海域巡防尖端科技利器：無人操控航空載具在亞太地區的蓬勃發展

Recent Development of Unmanned Aerial Vehicles in Asia-Pacific Regions

◎文/吳東明、蘇漢霖、許智傑

◎Article/Wu Tong-ming, Su Han-lin, Hsu Tsu-jay

一、前言

自第一次世界大戰早期，英國初次進行研發計畫，以製造生產遠距遙控無人駕駛航空載具(Remotely Controlled Pilotless Aircraft)，進而對抗德國空中飛船(German Airships)，並且有效降低飛行員的折損數量。雖然這些無人駕駛航空載具的操作任務用途，在以往超過四十年間均被軍方所應用，以為執行目標偵蒐及監視等任務載具系統(Reconnaissance and Surveillance Vehicles)。並且在研發載具的其他用途方面，其所需費用成本相較時下者，展現明顯非常低廉成果。根據諸多正面理由所佐證，製造廠家仍選擇審慎依循無人駕駛航空載具路徑，持續進行研究改良開發工作。

最終這些無人駕駛航空載具即被正名為無人操控航空載具(Unmanned Aerial Vehicles；UAVs)，並且直到現今仍保留相對簡易型載具設計概念，而捨棄攻擊性用途的更為複雜型載具設計(Complex Vehicles for Offensive Uses)。除有限少數載具外，直至西元一九九三年間，大多數無人載具功能僅備有限續航能力，通常是沒有搭載武器系統，僅擁有基本自衛能量，並且主要被應用於直接支援陸海表面作戰武力(Direct Support of Surface Forces)。

I. Preface

Since the early phase of World War I, the UK has begun developing the skill to produce remotely controlled Pilotless aircraft to counter the airships of the Germans to decrease the pilot causalities in efficiency. Then for over forty years later on, these pilotless aircraft have been used and practiced by the military to execute missions and act as reconnaissance and surveillance vehicles. In developing other functions of the vehicle, the researching cost was relatively low to current budget, which definitely turned out under-satisfying results. Base on many positive evidence, manufacturers have meticulously chosen the way they carried on the development and research works of such vehicles.

The remotely controlled pilotless aircraft was finally and officially called as unmanned aerial vehicle (UAV) and many compact vehicle designs are still kept and can be seen in current ones. It is evident that manufacturers have abandoned the making of more complex vehicles for offensive

無人操控航空載具科技業已被充份應用，藉以提供戰場指揮官，有關近似即時目標偵蒐及監視情報資訊(Near-real-time Reconnaissance and Surveillance Information)、電子作戰支援(Electronic Combat Support)及作戰傷亡評估(Battle Damage Assessment)等，並且確保友軍儘量減少損傷或遠離風險。同時現今科技正值突飛猛進階段，可容許該無人操控航空載具(UAVs)，扮演若干其他空中戰力的功能角色，諸如採用全自動模式(Totally Autonomous Mode)，或從空中或陸海表面站臺(Airborne or Surface Stations)等遠距遙控指揮，執行電子作戰、攻擊及空中防禦等(Electronic Combat, Strike and Air Defense)軍事任務。另由於在推進系統(Propulsion Systems)、複合材料(Composite Materials)、多元頻帶隱匿功能(Multi-spectral Stealth)、導航控制系統(Guidance Systems)，及感測儀器與武器系統小型化(Miniaturisation of Sensors and Weapon Systems)等方面，現今科技均有突出研發改良表現，因此亦促使目前生產相對價格低廉的無人操控航空載具成為可能，並且適合執行廣域多元目標任務角色作業，其中包括有扮演攻擊性武器(Offensive Weapons)的積極功能角色[1]。

自從西元一九九0年代初期，若干亞太軍事強權國家(Asia-Pacific Military Powers)，諸如澳大利亞、中華人民共和國、印度、日本、大韓民國、新加坡、泰國及中華民國等均業已開始研究開發一系列無人操控航空載具(UAVs)，以期能執行軍事活動偵蒐及戰場監視等特殊任務(Reconnaissance and Battlefield urveillanceMissions)。

二、澳大利亞

澳大利亞陸軍航空部隊(Australian Army Aviation；AAAvn)正積極評估各種不同應用無人操控航空載具等概念，以期擔任前線戰場觀測及偵蒐監控等任務角色(Forward Battlefield Observation and Surveillance Role)。最終澳大利亞陸軍航空部隊可能決定，採購一組能夠執行150公里範圍偵察任務，並且能夠適合多重任務角色的無人操控航空載具機隊(Fleetof Multi-role UAVs)。

基於靶機目標拖曳(Target Towing)及電子作戰模

uses. Except a limited models of vehicles, since the WWI to 1993, most unmanned vehicles only had restricted endurance and rarely were equipped with heavy weapon systems other than self-defense abilities. These vehicles were applied to provide direct support of surface forces.

The unmanned aerial vehicle technology is currently applied in wide ranges to provide war field commanders with near-real time reconnaissance and surveillance information, electronic combat support, and battle damage assessment to ensure a minimal casualties and risks for friendly troops. With advancing technology breakthroughs, it is advisable to cast UAVs to play a part in current aerial forces. These vehicles can engage in totally autonomous mode or can be remote controlled from airborne or surface stations to carry out electronic combat, strike and air defense missions. With breakthroughs in propulsion systems, composite materials, multi-spectral stealth, guidance systems and miniaturization of sensors and weapon systems, it is highly possible that we produce budget sensitive UAVs. They are also applicable to perform multiple missions including aggressive roles as to act as offensive weapons.

Since the beginning of 1990s, several military powers in Asia-Pacific region, such as Australia, PRC, India, Japan, Korea, Singapore, Thailand, and ROC, have gradually developed and researched into a series of UAVs to carry out special missions such as reconnaissance and battlefield surveillance.

II. Australia

The Australian Army Aviation (AAAvn) has actively assessed various UAVs to act as the device to do forward battlefield observation and surveillance role. The AAAvn may in the end decide to procure a fleet of multi-role UAVs to carry out

圖一 澳大利亞陸軍金迪維克型次音速型無人操控航空載具 Picture1 Jindivik Subsonic UAV pf Australian Armed Force

子作戰模擬(Electronic War Simulation)等軍事任務目的，澳大利亞陸軍(Australian Armed Forces)可能會應用由澳大利亞航空太空科技公司(Aero Space Technologies of Australia)所研發建造的金迪維克型次音速型無人操控航空載具(Jindivik Subsonic UAV)，詳請參看圖一所示。

三、中華人民共和國

中華人民共和國(The People's Republic of China)嘗試研究開發無人操控航空載具迄今已有數年，在事實上已研製完成佈署一套名為CJ-1C型無人操控航空載具系統，並且該系統能從「運八型渦輪螺槳戰術運輸機」(Shaanxi Y-8 Turboprop Tactical Transport)上被發射施放，詳請參看圖二所示。至於該系統配備有中國自行研發製造的渦輪噴射引擎(Domestically Developed Turbojet Engine)，原本係被應用為一防空砲兵對航空器炮火射擊訓練(Anti-aircraft Artillery Gunnery Practice)的易於操控之目標靶機拖曳系統(Manoeuvrable Target Towing System)。

中共現今仍持續積極與位於俄羅斯卡佔的蘇愷OKB設計局(Kazan-based Sokol OKB Design Bureau of Russia)進行討論，以期研製生產DAN型多任務用途的無人操控航空載具，並且業已成功交付與人民解放軍的空軍部隊(People's Liberation Army Air Force ; PLAAF)服役應用。毫米短波雷達(Milli-metric Wave Radar)或反雷達波搜索器(Anti-radiation

reconnaissance missions within the range of 150 kilometers.

As for target towing and electronic war simulation, the Australian Armed Forces has adopted the Jindivik Subsonic UAV developed by Aero Space Technologies of Australia to meet the tasks. (See Picture 1)

III. People's Republic of China

The People's Republic of China has attempted to develop UAVs for years. In fact, it has already finished deploying a similar system called CJ-1C, which can be carried by a Shaanxi Y-8 Turboprop Tactical Transport and launched it. (See Picture 2) The system is equipped with a domestically developed turbojet engine and was originally used as a maneuverable target towing system in the anti-aircraft artillery gunnery practice.

The PRC has kept active discussions with Kazan-based Sokol OKB Design Bureau of Russia to develop the DAN-type multi-role UAV. The system has already delivered to the People's Liberation Army Air Force (PLAAF) for service. The nose of the vehicle is installed with an optional milli-metric wave radar or anti-radiation seeker. Its function is to do target detection and identification. There

圖二 中國施放CJ-1C型無人操控航空載具的運八型渦輪螺槳戰運輸機
Picture 2 The Shaanxi Y-8 Turboprop Tactical Transport that drops the CJ-1C of PLAAF

Seeker)被裝設於無人操控航空載具的機鼻位置，其用途在於目標偵測及敵友辨識(Target Detection and Identification)，並且在該載具系統上配置有一具雷達高度計(On-board Radar Altimeter)，確保在低空高度巡航時的飛行安全(Low Level Cruise Flight)。

四、日本

在日本，富士重工業株式會社(Fuji Heavy Industries；FHI)在日本國立技術研究開發研究所(Technical Research Development Institute ； TRDI)的管理指導下，業已開發出一新式小型的無人操控航空目標載具(Small Target Drone)。該系統載具被設計從戰鬥機上施放，並且主要被應用於空對空火力射擊訓練實務(Air-to-air Firing Practice)，至於該消耗性型的無人操控航空載具(Expendable Drone)自從西元1987年即開始生產迄今。截至目前為止，該會社業已接獲105架次採購訂單，藉以替代泰利黛雷恩BQM-34AJ火蜜蜂(Teledyne Ryan BQM-34AJ Firebee)型無人操控航空載具。

最近富士重工業株式會社所研發中的無人載具系統係為小型無人操控航空載具。該無人操控航空載

is also an on-board radar altimeter to secure the safety during low level cruise flight.

IV. Japan

In Japan, the Fuji Heavy Industries (FHI) has established Technical Research Development Institute (TRDI) to succeed developing a new small target drone. The system is designed to lunch from a fighter plane and is mainly used in air-to-air firing practice. As for its sibling, the unmanned expendable drone has been produced since 1987. Until now, the Institute has received 105 orders that tend to replace Teledyne Ryan BQM-34AJ Firebee UAVs.

The Institute is currently developing small unmanned aerial vehicles. The vehicle is code named as F-4EJ or F-15J, the design uses delta wings and jet engines, with cruising speed as 0.9 Mach number. In the mean time, the Japan Aviation Electronics Industry (JAEI) has cooperated with NEC Corporation and Tokyo Keiki to develop

具在編號為F-4EJ 或F-15J等研發計畫下實施，其設計為三角展翼式(Delta Wings)，採用噴射引擎，其巡航飛行速度為0.9馬赫(Mach Number)。另一方面，日本航空電子工業株式會社(Japan Aviation Electronics Industry；JAEI)，與NEC日本電氣株式會社(NEC Corporation)及東京電器業株式會社(Tokyo Keiki)等業已共同研究開發一型遠距遙控的直昇機載具(Remotely Controlled Helicopter)，被命名稱為KG-135型空中機器人(KG-135 Sky Robot)，其主要用途係可從空中拍攝清析的地理影像照片。

該機型為3.82公尺長，及1.06公尺高，並且其擁有一具雙水平對臥汽缸，同時(步)點火型引擎(Horizontally Opposed, Simultaneously-ignited Engine)，可以有效提供低振動功能。同時採用一套飛行穩定系統(Flight Stabilization System)，能夠保持飛行姿勢、航向及高度，可減低對空中亂流所造成影響(Turbulence Influence)，並且有效降低載具操控者的工作負荷(Operator Workload)等。其設有雙飛行模式穩定系統(Dual Flight Stabilization System)，可以依循預先規劃路線(Pre-programmed Route)，進行空中飛行任務，並且透過運用數位化信號(Digitized Signals)及特定化信號脈衝長度(Specified Pulse Length)等控制方法，即可規避外在電子信號擁塞干擾情形(Electronic Jamming)。

現今日本仍正在進行，最具企圖心的無人操控航空載具研究開發計畫(Most Ambitious UAV Development Programme)，該計畫係由三菱重工業株式會社(Mitsubishi Heavy Industries；MHI)所統籌，並已成功地將美國洛克希德公司所製F-104J型星際戰士(Lockheed F-104J Starfighter)戰機，修改成為一型無人操控航空器(Unmanned Aircraft)，詳請參看圖三所示。其中首批兩架系統載具已經驗收交付，導航操控員可坐在設有一具操控搖桿(Control Stick)，及由摩托羅拉所供應，以為操控QF-104J型航空戰機飛行(QF-104J Flight)的電視螢幕顯示器(TV Monitor)模擬駕駛艙的地面操縱臺(Ground Console)上操控。

a remotely controlled helicopter, code named as KG-135 Sky Robot, to take high resolution geographical pictures from the air as its main task.

The helicopter measures at 3.82 meters long and 1.06 meters tall. It has a set of horizontally opposed, simultaneously-ignited engines to efficiently generate low vibration power. The model also has a flight stabilization system to keep its flight position, altitude, and direction to reduce the turbulence influence, which effectively lowers the operator workload. It is embedded with dual flight stabilization system and can fly according to pre-programmed routes for assigned missions. Though digitized signals and specific pulse length, it is possible to avoid external electronic jamming.

The most ambitious UAV development program that is undergoing is managing by Mitsubishi Heavy Industries (MHI), and has succeeded in modifying the Lockheed F-104J Starfighter as an unmanned aircraft. (See Picture 3) The very first two batches of vehicles have been checked in, the pilot can use a control stick, developed by Motorola, to control the flight of QF-104J through the TV monitor in the simulation cabin in the ground console.

V.Conclusion

Since the beginning of 1990s, several military powers in Asia-Pacific region have gradually developed and researched into a series of UAVs to carry out special missions such as reconnaissance and battlefield surveillance. As far as South Asia or South-east Asia is concerned, the monitor on executive economic zone (EEZ) during peace time is highly critical for national security, natural resources protection and environmental prtec-

圖三 日本富士重工業株式會社所研製小型F-4EJ無人操控航空載具
Picture 3 The small unmanned aerial vehicle, F-4EJ, developed by FHI

五、結 語

自從西元一九九O年代初期，若干亞太軍事強權國家均業已開始研究開發一系列無人操控航空載具(UAVs)，以期能執行軍事活動偵蒐及戰場監視等特殊任務。無論是在南亞或東南亞等任何地區而言，和平時期的專屬經濟海域(Executive Economic Zone；EEZ)之監視工作，對於其國家安全(National Security)、天然資源保護(Natural Resources)及海洋環境保育(Environmental Protection)等任務均具相當重要關鍵地位。基於前揭國家重要任務因素，必須建置與佈署的海上力量，提供早期預警情資，以協助維持海洋法治秩序，有力逮捕領海水域內外國拖網漁船非法捕漁作業(Illegal Fishing)，確保快速反應處理海洋污染案件，維護海上人命安全等。由於實施新國際海洋法制理念，其直接導致海事監視(Maritime Surveillance)工作重要性的日漸提昇，至於該新法制賦予沿岸及其後鄰等國家，在其延伸海域範圍內擁有不同程度權利，並且同等重要責任。無論如何，各沿海國專屬經驗海域的有效監視工作均是令人畏懼退縮之任務，其涉及廣大水域範圍，海岸防衛隊(Coast Guard)、海軍(Navy)及空軍(Air Force)等有限資產設備與執勤能量，傳統與尖端偵測辨識(Detection and Identification)科技的紛亂應用組合，

tion jobs. Because of national missions, it is necessary to establish and deploy marine power for early prevention intelligence to safeguard marine orders. With this intelligence, it is possible to seize illegal fishing with our marine territory and ensure rapid response to marine pollutions for a better security of people working on the sea. On account of international marine laws, the importance of maritime surveillance is increasing. Thus, these new regulations have endowed coastal and neighboring countries to possess various levels of rights and responsibilities in their extended territory on the sea. No matter, such effective surveillance task in the EEZ is a daunting mission to perform. The mission involves Coast Guard, Navy, and Air Force with their limited resources and performance capacity, a messy combination of conventional and advanced detection and identification technologies to cover the marine and aerial space with the zone.

In maritime surveillance, the two vital effectiveness are in detection and identification tasks. However, it is not sufficient to have just detection.

甚至海域所涵蓋水空域範圍應用等。

至於海事監視工作的執行有效性取決在偵測與辨識等兩項重要關鍵能量。惟事實上，僅有偵測本身是不足夠的。假若一艘漁船被偵測到，能在此海域活動諸多其他船舶中，有效辨識該漁船係極為重要的。因此必要擁有遼闊海域的掃描監視能力，以有效提供高解析度影像(High-resolution Imagery)及近似真時訊號傳輸(Near Real-time Transmissions)等，並且該作業亦必需儘可能經濟有效。針對未來專屬經濟海域的有效海事監視工作之兩種可能選擇方案，即一者是在海域佈署無人操控航空載具(UAVs)，另者係發射該任務指示的人造衛星(Artificial Satellite)。惟考量未來海事監視的應用科技發展，特定海事任務的專責無人操控航空載具設備(Maritime-specific UAVs)佈署應是最佳選擇[2]。

自民國八十九年初成立行政院海岸巡防署(Coast Guard Administration, ROC)以來，其主要任務均係專責維護台灣地區海域及海岸秩序，與資源保護利用，確保國家安全，保障人民權益[3]。同時依據行政院海岸巡防法第四條規定掌理事項[4]，無論海域安全管制、船筏安全檢查、查緝走私偷渡、安全情報調查、海上交通管理、海難搜索救助、漁業資源維護、海洋環境保育及海洋科學研究等海巡法定任務項目，或者海洋地質調查、海域資源探勘，甚至未來國土安全任務，均可見該無人操控航空載具設備的可能應用潛力。時值海巡署策進未來、精亦求精之際，誠應積極引進尖端科技設備，培訓科技應用人力資源，藉以遂行有效打擊非法遏制犯罪，方能達成海巡執法、海事服務及國土安全等任務目標。

（本文作者分別為中央警察大學水上警察學系專任教授兼系主任、海巡署情報處副處長、海洋巡防總局北部地區機動海巡隊科員）

If a fishing boat is detected, it is important to identify the boat among the various ones on the sea. Therefore, it is necessary to have a vast scanning ability on the sea to effectively provide high-resolution imagery and near real- time transmissions to strengthen the efficiency. As for the future maritime surveillance task in EEZ, one of the options is to deploy UAVS while the other to maneuver artificial satellites. To consider the application development, the deployment of UAVs in specific maritime mission is a better choice.

The Coast Guard Administration was established at the beginning of 2000, it is a major unit to safeguard the order Taiwanese marine and coastal areas, protect resource and utilization, ensure national security, and keep people's rights.

In the mean time, base on the Fourth Article of Coast Guard Service Act, it evident that UAV has great potential in the application of various missions, such as marine area security control, raft security check, smuggling seizure, intelligence investigation, marine traffic control, marine accident rescue, fishing resource maintenance, marine environment protection and marine research, marine geological investigation, marine resource exploration, and even national territory security matters. It is now a time for the CGA to look into the future and improve for better performance, so the Administration should actively introduce high-end technologies to cultivate technological talents to effectively stop and seize criminal acts. This will then achieve the goals of maritime law enforcement, maritime services, and national security.

(The author is a professor and Department Head of Department of Maritime Police, Central Police University; Deputy Director of CGA Department of Intelligence; officer of Northern Sector Flotilla, of Maritime Patrol Directorate General)

參考資料：

1.Sengupta, Prasun, K., New Roles Emerging for UAVs, Asian Defense Journal, November 2000, pp.28.

2.Sengupta, Prasun, K., New Roles Emerging for UAVs, Asian Defense Journal, November 2000, pp.31.

3.吳東明及王需楓，國際間區域性港口國管制制度的實施現況及研究發展-我國海岸巡防署的海巡執法因應作為之邏輯思維，第一卷，第二期，執法新知論衡，中央警察大學，中華民國九四年十二月。

4.行政院海岸巡防法第四條規定掌理事項：

(1).海岸管制區之管制及安全維護事項。

(2).入出港船舶或其他水上運輸工具之安全檢查事項。

(3).海域、海岸、河口與非通商口岸之查緝走私、防止非法入出國、執行通商口人員之安全檢查及其他犯罪調查事項。

(4).海域及海岸巡防涉外事務之協調、調查及處理事項。

(5).走私情報之蒐集，滲透及安全情報之調查處理事項。

(6).海洋事務研究發展事項。

(7).執行事項：

a.海上交通秩序之管制及維護事項。

b.海上救難、海洋災害救護及海上糾紛之處理事項。

c.漁業巡護及漁業資源之維護事項。

d.海洋環境保護及保育事項。

(8).其他有關海岸巡防之事項。

Reference:

1.Sengupta, Prasun, K., New Roles Emerging for UAVs, Asian Defense Journal, November 2000, pp.28.

2.Sengupta, Prasun, K., New Roles Emerging for UAVs, Asian Defense Journal, November 2000, pp.31.

3.Status Quo and Research on International Regional Port and Regulation--The Responsive Bahvior and Logic of CGA by Wu Dong-Ming, Wang Xu-Fong, Volume 1, 2nd Period, Law Enforcement Review, Central Police University, December, 2005.

4.Content of the Fourth Article of Coast Guard Act:

(1).Perform the control and the security work of the Coast Control Zone.

(2).Conduct security checks on inbound or out bound vessels or any other maritime transportation.

(3).Investigate and seize smuggling and prevention of illicit entry or exit at the Waters, the Coast, estuaries or non-trading ports.Carry out security checks on travelers at trading ports. Investigate any other crimes.

(4).Coordinate, investigate and handle foreigner-involved affairs about guarding the Waters and the Coast.

(5).Search and collect smuggling information. Investigate and handle the information about infiltration and security.

(6). Conduct research and development on oce anic affairs.

(7). Executing affairs:

a.Control and keep the order of maritime traffic.

b.Salvage, rescue and handling disputes that occur at sea.

c.Patrol and protect fishing zones. Preserve fishing resources.

d.Protect and preserve oceanic environment.

(8). Any other affairs relating to coast guarding.