Republic of Tunisia
University of Monastir,
Faculty of Sciences of Monastir

The 2nd Mission Idea Contest for Micro/Nano-satellite Utilization

Microelectronics & Instrumentation
03/UR/13-04

Satellite real time monitoring of water flood and quality in Tunisia

Nader Gallah, Amani Chaouch, Pr Kamel Besbes, Faculty of sciences of Monastir, University of Monastir , Bd Environment, 5019, Monastir, Tunisia
Phone: +216 98627217, Fax: +216 73500278, kamel.besbes@fsm.rnu.tn

INTRODUCTION

Water is one of the most important wealth of our planet, Its scarcity in dry periods and floods in periods of intense rainfall requires continuous and real-time control of dams and lakes. The floods may have many causes combined natural (related to climatic) or anthropogenic direct (drainage, irrigation, soil sealing and soil degradation) or direct human (institutions of locks, dams and lack of management coordination of dams to flood the approach) or indirect human causes linked to global climatic changes.
This is even more important in dry regions, especially in Africa and all south Mediterranean Sea countries. Tunisia, a country with modern human and scientific resources should be among the countries promoter of good management of this resource. During floods, it can be dangerous with when drought is of vital importance that can cause loss of life and displacement of populations. The use of tag-nanosatellites System on rivers, dams, lakes in Tunisia, allow us to control reserve of water for multiple uses, providing energy, water supply, irrigation, low flow support, both the hydro dynamic data that physico-chemical data (water level, debit, turbidity, temperature ...).
This system will monitor real-time movement and quality of large volumes of water with GPS positioning. It will provide hydrodynamic and physicochemical models and simulation.

IMPACT ON ENVIRONMENT

Flood expansion prediction and management of dams.
Real time volume water control of big lakes and dams
Economic water resources data
Models for water deployment in flood situation Development.
Control water conservation and treatment

IMPACT ON SOCIETY

Protect the human being.
Protect the agricultural sector.
Minimize the damage happening due by flooding.
Development of flow models of water.

BUSINESS MODEL STRUCTURE

In a first step, we have to establish a scientific program for this application to validate hardware and network programs in university environment. Funded will be by cooperation programs with state and international agencies
In a Second step, we will start economic program development. A Startup Company can be created in Water GPS-telemetry beacons with multi-mode satellite communication.
Different example of application may be founded in the list below:

- **General Management of Dams and Major Hydrological Works**
- **Public organization responsible for the following tasks:**
  - Prepare hydraulic studies.
  - Develop control studies of surface water.
  - Develop studies of water mobilization.
  - Develop studies of large hydraulic mobilization of surface water.
  - Develop broad studies of hydraulic.
  - Control and assure the maintenance of large dams.
- **Technical Center for Aquaculture, water distribution and irrigation administration**
  - **B**iological and chemical characteristics Control.
  - Analysis and monitoring of water treatment.
  - Pollution control modeling.
- **The Electricity and power production Companies**
  - Distribution of available energy in the reserve of water from a dam depends on its volume.
- **Transfer this experience to other countries in Africa and Asia…**

PROJECT IMPLEMENTATION

This Program will be projected for three years. The available service is according to the life period of the satellite project.
Transmit data hydrologic such as level and water quality of rivers and dams lakes through a nanosatellite by deploying sensors in each of the dams and rivers that can communicate with satellites. The data will take the kind of physicochemical measurements which can be exploited like the conductivity, temperature, turbidity and debit.
The platforms transmit automatically the data to the satellites (constellation HumSat). Each data is sent in the form of a wave with a unique identification number which permits tracking.
Once the platform has sent their data to satellites, these data are downloaded beings by a ground station GENSO. Finally authorized users can access their data via internet connection.
We have two scenarios:
First scenario, University Program: using actual satellite constellation platforms to reduce prices, risks and time to action. (Project HUMSAT-GENSO)
The initial cost is estimated at 0,864M$ and the yearly cost is 0,6M$
Second scenario, future Startup company
The initial cost is estimated at 15,564M$ and the yearly cost is 0,6M$

RISK ANALYSIS

We can meet some risks such as the absence of satellites partners, the rupture of the communication for incompatibility of the protocol and finally the Failures on the level of the beacons.

REFERENCES

[1] M. Djebbi, Delineation of the Flood Prone Zones along the Medjerda River Downstream of Sidi Salem Dam in Tunisia, Journal of Sustainable Watershed Science & Management 1 (2): 46–52, 2012
[2] CH Guillaud, M Trabelssi, Gestion des ressources hydriques en Tunisie centrale: Les projets de Sidi Saad et ElHouareb, Hydrology for the water management of large Rivers Basins (Proceeding of the Vienna symposium, August 1991, IAHS. Publ. N° 201 1991

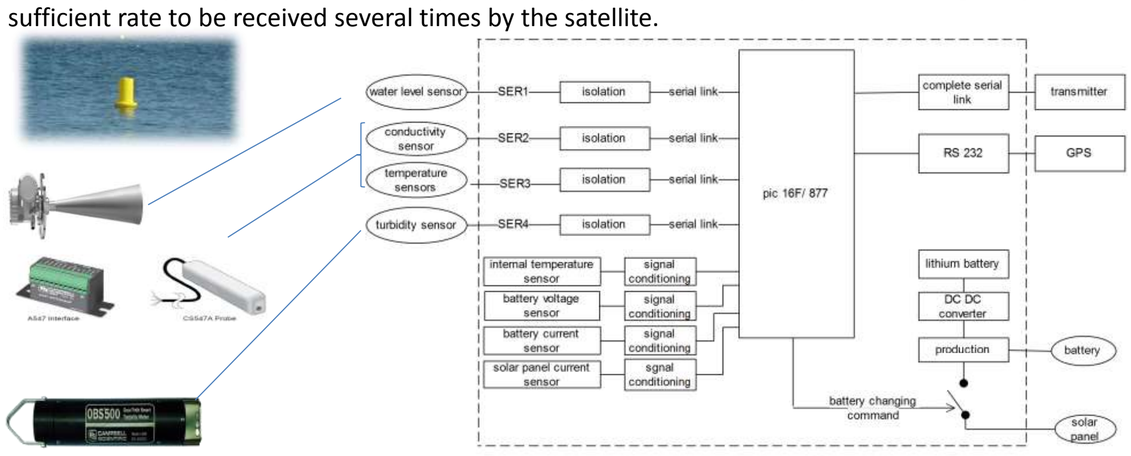
DEVELOPPING PLAN

To achieve our goal, we propose to deploy ground tags able to collect multi-sensors data and sent it to the satellites via (system HumSat), The download of this data are made from the ground stations included in GENSO network. Finally, users will retrieve the data via internet.
The development of this project will be done first by Sciences Faculty of Monastir (University of Monastir), after that it will be done by Startup Company.
The main objective of this idea is protection of Human being life and well management of surface waters.
The initial cost of this plan is 0.864M$ as calculated for University program and 15.564 $M as estimated for Startup Company,
The operation yearly cost will take the value of 0.6 $M for both.

For example in 2012, flooding in the borders between Algeria and Tunisia and mismanagement evacuations dams have caused major floods causing damage estimated at more than $ 30 million.

ARCHITECTURE OF THE ELECTRONIC CARD

The minimum necessary equipment to use Humsat system composed from the electronic unit, its interconnection and the antenna. Additional elements can be provided in order to possibly ensure the range of the ground sensors. The platform electronics conceived to function under the most severe environmental conditions. It is consist of the subsystem UHF (transmitter), microcontroller type Pic 16 F/ 877 and interconnection.
In this system, the platforms are not questioned by the satellites. They emit data regularly with a sufficient rate to be received several times by the satellite.



"Beacon platforms" allow the remote monitoring of hydrological parameters such that**,** reliable platform and has low costs, Main measurement in hydrology of level and water quality, Autonomous solar supply, Protective external box and A receiver GPS integration.
This platform allows the monitoring and the transmission of level and water quality (rivers, dams) by satellite. Physicochemical measurements which can be exploited (conductivity, temperature, turbidity, debit).

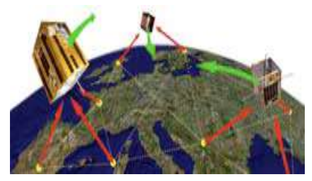
LOGISTICAL FEASIBILITY

General description of Humsat project and GEOID initiative:
Humsat project is an international initiative for building a constellation of nanosatellite providing communication capabilities to areas without infrastructure. It is based on the cubesats standard and using GENSO as ground station.
In fact, GEOID initiative will be a GENSO test bed trough HUMSAT compatible nanosats that ESA will launch in support of the project and for educational purposes. The initial version of system HumSat contains constellation of 9 cubesats.

1.Payload and the bus level of the satellite
2.Number of the satellite

- First scenario: The initial version of the HUMSAT system consists of 9 cubesats.
- Second scenario: Startup company

- **Number and specification of ground stations**
  Launch configuration with reason
  Specification of ground sensors



number of ground sensors	740 sensors in Tunisia	740 sensors in a circle of 1000km radius
information collecting mission scenario	each sensor can uplink for 600/740 =0.81 sec	the size of message is 640 bits (requirements of HUMSAT project)
	Data accumulated in a satellite per one day	740sensors x 640 bits x14 (number of orbit per day of each cubesat) x9=7.4592MB
Mission payload	Information collecting mission with 1200bps	Resources occupation 60%
bus level	low level bus	downlink speed 9.6kbps
number of ground station and comm.speed	1 station with 9.6Kbps	downlink latency 12 hours
number of satellite Scenario 2 (startup)	3 satellites in coordinated orbit	uplink interval 4 hours
number of satellite Scenario 1 (Humsat)	9 satellites in coordinated orbit	uplink interval 1.33 hours

Sensor to space interface	Uplink
Frequency allocation	UHF Radio amateur 435-438 MHz
EIRP	0.5W
Modulation	GMSK
Data rate	1200 bps
Message duration	Up to 500ms
MAC	Aloha with random message repetition
Polarization	Lineal
Receiver sensitively	Better than - 122dBm
Doppler compensation	On satellite

BUSINESS FEASIBILITY

First scenario: University project
calculate initial cost

Cost	M$
Ground sensors	0,814(A sensor cost is assumed to be 700$ per one unit)
Ground station	0,05
Total	0,864

Calculate operation cost

Cost	M$
Ground station operation	0,1
Data analysis (per year)	0,5
Total (yearly)	0,6

Second scenario: Future Startup
Calculate initial cost

Cost	M$
Bus	1,5
Payload	1,2
Ground sensors	0,814(A sensor cost is assumed to be 700$ per one unit)
Ground station	0,05
Launch	12
Total	15,564

CONCLUSION

We believe that our project, in addition to scientific opportunity offered by MIC2, it can create a new synergy in research and training in space technology and move quickly to socio-economic projects to develop new trades and new services in Tunisia and African countries.