Title: PARDUS-SAT
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Need

Since the beginning of the known history, there is an unbalanced fight between human and animals. Humans hunted animals for living and survive in the wild. After the developments and inventions hunting term changed into something different. Some people started to hunt animals without any logic just for fun. This illogical action increased by the years and caused extinction to some specific kind of animals. Technology and population increase destroyed natural life in the years and without their habitat animals could not stand long.In different part of the world there are lots of examples for this extinction but as a member of ATILIM University we are very disturbed about illegal hunting on extinction animals in Turkey. There is an extinction animal which called Pardus (Anatolian Leopard). This animal lives in south-western Turkey but some proofs show that it can be seen in other parts of the country. This special animal has been in danger over than 100 years because of illegal hunting. Some scientists believe that there is no more pardus left in the world but the first camera trap photograph of a leopard in Turkey was obtained in September 2013 in the Trabzon Province (Black Sea Region). In November 2013, a leopard was killed in the Çınar district of Diyarbakır Province (South-eastern part of Turkey). The last one before this event occurred in 1974 (Fig.1). These events prove that there are very rare animals still living in these regions. Our aim is to help the preservation of Anatolian Leopard, called Pardus, from extinction. In order to achieve this goal, we need to observe the specific region where Pardus lives. The region is mountainous and difficult to reach. Therefore, there is a need to observe the region, detect and recognize the animals and determine their way of living and number of them. After the tragic and devastating news mentioned above, we think that the most useful method for achieving our goal is to use an observation nano-satellite. We planned to use nano-sat technology to prevent other tragedies. Nano-sat technology will provide reconnaissance and observation of the specific area on the habitat of pardus. The satellite is planned to travel over the region periodically and collect data in the form of coloured images. These images will be downloaded into the ground station installed in the ATILIM University. Well planned and designed a nano-sat system that can observe specific areas and establish a connection between space and ground. We call the system as PARDUS-SAT. After observing and getting specific information, a ground station will collect the data and make analysis about the behaviour of the Pardus. This will help that Illegal hunting can be stopped with only real evidences and scientific proofs about pardus and its habitat. This project aims to claim pardus existance and their movements in specific time periods. Fully prepared nano-sat can observe selected areas and sent instant information to the ground control base. By the help of this technology we hope that there will be no more illegal hunting on Pardus.

The system is designed by the students and researchers at ATILIM University and it is implemented by ASELSAN Company in Turkey.

Figure-1 Tragic events in 1974 and 2013. This torture still continues

Mission Objectives

PARDUS-SAT is a special purpose nano-sat system that aims to provide aerial observation to protect Anatolian leopard (PARDUS) from illegal hunting. Main objective is the control of the selected area to get information about the Pardus and determine their behaviour during specific time periods.

Objectives list;

1- Scanning and finding Pardus in their natural habitat;
2- Collecting information by using camera module in coloured images and sending them to the ground control base station;
3- Observe Pardus movements and create a map of their habitat borders;
4- Observe Pardus breeding and natural contender relations;
5- Prevent illegal hunting and early warning system in dangerous situations.

Concept Operations

PARDUS-SAT is a nano-satellite system that is composed of a space segment and a ground segment. The space segment is the satellite itself. It will travel around the earth in a circular orbit, collect images from the specific region, and send them to the ground station where the images are processed. The ground segment will have the capability to recognize the animals from the images by an intelligent algorithm designed for this purpose, follow them and provide valuable information about the behaviour of the animals and their habitats.
Block diagram of the PARDUS-SAT is shown in Fig.2. As seen, the system has two main parts. The ground segment receives telemetry information through the narrow-band telemetry/telecontrol channel and the data collected through the broadband data link channel. The satellite in the space segment is also controlled through the telemetry/telecontrol channel from the ground station. The space segment and the ground segment are described in the following sections in detail.

The PARDUS-SAT will travel the same region at every week. It will pass through the region during day-lights. It will have a memory capacity of 16 GB. It will take pictures at every 15 seconds. The system is asked to provide the user with the images that are taken simultaneously with the time that the image is taken. It will damp the images to the ground station. Images are processed within the ground station computer by two intelligent algorithms. One of them is an artificial neural-net algorithm based on SVMs and the other is an image matching algorithm based on SURF method.

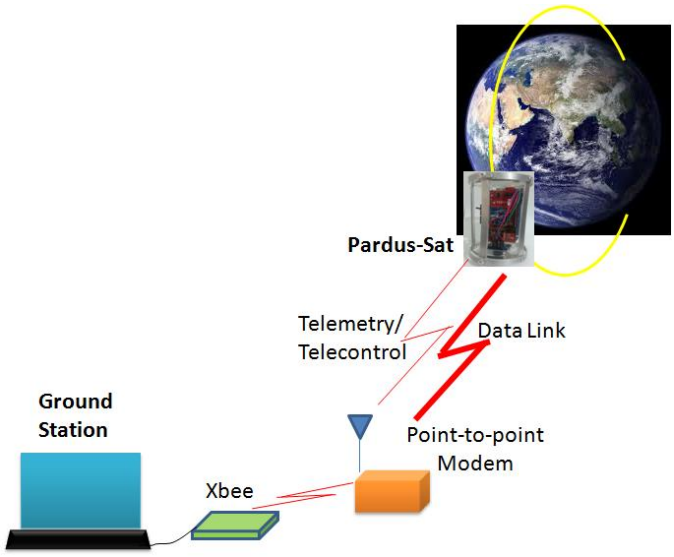

Figure-2 PARDUS-SAT system that is composed of a space segment and a ground segment

Before starting PARDUS-SAT, we experienced with can-sat system as a first prototype for future works (Fig.3). PARDUS-SAT will be a basic nano-sat product but its concept will be unique because purpose of this satellite is a bit different than similar products.

In Fig.3, the first can-sat system designed for observe a selected area by using simple camera module and system launched with a missile to reach desired altitude ,s shown.

Figure-3 The Can-Sat

PARDUS-SAT will have similar conceptual design parameters as can-sat but some modules and main frame will make an explicit change on chassis. To get better images during orbital movement camera module must be good enough to detect pardus in its habitat. Size and weight limitations will directly affect the selection of camera module and shell component.

Key Performance Parameters

PARDUS-SAT is well prepared system to observe pardus in its habitat so sensitivity and repeatability of the camera system must be faultless because main objective is to protect this animal from illegal hunting and to prevent extinction of its kind.
PARDUS-SAT will contain;

1- Coloured camera module
2- Xbee for Serial communication system
3- Dynamic range
4- Precise and accurate data transfer parameters
5- 1 week re-visit time
6- Image resolution < 50 cm
7 – 16 GB memory storage unit for images
8 – Data link with analog point-to-point modem
9 – Intelligent image recognition algorithms at ground station

Space Segment Description

PARDUS-SAT will be a specific observation and data collection system when completed. There will be special modules that help achieving the missions during the different time parts of the year because system will be observing the region where pardus lives 4 times in a mount for 1 year. Air conditions climate changes and other disturbances may create connection loss during missions. The highest priority is the taking clear photos of pardus and sending them to the ground control base without any corruption and delay. To accomplish this mission there have to be special sub-modules those make this possible.

1- Camera Module

After making a decision about mission of PARDUS-SAT the most important part is camera module. Taking pictures of a predator from air is not easy because they are really good at camouflage in the wild lands.
Size and weight limitations inhibit to use huge cameras and wide lenses which are using in ground observations. First design will contain a camera which is designed for nano-sats. The base of the PARDUS-SAT will be designed for this camera to mount easily and take pictures without any blockage.

Picture 2: NanoCam C1U

2- Shell

The outer part the PARDUS-SAT will be designed to keep everything safe and rigid during flight and missions for 1 year. . As for the shell we have had three options. These are Aerogel, Aluminium and Carbon fiber. Carbon fiber is eliminated due to its high cost and not having the tools to machine it. Aerogel is just like a ballistic gel which is used by the security forces to recreate the homicide and test the effects of a bullet on a human skin. This gel is elastic, and melded into a certain shape. It is light. However it has a high cost and in our thought it won't endure the friction during the process. Therefore we have decided to use an aluminium shell. It is simple to machine and easier to obtain. Also it comes with good prices as mentioned above.

3- Communications

Communication is the main problem of this project because the system is asked to provide the user with the images that are taken simultaneously with the time that the image is taken. Therefore we have had three options and these are; XBEE, Phones, and RF Modules. Phones are eliminated when we have decided that it will be impossible to reach the embedded codes inside the mobile phones. A person can ask why a smartphone hadn't been used. The answer is simple. We know that the smartphones have six different operating systems which are, IOS, BlackberryOS, Android, Windows, Symbian and BADA. IOS, BlackberryOS and BADA are closed operating systems which mean that the operator cannot do any software changes on the system. Symbian is a slow operating system and cannot provide us with the needed data transfer speed. Windows phones are quite expensive. Android can be programmed by the user however, android phones have high costs just like Windows phones and iPhones and in order to send the information to a ground control unit we have to have the original embedded code and make differences on it which is impossible since the operating code cannot be reached. However XBEE communication module is very easy to use and possible to amplify its range 25 km during outdoor missions. As we try to achieve communication between PARDUS-SAT and ground control base using XBEE communication module is suitable choice.

4- Power

Deployable solar panels which cover the all faces of the PARDUS-SAT will contain enough power during missions also the geographic position and mission length is very helpful to cover power without any problem.

Orbit/Constellation Description

The PARDUS-SAT will have a circular LEO orbit. The re-visit time is 1 week. In the first application, only one satellite will be launched into the orbit. If one satellite is not enough to satisfy the objective, we also have a plan to increase the number of satellites in the same orbit. The re-visit times will then be increased.

Implementation Plan

Organization: PARDUS-SAT is a student based project that will be possible with funding resources to make it on time and use better equipment to create solid and robust product. Atılım University will give support by letting laboratory facilities and undergraduate student support during production. A partnership with Aselsan Company will produce the satelllite.

Cost: PARDUS-SAT is very wide range project because its main purpose is the protect animals from illegal hunting and prevent extinction of special kinds. This project is more than an engineering design because there is a social part which generates the main idea and spirit up to make it real.

The total cost is estimated as 1 000 000 US dollars.

Conceptual Design	July 2014- Sept. 2014
Engineering Model Construction and test	Sept. 2014- Jan. 2015
Flight Model	Jan. 2015 – May 2015
Launch Prototype	May 2015- July 2015
Constellation Construction	July- 2015- Sept. 2015
Constellation launch	2016
Ground control base design	2016
Ground control base Construction	2016

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