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THE PROBLEM

Eradication of landmines throughout the world requires the development of technology and mechanical systems that are flexible, reliable, cost-effective, and able to perform landmine detection and mapping of enormous reaches of land. The United States Department of State estimates that 80-110 million landmines litter the world. This prevents growth and development in emerging and redeveloping countries, impedes repairs to infrastructure, and destroys the lives of people living near the minefields. As a result, the United States established the Demining Assistance Program to initiate research and development into cost-effective technologies for wide area detection, marking, and mapping of landmines.

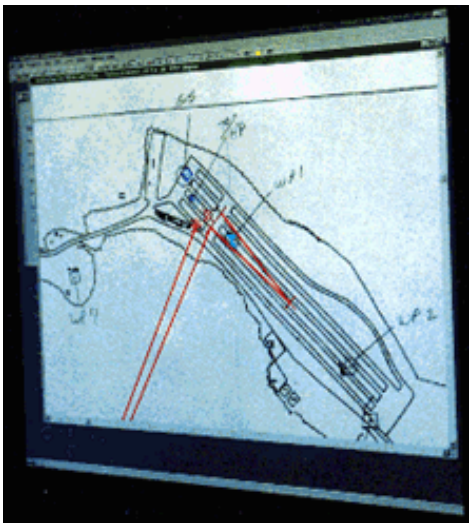
In response to worldwide requirements for Humanitarian Demining, Schiebel Technology, Inc., an independent U.S. based corporation, has focused on the research, development, and production of the CAMCOPTER Unmanned Aerial Vehicle System particularly germane to mechanically assisted landmine detection and clearance.

A SOLUTION FROM SCHIEBEL TECHNOLOGY: THE CAMCOPTER™ UNMANNED AERIAL VEHICLE SYSTEM (UAV)

CAMCOPTER is an unmanned remote controlled/autonomous Vertical Takeoff and Landing (VTOL) aerial platform. Although there is a wide range of civilian and military applications for this system, CAMCOPTER has been particularly successful during Test and Evaluation flights specifically for the detection, identification, mapping, and marking of landmines. The System is comprised of the Aerial Vehicle, the Ground Station, and Support Equipment.

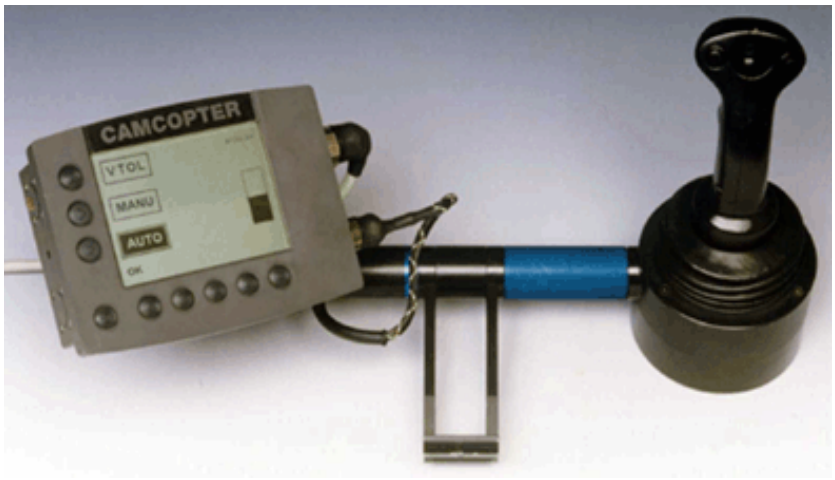
For the purpose of landmine detection, the UAV employs an Inertial Navigation System (INS) coupled with a Differential Global Positioning System (DGPS) for precise positioning, and an Electro-Optical/Infrared Sensor (EO/IR) suite attached to the universal payload mounting base. The UAV is currently powered by a 15 HP two-stroke engine, allowing approximately 55 lbs. of payload. It cruises comfortably at 45 mph with a maximum speed of 56 mph and provides up to two hours of flight time out to 10 km of range.

The payload base, located directly below the main rotor vertical shaft, maximizes the payload weight while remaining within center of gravity limits. Typically, the payload station is used for mounting cameras, sensors, dispensing pods, or pendants for inserting and extracting external loads. However, many more applications are obvious. The engine powers three generators that produce 300 watts of power for the electronics module and payload power requirements. Efforts are underway to integrate and test a 38 HP engine that will provide 900 watts of power, plus additional altitude and lift capabilities.



The Ground Station is a vehicle-mounted Windows NT computer system that allows the operator to conduct mission planning, mission control, view real-time video and data displays, and control the payload via video and data links to the UAV. The Mission Planning Computer provides images to a 20" LCD TFT color display allowing the operator to simultaneously view all mission critical information on pull down windows. This computer is the means by which landmines may be precisely located and mapped.

The Geographical Information System window displays a digital map, selected GPS waypoints, pre-planned and actual route of flight, vehicle and target icons, and markers for position of sensor images. The Camera window displays live images from onboard cameras. These include the fixed mount CCD Navigation Camera providing color or black and white video for navigation and situational orientation and the IR/EO gimbal-mounted cameras for landmine detection and surveillance. The third display on the screen is the Mission Data window which gives flight time, time of return, UAV and sensor point of vision (target) position, and status information. The Flight Control Computer provides data link information to the UAV as control commands based on pre-planned mission data or manual flight control inputs from the Pilot Control Unit.

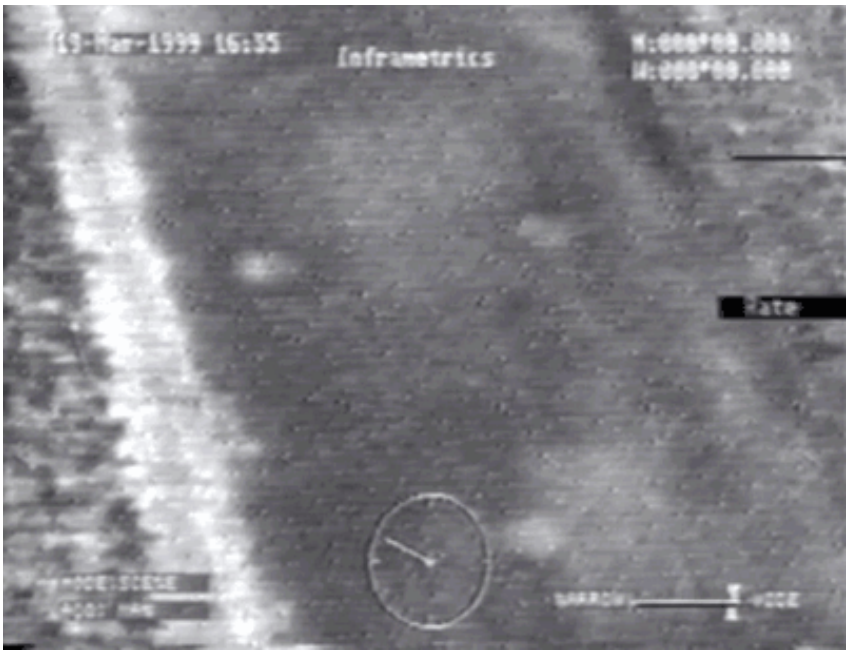


The operator may select from four modes of flight at any given time during the mission. In the Auto Mode, the flight control computers automatically direct the AV along a pre-planned mission program at a pre-planned altitude and speed. In the Manual Mode, the operator controls the AV manually using a joystick. The unique feature in the Manual Mode is that even when the operator is flying manually, flight stability is provided by the onboard computers. The operator is simply providing input to the computer with the joystick. This feature minimizes the training requirement for the operators. Aviation experience is not required to operate the system effectively.

At any point during an Auto mission, the operator may select the Manual Mode and take control manually to perform maneuvers or conduct an intense search of an area. He may then either continue manually or return to the Auto Mode and resume the pre-planned automatic mission.

The Vertical Takeoff and Landing (VTOL) Mode is used for takeoff and landing as well as close in-area search. In this mode, the system reduces the AV's reaction to manual commands allowing the operator to concentrate more on flight conditions or sensor data for a more precise search in the vicinity of the landmines.

Lastly, the Home Mode provides an automatic return to the pre-selected home point. It may be selected manually, or is automatically invoked if the data link to the Ground Station is lost. During mission planning, the Ground Station operator programs the software with the Home Mode instructions. Typically the AV is programmed to hover for a selected period of time, and climb to attempt to reestablish the data link. If the link is not established, the AV returns to the home point via direct or outbound route (as preprogrammed by the operator).



Complementary to this capability are the multi-functional remote control features of the EO/IR suite, providing precise standoff survey capability. The payload controls provide remote focus, zoom, and precision auto-tracking capability. The operator can use these capabilities to conduct very precise surveys at varying altitudes in a variety of environmental conditions.

The Support Equipment for CAMCOPTER includes the antenna array and mast, the remote ground power/starter unit (that falls away from the UAV before takeoff), a generator, and cabling. The entire CAMCOPTER system including the UAV is contained inside a Ford Expedition giving no outward appearance of the functional mission.

The system is simple to operate and may be employed quickly. Once an operating location is selected, the two operators can unload, assemble, and prepare for takeoff in a 20 minute period. No additional support equipment or specialized surface is needed.

OTHER APPLICATIONS OF THE CAMCOPTER

In support of the U.S. Army Humanitarian Demining Research and Development Program at the Night Vision and Electronic Sensors Directorate at Ft Belvoir, VA, Schiebel Technology, Inc. has conducted a series of wide area mine detection test and evaluation missions using the CAMCOPTER with the EO/IR Gimbal sensor. The "mine lanes" at Fort A.P. Hill, Virginia provides and ideal test site with various types of soil and vegetation where a variety of mines have been buried for over two years. The average depth of the mines is 2-6 inches. The images of the landmines collected during the tests clearly show the location, shape, and size of buried mines. These tests validated the ability of CAMCOPTER to detect buried landmines and retain precise location using the DGPS data. During these tests it became evident that a VTOL platform proved to be a highly responsive standoff detection tool.

To date, the CAMCOPTER Team has focused on the Infrared sensor as the sensor of choice for landmine detection, however several other capabilities are being actively researched. In keeping with incorporating off-the-shelf technology to the maximum extent possible, Schiebel is exploring the utility and reliability of five key technologies to enhance the "tool kit" of the demining professional.

- Ground Penetrating Radar
- Vapor Sample Collector
- Large Format Mapping Camera
- Improved Fixed Mount Infrared Camera
- Explosives Placement

The Ground Penetrating Radar (GPR) is currently being tested and flown on fixed wing platforms and is readily adaptable to CAMCOPTER. This system incorporates a Synthetic Aperture Radar (SAR), which collects data along the mission path. The SAR image yields high resolution with reduced ground clutter. This low-cost system surveys at the rate of 10 to 40+ acres per hour using a standoff, oblique angle technique for producing true 3D images. The oblique angle technique allows the energy transmitted through the surface to be maximized, reducing surface backscatter and improving the visibility of near surface buried mines.

The Vapor Sample Collector is an adaptation of the South African MEDDS system. The CAMCOPTER carries a vacuum pump, suspended collection intake system, and collection tubes on board. The Ground Station maps the precise location where samples are taken and the collected air samples are returned for analysis by dogs or a laboratory. This provides a safe low-cost means to conduct a rapid area survey to detect the presence of explosive vapors or verify that an area has been cleared.

Deminers need adequate and up-to-date maps from which to conduct their operations. The Large Format Mapping Camera takes aerial photographs of what the minefield looks like today, which can then be tailored to meet current needs. This system can also be digitally reproduced to serve as the CAMCOPTER map.

There certainly will be instances when non-government organizations in particular would prefer a lower cost alternative to the gimbaled IR. The Improved Fixed Mount IR Camera provides capabilities similar to the gimbal system at a reduced cost, making it

an attractive alternative. Although forfeiting some of the gimbal features, this camera is well suited to landmine survey techniques.

Explosives placement for landmine clearing may be accomplished by precisely placing small explosive charges using the onboard cameras. The charges may then be detonated remotely from a standoff position. CAMCOPTER has tested for the precise placement of external loads with resounding success.

THE FUTURE OF THE CAMCOPTER

As Humanitarian Demining efforts continue throughout the world, CAMCOPTER provides the appropriate low-cost technology to perform a variety of standoff landmine detection and clearance support operations while keeping personnel at a safe distance from the landmines. The CAMCOPTER Unmanned Aerial Vehicle System introduces a new generation of standoff landmine detection equipment that promises a breakthrough in demining survey, detection, and clearance capabilities.