# Design and Implementation of an Embedded System for a Novel McPhail Trap

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International Symposium on Ambient Intelligence and Embedded Systems, AMIES 2015
Oostende, 24/9/2015

# Presentation Outline

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- Our Approach
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- Future Work - Challenges

# The Problem I/II

- Over 750 million olive trees are cultivated worldwide, 95% of which are in the Mediterranean region.
- 93% of the European production, comes from Spain, Italy and Greece.
- Greece devotes 60% of its cultivated land to olive growing. It is the world's top producer of black olives and has more varieties of olives than any other country. Greece holds third place in world olive production with more than 132 million trees, which produce approximately 350,000 tons of olive oil annually, of which 82% is extra-virgin.
- Annual national gross incomes, exceeds 1.6 billion Euro.

# The Problem II/II

- One of the main threats for the Olive trees and therefore for the production of the olive oil is ***Dacus - Bactrocera oleae.***
- It is considered the most serious pest towards olives in regions where it presides, significantly affecting both the amount and quality of production in most olive growing areas.
- The damages caused by the olive fruit fly are of two types***: quantitative*** and ***qualitative***.
  - From a **quantitative** point of view, the damage is caused by the removal of the significant proportion of the pulp which as a consequence results in reduction in the yield of olives. Part of the production is also lost due to premature falling of the attacked fruit.
  - A **qualitative** aspect to be considered is the significant deterioration in the quality of the oil extracted from olives with a high percentage of attacks. The oil obtained from infected olives has a high acidity level and a lower shelf life as it has a higher peroxide value.

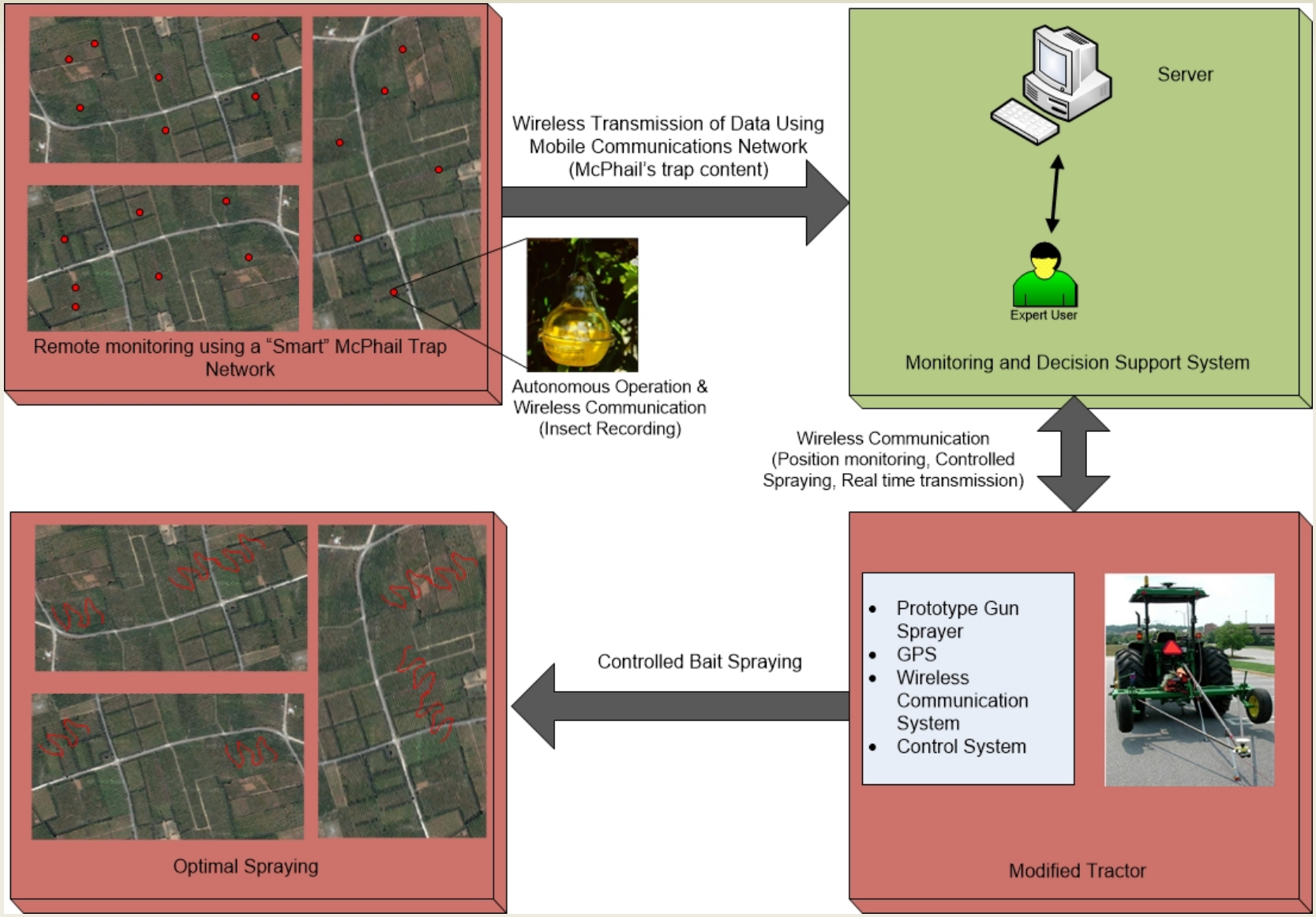
# Current Practice

- Monitoring of the Dacus population using McPhail traps.
- Creating a grid of traps in the areas of interest.
- Each trap contains a 2% of ammonium or protein solution as well as borax in order to attract the flies, it is placed within tree canopy, and the captured insects are counted every 5, 7 or 10 days. When the mean number of captured adults per trap and per week is more than 8-10, bait sprays are applied with the registered insecticide. The attractiveness of such a trap is about 20 m, but it is significantly reduced in a distance of 40 m.

**Disadvantages**

- ✓ Dependence on the procedure of the personnel.
- ✓ Costly process (personnel, logistic aspects etc.).
- ✓ Failure to be either proactive or even in some cases to spray on time.

# Our Approach – An Integrated System for the protection of the olive trees from Dacus



# Automated McPhail Trap I

- We have developed an embedded system to **automate the monitoring process** of Dacus in the field.
- Our main considerations during the design phase where
  - Reliability
  - Robustness
  - Accuracy
  - Low Cost
  - Endurance
- Our approach was based in three core design parameters:

✓ Remote monitoring
✓ Wireless Communication
✓ Minimize human intervention

# Automated McPhail Trap II – Core Components

1. **MSP430F5436 Microcontroller** (16-Bit Ultra-Low-Power Microcontroller, 192KB Flash, 16KB RAM, 12 Bit ADC, 4 USCIs, 32-bit)
2. **A GSM Module** GM862 TELIT with GPRS
3. **2 MP Camera**
4. **LED light array** for internal lighting
5. **3 Power supply modules** (3.3, 3.8 and 5 Volts)
6. **One battery** 12 Volts

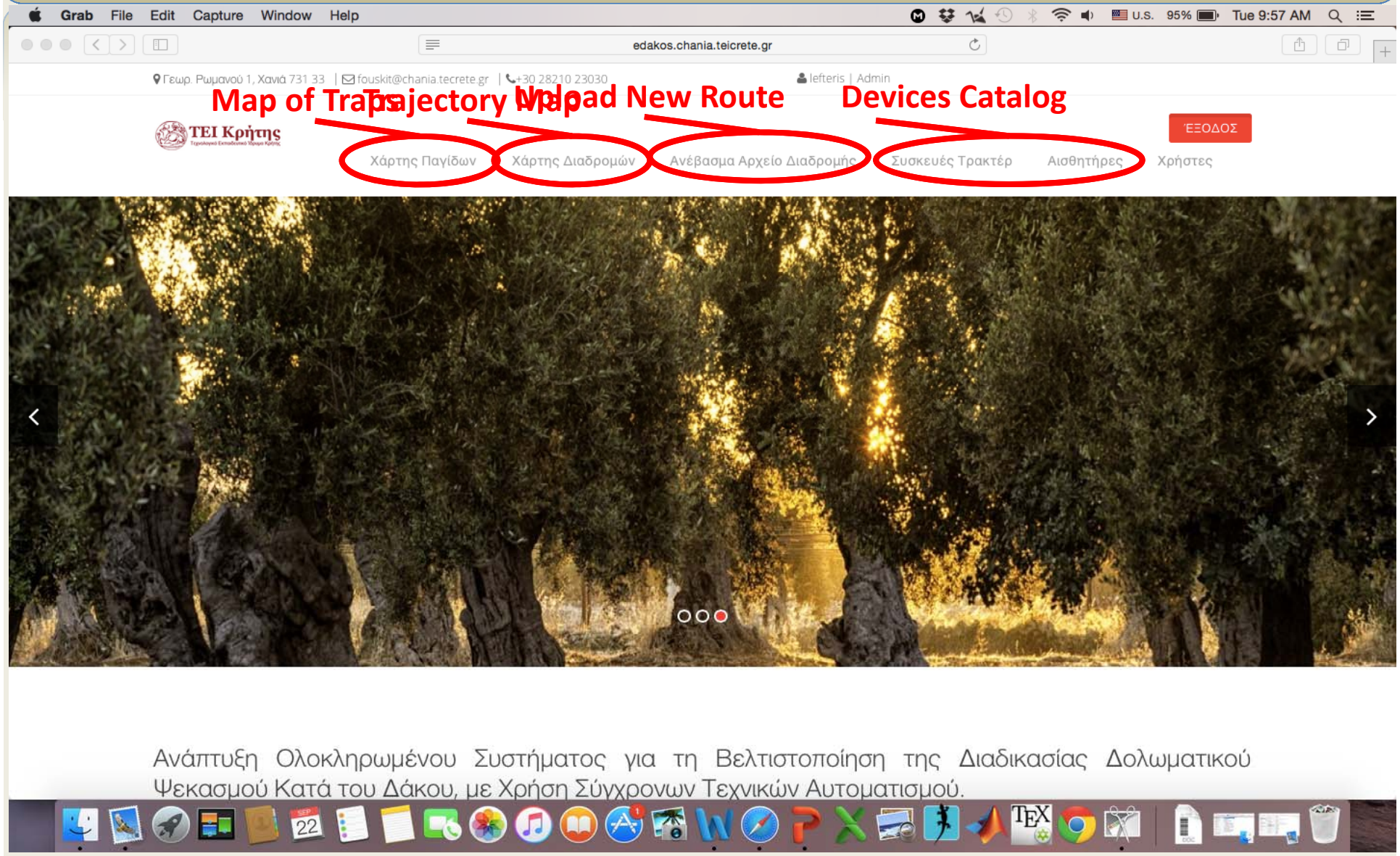
# Automated McPhail Trap III – Preliminary Experiments

- ✓ A prototype was deployed in the field
  - ✓ Performed without problems for a long period
  - ✓ The initial camera (standard VGA) wasn't adequate and replaced from a 2MP camera
  - ✓ Lighting was identified as a main issue for the quality of the pictures
- ✓ A remote server was implemented in our lab and the pictures from the trap were send using the GSM network using the ftp protocol
- ✓ All registered users had access to the ftp server to evaluate the performance of the prototype

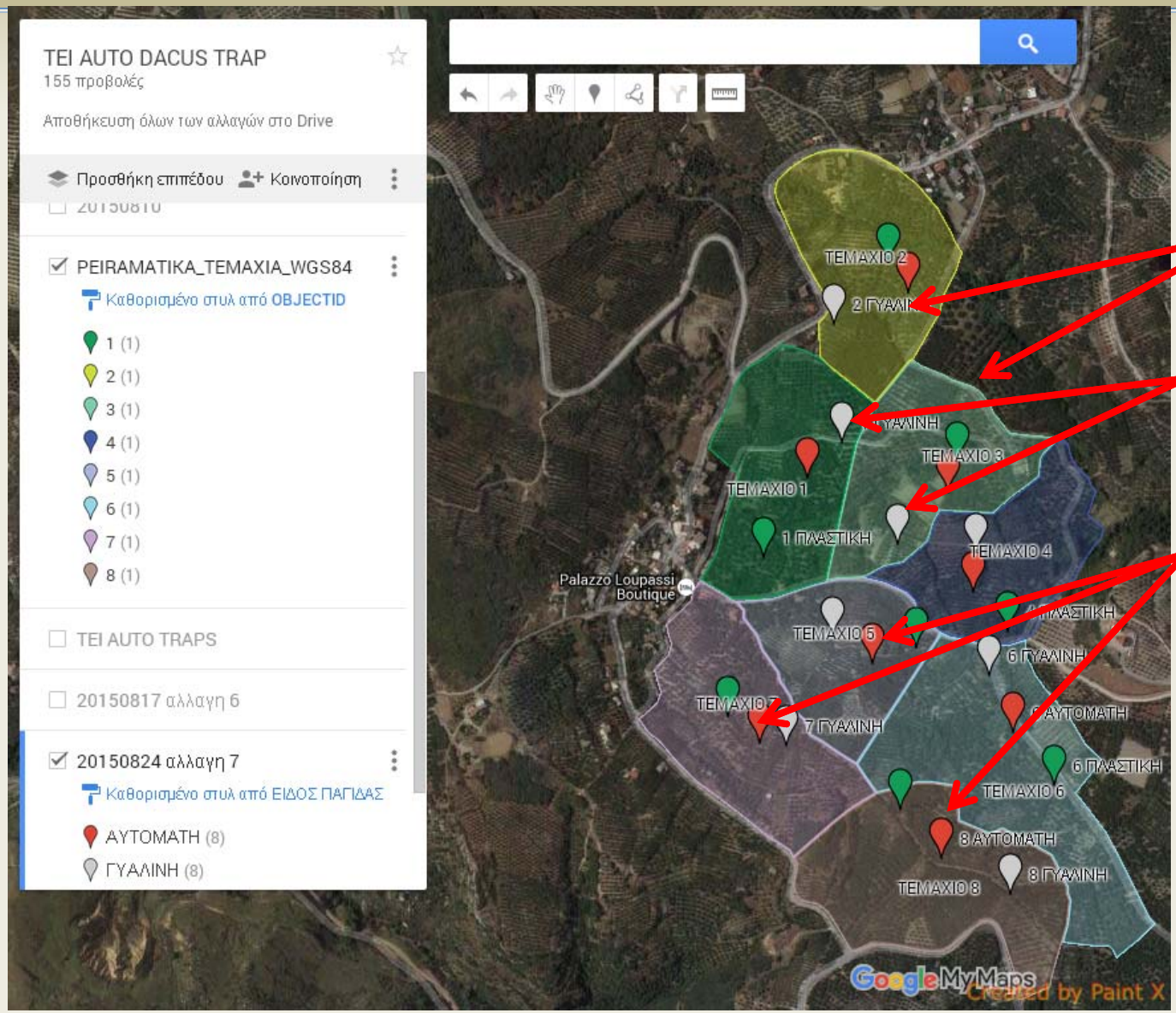
# Automated McPhail Trap IV – Web Interface

- ✓ The initial configuration with one trap and the web server, wasn't user friendly and expandable to support a network of automated traps
- ✓ To overcome all the disadvantages we have designed and implemented a web-based interface which allows the users to interact with all the components of the integrated system
- ✓ The users have access based on their permissions and roles to the different functionalities of the interface
  - ✓ Our server runs Linux – Debian 8
  - ✓ The frond end of our application has been designed using HTML5 and Javascript
  - ✓ For visualization purposes we have integrated Google Map using Googlemap api 3

# Automated McPhail Trap IV – Web Interface



# Automated McPhail Trap V – Web Interface

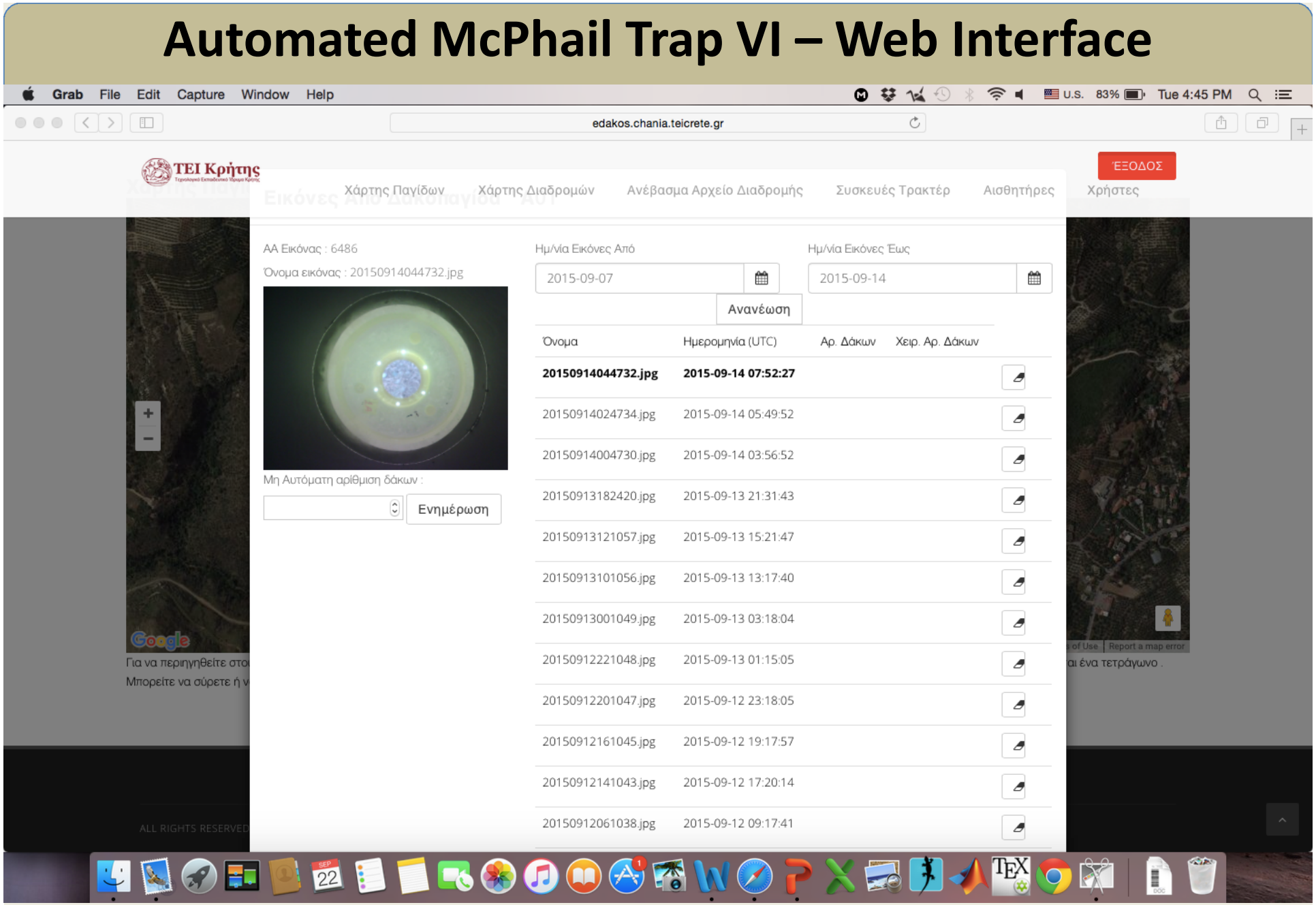



**Areas of Interest**

**Regular Traps**

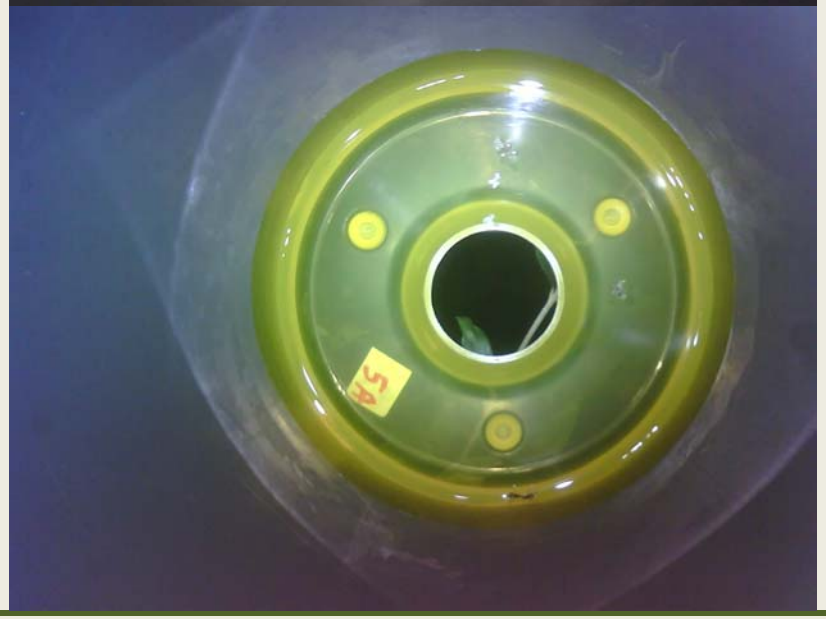
**Automated Traps**

# Automated McPhail Trap VI – Web Interface

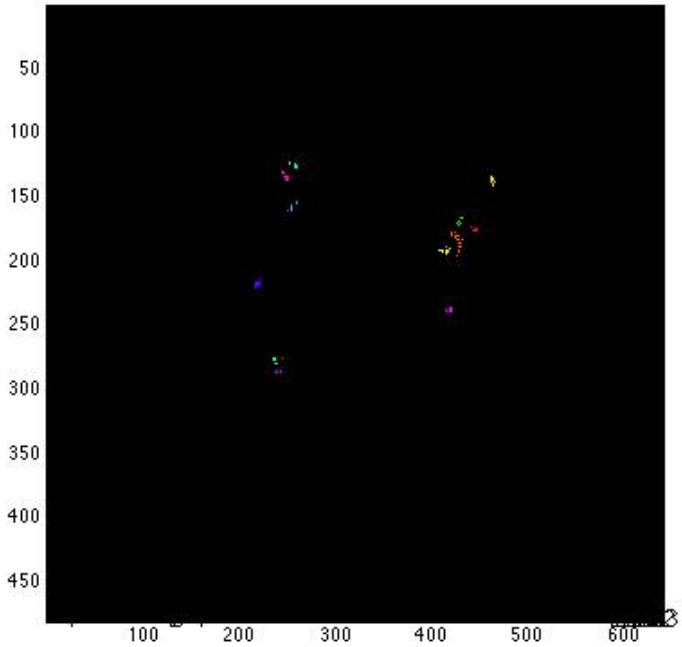


# Automated McPhail Trap VI – Sample Pictures






# Automated McPhail Trap VII – Automatic Dacus Recognition




- Experimentation using blob analysis
- Difficult problem
- It is hard to find the exact type of insect
- Problems in the case that we have a lot of insects concentrated at a specific region
- Problems with different lighting (i.e. different threshold needed)

# Future Work - Challenges

- Further experimentations in the area of automated Dacus recognition. This is essential especially in the case of large trap networks
- Reduce the cost of the prototype by optimizing the design
- Use local area communication networks
- Enhance the design of the trap by adding different sensors (i.e. environmental)
- Add equipment that will enhance the autonomy of the device (i.e. small solar panels).

# Acknowledgements



BASF
The Chemical Company

vodafone

*Thank you!!!!!*

*Questions?*