ATMOS UAV

High-tech startup with game-changing ideas

Since the early years of aviation, aircraft manufacturers have taken multiple shots at aircraft that combine vertical take-off and landing (VTOL) with horizontal cruise flight - an idea that to this day continues to be technologically challenging. ATMOS UAV successfully applied this concept to unmanned aerial vehicles (UAVs) resulting in a portable, lightweight and practical system with unprecedented specifications.

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High-tech start-up ATMOS UAV is developing a new type of small-unmanned aircraft that distinguishes itself from current market offerings in both design and capabilities. The unique design is best described as a clever combination of a fixed-wing aircraft and a helicopter, utilizing the advantages of both. The ability to take off and land vertically removes the need for a runway or other additional infrastructure for launch or recovery. Furthermore, the system is able to fly at very low speeds or hover for stationary measurements and observations, while the mission area can still be traversed quickly with a relatively high cruise speed. Since wing-borne horizontal flight is a substantially more efficient means of flight than hovering, the range and flight endurance of the vehicle are greatly increased. An additional advantage of the ATMOS system is its ability to handle rough weather and high winds much better in comparison to other VTOL UAVs of similar size and mass.

Despite the efforts of several aircraft manufacturers and research institutes, combining VTOL with horizontal flight still proves to be a technological challenge: only a small number of VTOL aircraft are in operation today, with the Harrier Jump Jet and the Bell-Boeing V-22 Osprey being the best known examples. Both have had a development process known for numerous setbacks, resulting in substantial unanticipated costs and delays. Part of the technological difficulties associated with VTOL aircraft can be overcome by using unmanned aircraft. Flight dynamics and control are no longer limited to human comfort and the system can have lower mass and higher agility. This allows for a fundamentally different design for the ATMOS UAV. Instead of tilting the thrust units (as it is applied in the V-22), the entire aircraft tilts forward in order to make the transition to horizontal flight. This reduces the mechanical and structural complexity considerably. This unique design leads to a UAV with unprecedented operational flexibility and favorable specifications. This concept capitalizes perfectly on the current trend that requires UAVs to be capable of performing an increasingly wide range of different, but complementary operations within a single mission. A depiction of the concept of the ATMOS system is illustrated in Figure 1.

AUTOMATED FLIGHT

A high level of flight automation is an important design objective for ATMOS UAV, as this decreases the operator's workload, thereby increasing situational awareness and focus on the mission. Since auxiliary equipment (e.g. a catapult) is not required for take-off and landing, it furthermore allows routine flights to be executed without intensive human interaction. Finally, flight automation increases the overall system safety. Studies show that human errors - not only control errors but also misperceptions and decision-making errors - are currently one of the main causes for UAV crashes (Asim et al., 2010 and Thompson, 2005).

When operating the ATMOS UAV system, the end user does not control the aircraft's actuators directly. Instead, the user enters the desired mission objectives into the ground control station. A complete mission can be planned beforehand and executed automatically, while real time alterations to the mission plan remain possible at all times. Subsequently, the vehicle translates this human input into a complex set of low level commands that

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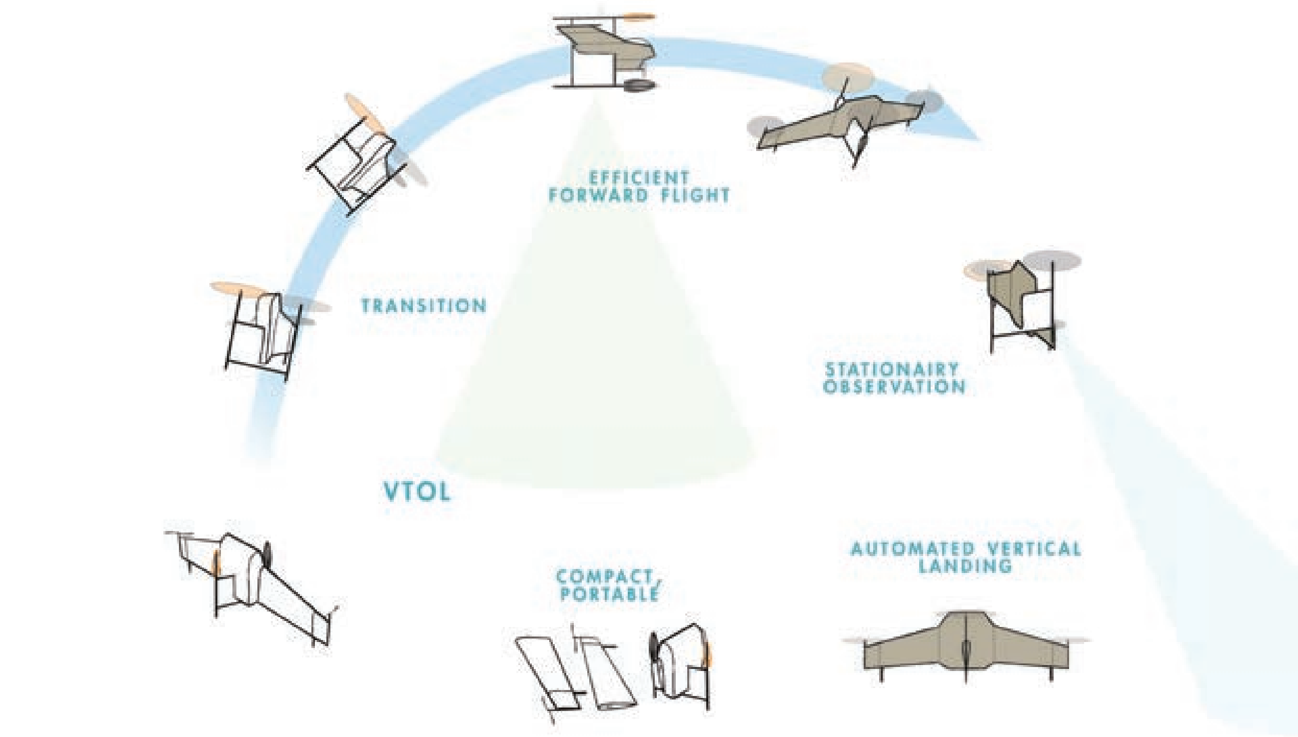

Figure 1. Schematic depiction of a typical mission of the ATMOS system.

determine the actual flight path. As a result, the user does not have to focus on keeping the vehicle safely airborne, without forming a hazard to other air traffic, interfering with airspace regulations or escaping the safe flight corridor. The user can fully focus on the received imagery, process the information in it and carefully devise the next step in the observation mission. The ground control station furthermore provides an easy interface to control the payload (e.g. pan/tilt of a camera), and allows multiple vehicles to be easily controlled by one operator.

HISTORY & FOUNDING OF THE COMPANY

The company was founded in June 2013; however, the six founders have been working on the technology for over two years. Originating from a Design Synthesis Exercise (DSE), a bachelor graduation project at the Delft University of Technology, the ATMOS team initially elaborated the conceptual design for participation in the UAVForge challenge, an international competition with the goal of performing a complex surveillance mission with a UAV. The design was promising and the team was selected to compete in the final fly-off held in May 2012 to put the system to the test. In four short months the design was transformed into functional prototypes and the novel control theory was further developed and implemented in the autopilot software.

The challenge, organized by the US research institution DARPA, was in fact so complex and demanding that none of the competing teams were able to complete the entire course without complications. Nevertheless, the ATMOS team left quite an impression with the transitioning vehicle that was different from the other more conventional designs and also turned out to be the only vehicle able to fly fully automated. The flights performed during the challenge were in fact, to the best of the team's knowledge, the first fully automated flights of a multi-modal UAV ever. The final result for the ATMOS team was a respectable third place out of the 140 initial contestants. This valuable result, together with the striking appearance and distinctive transition flight of the vehicle, led to a growing interest from the university, the media, but also the industry. After the competition, ATMOS UAV was additionally rewarded with the UfD Bachelor Grant and the UfD Teamwork prize. Furthermore, the Dutch Aerospace Fund (NLF) acknowledged the company with the Dutch Aerospace Award in November 2013.

The team consists of six aerospace engineers, each with a specialty in a different field, resulting in a complete and complementary set of disciplines required for the design and production of unmanned aerial systems. This unique combination of in-house knowledge is one of the preconditions for a successful high-tech company. Coupled with the growing demand from the market it was a logical decision for the team to bring the project to a higher level and commercialize the technology.

EMERGING CIVIL DRONE MARKET

The first unmanned aerial vehicles were already used during World War I, starting with the development of Hewitt-Sperry's automatic airplane (Pearson, 1997). Up until the last decade, research and development of UAVs was mostly performed for military purposes. Currently, however, the civil market segment is rapidly expanding (Teal Group, 2012). Ongoing technological developments in the area of electronics, sensors, propulsion and energy storage result in increasingly lower cost and higher performance of those components and allow UAVs to become available to civil users. This technological revolution, together with growing public acceptance, is accompanied by a wide range of new opportunities and applications.

In many situations, unmanned aircraft are a cheaper alternative for manned aircraft, and can even add additional capabilities. This allows them to be deployed more often and for multiple purposes, with much higher flexibility compared to traditional methods. Unmanned systems are beneficial for search and rescue teams, firefighters, and other emergency response teams as they can have an overview of a situation instantaneously. In addition, the surveillance of industrial areas (e.g. refineries or power plants) can be performed at relatively low cost and effort with UAVs. Also, inspections of industrial assets like windmills or gas-flares can be performed in a safer and cost efficient manner.

A promising application is precision agriculture: a UAV equipped with a multispectral camera captures detailed images of crops. This allows the farmer to detect local lack of nutrients, lack of irrigation or disease afflicted plants and take appropriate and targeted actions, resulting in an increased crop yield. UAVs offer valuable possibilities in other sectors as well. In geodesy, UAVs are used for performing land surveys and volumetric analyses of bulk materials. In wildlife conservation, they are being deployed for localizing poachers. In the television and film industry, they shoot a scene from a birds-eye view, and in real estate they take appealing photos of a property for sale.

Besides using unmanned aircraft for observation purposes, scenarios are being investigated where UAVs are deployed as a means of cargo transportation. The delivery of consumer packages on demand is an example. However, it will take years before the regulatory and procedural framework has evolved sufficiently to integrate such infrastructure in the airspace. Moreover, delivery in urban areas is still technologically challenging. However, this concept is definitely a promising solution for cost-efficient transportation of emergency supplies to areas afflicted by (natural) disaster or for distributing vaccines or medication to regions without proper infrastructure.

LEGISLATION

Entrepreneurs and companies have noticed the fact that this new market offers great potential globally. In the Netherlands alone, some 150 companies have already been founded that are exploring the opportunities of the technology. The problem they are facing, however, is that putting the legal aspect of their operations in order is currently remarkably complicated. As it is often the case for newly introduced technology, a regulatory and procedural framework has not been fully defined yet. Currently, it is only possible to fly small unmanned systems legally by requesting exemptions on laws of both local and national authorities, a cumbersome and time-consuming procedure, that is moreover poorly and inconsistently documented. UAV operators, designers, researchers and manufacturers are spending too much time and effort in getting familiar with them and satisfying accompanying administrative obligations.

The Netherlands has a great opportunity to become a significant player in the global drone market, as it has a leading position in related industries, such as high-tech sensor and data processing technology. The current (lack of) legislation, however, negatively affects development and proliferation of UAV technology. This contrasts with neighboring countries, where a more adequate and straightforward legislation is in effect. Possibly, Dutch companies will feel compelled to move their operations abroad for this particular reason. That is one of the reasons why the Dutch Association for Remotely Piloted Aircraft Systems (DARPAS) was founded, representing the interests of the professional Dutch UAV community. It pleads for easier procedures and better communication and incites the legislators to accelerate the generation of a workable and safe regulatory framework that stimulates and supports the expansion of the industry.

KEY APPLICATIONS OF ATMOS UAV

Small UAVs, and especially multi-rotors, are being used at an increasing rate for civil applications, yet end users claim to repeatedly experience the same set of drawbacks of current systems. One of the often-heard complaints about these systems is the limited flight time. Although many manufacturers of VTOL UAVs of this size claim flight times of up to 40 minutes, in practice these UAVs even struggle to reach 10 minutes of consecutive flight. For a lot of applications however, switching to fixed wing systems is not an option, since fixed wings do not offer stationary observation and often come with cumbersome operations for deployment or recovery, requiring a runway, catapult and/or catching mechanism. Furthermore, most of the existing systems highly depend on the communication link; a lost link often results in a crash. Since all flight control of the ATMOS UAV is executed on-board, the vehicle is not dependent on a stable communication link. All of the above make the ATMOS UAV the preferred option in many applications. The key specifications of the system are shown in table 1.

ATMOS UAV has a strong focus on inspection and surveillance applications where quick response time, reliability and mobil-

Figure2. Artist impression of the ATMOS system performing coastal inspection

Figure 3. Team members conducting final flight checks on the sixth prototype

Figure 4. Flight-test of the sixth ATMOS prototype

ity are important aspects. Targeted end users are companies with large industrial assets, emergency response organizations and security companies. The ATMOS system can also be used as replacement for existing fixed-wing UAVs of a similar size, reducing deployment time and complications during take-off and landing. An example of such a surveillance application is the automatic routine scanning of large industrial areas such as port areas, producing high-resolution maps at scheduled intervals. These maps subsequently can be used for the detection of unwanted disturbances, monitoring of construction site progression or documenting changes in large container storage areas. Furthermore, the system would be very suitable for inspections of critical infrastructure, such as dikes or coastal areas. In Figure 2 the ATMOS UAV is illustrated performing a coastal inspection.

Another surveillance application worth mentioning is the deployment of ATMOS UAV on ships and other offshore assets. The VTOL capability ensures that the vehicle can easily take off from ships, while the forward flight capabilities allow the vehicle to withstand windy sea conditions and quickly travel the required distances. A feature that is especially useful in supporting security teams on freighters operating in and near pirate hot spots. The problem these teams face is distinguishing pirate vessels from fishing boats or trade ships. Although the detection of neighboring boats is already possible, the identification of those vessels and the level of threat are still hard to determine (Gard AS, 2012). The ATMOS system can be used as a flexible tool to identify those possible threats considerably quicker.

FUTURE

Currently ATMOS UAV is in the stage of product development. The next milestone is a product pilot in the summer of 2014 that will showcase the full functionality of the system and demonstrates its benefits to interested parties and potential customers. The product launch is planned in spring 2015. It is the goal of ATMOS UAV to establish a high-end brand recognized for reliable and practical unmanned aerial systems and to grow the company into one of the major players in the industry. Key ingredients for realizing this are a highly flexible and efficient development team, a strong, shared focus, an ambitious business plan and a unique selling point.

Table 1. Design specifications

Design cruise speed	70km/h
Design top speed	100km/h
Range (max)	60km
Hover endurance (max)	20min
Horizontal flight endurance (max)	65min
Payload capacity	500gr
Maximum take-off weight	2500gr
Wingspan	1.5m

For questions about the team, the product, the company or career opportunities, feel free to contact us at:

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