Aiming High

Turkey's Efforts to Develop a Capability in Space Remote Sensing

Since the end of the Cold War, in the NATO countries of North America and Western Europe, defence and security matters have had a much lower profile and emphasis than before. As a result, defence budgets have been cut substantially and - notwithstanding the subsequent civil wars in Yugoslavia - the size of their military forces has been reduced greatly. However, further east, in the Near and Middle East, the situation has been very different with continuing tensions and conflicts and threats of war.

By Prof. Gordon Petrie & Dr. Gurcan Buyuksalih

Although Turkey is a long-standing member of NATO, it has not been able to relax its military preparedness in the manner of its Western allies. In particular, the problems posed by the incursions of terrorist groups based in the northern parts of Iraq and Syria have been a matter of great concern. Furthermore considerable tensions exist with Greece over Cyprus and with Syria over the border area of Hatay around the port of Alexandretta (now Iskenderun) and over the control and supply of the water from the Euphrates and Tigris Rivers whose upper reaches lie within Turkey. The wars in the neighbouring Caucasus republics of the former Soviet Union have also helped to ensure that defence and security remain at the very top of the country's political agenda. One of the many consequences of this situation has been the strenuous efforts by Turkey to gain access to high-resolution space imagery for reconnaissance, intelligence gathering and mapping purposes - especially for those areas lying on both sides of the country's borders. This has taken a number of different forms. These include (i) extensive purchases of space imagery from foreign sources; (ii) the development of a national ground receiving and processing capability; and (iii) serious attempts to develop the capability to acquire space imagery under direct national control.

Mapping from SPOT Stereo-Pairs

With regard to the acquisition and use of foreign space imagery, the military-controlled General Command of Mapping (GCM) - which is the country's national mapping agency - has made considerable use of SPOT stereo-pairs. These have been used both for the updating of Turkey's own extensive topographic map coverage, as well as the mapping or the revision of existing maps of the areas bordering the country. For this purpose, the SPOT stereo-models have been formed both using hard-copy images in Zeiss analytical plotters and using digital images in Autometric SoftPlotter DPWs. The required map data is then extracted visually and manually in 3D using these instruments. In some other cases, a DEM is measured first, on the basis of which, an orthoimage is then generated using either PCI or ERDAS software. Thereafter the map data is extracted monocularly on-screen using a graphics workstation.

Use of Israeli Space Reconnaissance Imagery

As is now well known, Israel operated its Ofeq-3 reconnaissance satellite during the period 1995-99. This was targeted specifically at coverage of the Middle East. With its orbital inclination of 143.4°, Ofeq-3 could only cover the area of the Earth lying between latitudes 36.6°N and S. This meant that it only just covered the northern parts of Syria and Iraq and the island of Cyprus. The assumption of most observers and political commentators is that Turkey received Ofeq imagery of these areas under the Turkish/Israeli accord. In December 2000, the Israeli-backed EROS-A1 commercial satellite (which is basically similar to Ofeq-3) was launched successfully. This produces pan imagery with a 2m ground pixel size. Since the EROS-A1 satellite is in a near-polar sun-synchronous orbit, it can now cover all those territories that are of interest to Turkey and lie within range of the main Israeli ground receiving station located near Tel Aviv. Obviously Turkish agencies should now be able to buy this high-resolution space imagery on a commercial basis.

Fig. 1: High-resolution panchromatic image of Izmir harbour on the Aegean Sea coast of Turkey acquired by the EROS-A1 satellite. (Source: ImageSat International)

Fig. 2: The 13m diameter antenna of the newly constructed ground receiving station installed at Istanbul Technical University (ITU). (Source: Datron Advanced Technologies)

Satellite Remote Sensing Data

With regard to the medium-resolution Landsat, SPOT, IRS, ERS and Radarsat imagery, use of this data has been growing steadily, principally by civilian government agencies and by universities and research institutes. The images have been used for a large number of different applications, including land cover and land use mapping, vegetation studies, estimation of agricultural crop yields, coastal zone monitoring, etc. Up till now, these images have either been purchased direct from foreign sources or through their Turkish agents. Now however, Turkey is making a big effort to instal its own facilities and develop its own capabilities to receive and process this type of space image data. First of all, a small ground receiving station was purchased from and installed by the American SMARTech company in January 1997. It is located at Gebze on the north-east coast of the Marmara Sea. The station is operated by the Remote Sensing & Digital Image Processing Lab (UZALGIL) of the Marmara Research Centre (MAM) belonging to Tubitak, the Turkish national research organisation. Mostly this facility has been used to acquire and process low-resolution AVHRR imagery from the NOAA satellites.

ITU's Ground Receiving Station

Recently a much larger and more powerful receiving station equipped with a 13m diameter dish antenna has been constructed on the Maslak campus of Istanbul Technical University (ITU) located in the northern suburbs of the city. This has been built largely through the initiative and efforts of Prof. Bingul Yazgan, head of the Telecommunications Division of the University's Faculty of Electrical & Electronics Engineering. The actual receiving station has been supplied by the American company, Datron Advanced Technologies, at a reputed cost of over $10 million. However the University has found it difficult to pay additionally both for the operational costs of the station and the substantial annual licence fees that are needed to allow it to acquire data from the wide range of civilian satellites (e.g. Landsat, SPOT, IRS, ERS, Radarsat) as was originally planned. Thus it is likely that the status of the station will be changed and that, in the future, it will be run as a university-owned company supported by government and other external funding.

It is known that much of the sale of IKONOS high-resolution imagery of the Middle East is to defence and intelligence agencies.

Space Imaging Eurasia

Currently another large ground receiving station is under construction at Golbasi in the Ankara area by Space Imaging Eurasia, an affiliate of the Space Imaging company from the U.S.A. This is being supplied by E-Systems, the principal partner in Space Imaging along with Lockheed Martin. The Turkish company that is building and will actually own and operate the station is Inta Space Systems. This has been set up jointly by Cukorova Holdings (which is one of Turkey's largest conglomerates) and the Uydusan company with 51% and 49% shares respectively. The establishment of this powerful ground receiving station has been controversial, to say the least. Most of the area of Central, Southern & Eastern Europe and much of the Near & Middle East is already covered by the Space Imaging Europe (SIE) ground station based in Athens, Greece. The rest of the Middle East is covered by the ground receiving station of Space Imaging Middle East (SIME) located in Dubai, U.A.E. Indeed there is already a substantial overlap in the ground coverage of these two existing stations. Thus, on the face of things, there was no need for an intermediate receiving station located in Turkey. However it is known that much of the sale of IKONOS high-resolution imagery of the Middle East is to defence and intelligence agencies. Various commentators have reported that the Turkish military authorities (as a potentially large customer for this imagery) were very unhappy with the prospect that the tasking and the data collection from the IKONOS satellite would be carried out under the control of a Greek organisation. Hence the building of the new ground receiving station in Ankara, principally to supply IKONOS imagery to the Turkish Armed Forces. This will come into operation quite soon.

Turkish Aerospace Industry

Given its strong interest in different space-related activities, a long-term aim of the Turkish government has also been to establish a national space-related industry. This would follow on directly from the successful establishment of a substantial aircraft construction industry in the shape of the Turkish Aerospace Industries (TAI). In recent years, this state-controlled company has built large numbers of aircraft and helicopters that have mainly been supplied to Turkey's military forces. Future plans include the construction of both short-range and long-range UAVs (unmanned aerial vehicles) equipped with imagers for reconnaissance purposes. However, up till now, Turkey has lacked the capability to construct, launch and operate satellites. So initially it has purchased a number of satel-

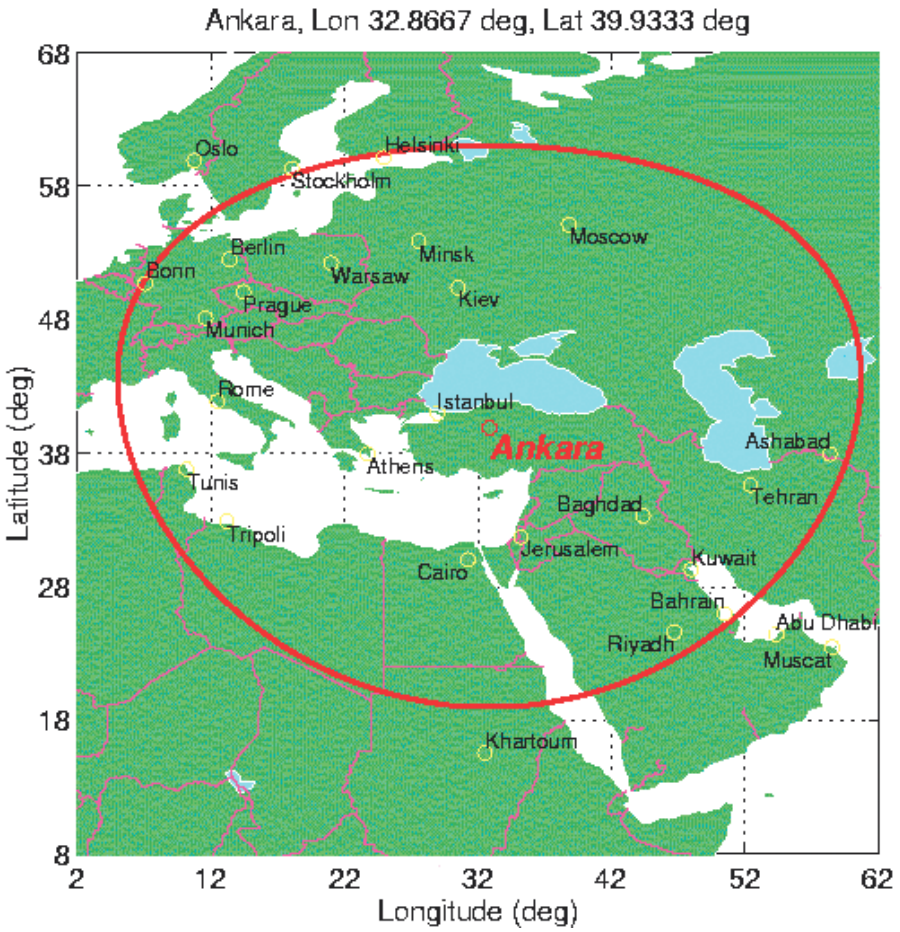

Fig. 3: The ground footprint of the Space Imaging Eurasia receiving station being constructed in Ankara. (Source: Inta Space Systems)

lites, e.g. the Turksat 1B, 1C & 2A communication satellites, from abroad. These have been built by the French Alcatel company. They provide satellite communication links mainly between Turkey and Western Europe and with the Turkic-speaking Central Asian republics of the former Soviet Union. The associated ground stations are located in Ankara and are operated by the state-controlled Turkish Telecom organisation.

Tubitak-Bilten

In line with Turkish government policy, over the last few years, the State Planning Organisation and Tubitak have been taking steps to ensure that the country will acquire a national capability and competence in space technology. Thus Tubitak's Bilten research institute for IT and electronics -which is located on the campus of Middle Eastern Technical University in Ankara - has initiated basic research into areas such as satellite design, satellite dynamics and control, space physics, etc., besides remote sensing. In 1997, Bilten applied to the Turkish Treasury and was given permission to obtain an international loan to fund the development and launch of a small research satellite that would have a remote sensing capability. This would allow knowledge and experience to be gained in a wide range of satellite technologies. To achieve this objective, Bilten looked for a foreign partner that could assist with the requisite technology transfer and simultaneously provide training for its staff. The chosen partner was Surrey Satellite Technology Ltd. (SSTL) in the U.K. This company had already carried out similar collaborative programmes with Korea, Portugal, Chile, Thailand, Malaysia and China that had resulted in the construction and successful launch of several micro-satellites with a remote sensing capability.

Given its strong interest in different space-related activities, a long-term aim of the Turkish government has also been to establish a national space-related industry.

(See the article on "Space Remote Sensing from Micro- & Mini-Satellites" published in the March 2000 issue of GeoInformatics).

BiltenSAT

The agreement between Bilten and SSTL is for the design and construction of an enhanced micro-satellite weighing 100kg and having an optical imaging capability, provisionally called BiltenSAT. The contract is worth $14 million. Starting this summer, this programme will be carried out at SSTL's facility in Guildford, Surrey. A number of Turkish engineers and scientists will be stationed in Guildford and will be directly involved in the design, building, testing and commissioning of the flight test model of the satellite. The contract also provides for the training of Turkish engineers in mission planning and in the operations of the satellite control station. When completed, BiltenSAT will be launched into a Sun-synchronous orbit at an altitude of 650km. The satellite is designed to carry digital frame cameras equipped with CCD areal arrays that will produce pan imagery with a 12m ground pixel size and multi-spectral imagery with a 26m ground pixel size. The satellite will also be fitted with an S-band communications downlink that will transmit the image data to the ground station at 2Mbps. Besides the cameras, provision is also being made for a Turkish designed and built scientific payload.

High-Resolution Intelligence Satellites

The latest stage in Turkey's efforts to acquire an independent space remote sensing capability concerns the Turkish Intelligence Satellite Supply Project. This called for the supply of two much larger high-resolution Earth Observation satellites. Based on Turkey's previous experience, the two main contenders for the contract were Alcatel and Israel Aircraft Industries (IAI). In July last year (2000), IAI - in collaboration with the ElOp company which was to supply the optical imager - was announced as the winner of the competition. The satellites were to be based on the Ofeq design. The cost would be over $200 million. However Alcatel protested the decision and asked to be allowed to submit an alternative offer. In August (2000), the Turkish National Defence Ministry announced that the revised bid from Alcatel had been accepted and the French company would

Fig. 4: A fused pan/colour IKONOS high-resolution image of the Besiktas area of Istanbul, including the Inonu football stadium and the Dolmabahce Palace. (Source: Inta Space Systems)

design and build the two satellites. These would be based on its Isys design utilizing its Proteus small satellite bus.

Cancellation & Postponement!!

However, on 18th January 2001, the French National Assembly passed a bill - which was signed by President Chirac!! - recognising that, between 1915 and 1917, Turkey had carried out a systematic genocide of Armenians during the closing period of Ottoman rule. Needless to say, this caused outrage in Turkey and, on 24th January, as part of a package of retaliatory measures, the contract with Alcatel for the supply of the two high-resolution satellites was cancelled. After this drastic action, it appears that the competition for the supply of the two satellites was re-opened with IAI and Lockheed Martin as the principal bidders. However, at the end of February, an economic crisis then overtook Turkey following the failure of several large banks and the subsequent devaluation of the Turkish lira. As a result, the whole matter of the supply of the high-resolution satellites has been postponed, together with several other major defence programmes.

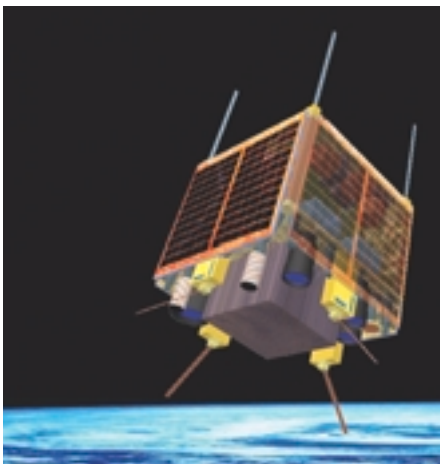

Fig. 5: An artist's impression of the BiltenSAT enhanced micro-satellite having an optical imaging capability. (Source: Surrey Satellite Technology Ltd.)

National Space Agency

Besides the various projects concerned specifically with space remote sensing that have been outlined above, at the strategic level, the Turkish government is also planning to establish a national space agency that would coordinate all of its civil and military space programmes. The agency is expected to become operational over this next year. Officials hope that this will pave the way for Turkish membership of the European Space Agency. If this could be achieved, then undoubtedly this would further assist Turkey in its objective of developing a viable national space programme.

Conclusion

As discussed above, Turkey is making a very determined and sustained effort to develop a national capability in space remote sensing, fuelled largely by its deep concern over the country's security.

Turkey is making a very determined and sustained effort to develop a national capability in space remote sensing, fuelled largely by its deep concern over the country's security.

Professor G. Petrie (g.petrie@geog.gla.ac.uk), Department of Geography & Topographic Science, University of Glasgow, Glasgow, G12 8QQ, Scotland, U.K.
Web Pages - http://www.geog.gla.ac.uk/~gpetrie

Dr. G. Buyuksalih (gurcan61@hotmail.com), Department of Geodesy & Photogrammetry, Zonguldak Karaelmas University, 67100 Zonguldak, Turkey