每組3人的精簡人力，本身都是優秀的登山隊員，搜救時常常碰上濃霧、大雨、雪地等惡劣天候，才不會救人反要人救。更重要地，這批人只負責搜索而不救難。搜救＝搜索＋救難，但其實救難是相對容易的固定技術，最大困難度在搜索。這批先鋒部隊的特色就是具備追蹤線索、腳程快的搜索專業。

Chen stresses, however, this system could never replace current rescue methods. It can provide accurate information, which at best contains the location of a missing hiker's last encounter with other hikers, but it may not guarantee his/her safety if the last encounter happens a long time ago or there's no encounter at all.

Vanguards Must Be Professional

The success of a rescue, Huang says, is determined by whether the first rescuer going into the mountain is well experienced. A professional rescuer is familiar with local terrain, is able to tell the tracks of the missing by their footprints or the twigs broken by them, and searches the scene with care without ruining valuable clues.

Zheng-han Lin, who had assisted trainings given in Taiwan by Mountain Rescue Association (USA), says that the first team of rescuers should be fewer than 12 members, with 3 in each group. These are real professionals capable of overcoming adverse situations like heavy fogs, storms and snow. They only “search” but not “rescue” because the former is much harder and more important than the latter. These vanguards are truly good at fast hiking and clue-tracking.

讓專業搜救人員優先抵達現場，再搭配山難黑盒子提供的正確訊息，未來，也許不會再有家庭，必須承受蘇醫師或江秋萍家屬所經歷的痛苦。發想黑盒子構想的黃致豪期待，不只玉山國家公園，這套系統將來能推廣到各地熱門登山路線。「如果這套系統能救幾條人命，這一生就沒有白費了」他說。

With professional rescuers acting fast and Cenwits black box offering accurate info, there may be no more such tragedies as cases of Dr. Su and Ms. Jiang. Expecting the black box to be widely used in popular hiking routes, Huang says: “If this system may save more lives, then our life will not be in vain.”

6

1. 山難黑盒子主要由 GPS 接收機(黑)及無線傳輸器(灰)組成 / 陳伶志提供
The mountain rescue black box is mainly composed of a GPS receiver (in black) and a wireless transmitter (in gray). / Photo provided by Ling-Jyh Chen
2-3. 外掛在登山背包的圓形儀器是 GPS 接收機，將來會整合在僅約名片盒大小的黑盒子內部。 / 陳伶志提供
The circular GPS receiver, hung out on the backpack shown in the picture, will be integrated into the black box, the size of which is about that of a business card box. / Photo provided by Ling-Jyh Chen
4. 多了份科技系統的保護，讓愛山的距離也能更近了些 / 陳伶志提供
With the protection from the technology, mountain lovers can get closer to the mountains. / Photo provided by Ling-Jyh Chen
5. 無限傳輸器近照。小小的電子產品，是經無數人投注的心力與精神所研發而來 / 陳伶志提供
Picture of a wireless transmitter. Such a small electronic product is the result of numerous researchers' efforts. / Photo provided by Ling-Jyh Chen
6. 有了周全的準備就可終結山難的發生，敬山就能樂山 / 鄭真義攝
Accident could be avoided as long as you are fully prepared, just show the mountains your due respect and climbing can be easy and enjoyable. / by Jhen-yi Jheng

陳伶志博士簡介
Profile of Dr. Ling-Jyh Chen

中央研究院資訊科學研究所助研究員。研究主題涵蓋無線網路、行動網路、臨機網路等三大方向，主要研究目標在提供行動網路使用者永遠最佳的網路連線服務、提供間歇性網路有效的資料傳輸服務。

Assistant Research Fellow at the Institute of Information Science, Academia Sinica. His research topics include wireless networks, mobile networks, and opportunistic networks. He focuses on providing the best network connection to users and offering effective data transmission in occasionally connected networks.