



universidade de aveiro
theoria poiesis praxis



instituto de
telecomunicações



QUADRO
DE REFERÊNCIA
ESTRATÉGICO
NACIONAL



UNIÃO EUROPEIA
Fundo Europeu
de Desenvolvimento Regional

ENERGY HARVESTING FOR A BIKE SHARING SYSTEM

Joel Dinis

Ricardo Matias

José Alberto Fonseca

dinis.joel@ua.pt

rjasm@ua.pt

jaf@ua.pt

International Symposium on Ambient Intelligence and Embedded Systems
October 2nd, 2014, Aveiro

PRESENTATION OUTLINE

- **Introduction to bike-sharing**
 - Why bike-sharing?
 - Differences between bike-sharing generations
 - Disadvantages
- **Bike-sharing New Concept**
 - Problems to solve
 - New characteristics and advantages.
- **Energy harvesting**
 - Technologies
 - State of the art
- **Conclusions and future work**

BIKE-SHARING: WHY?

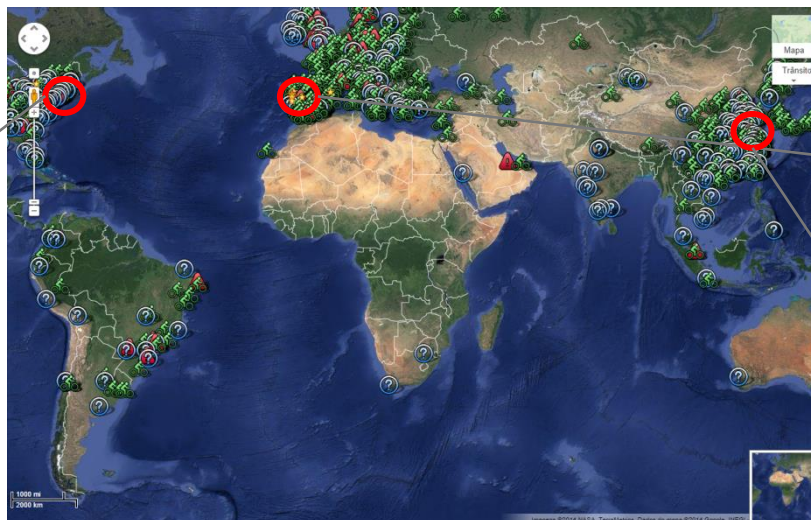
- **Rapidly adopted by the most important cities**
- **Sustainable transportation**
- **Fast and easy access**
- **Link between public transportation and the destination**
- **Rent bicycle at one location, return at another**
- **Encourage not to use cars for short city-trips**

BIKE SHARING



New York

Source: greenforwardblog



Source: google maps



Aveiro

Source: noticiasdeaveiro

Differences between bike-sharing schemes:

- Type of bicycles
- The way we have access to bicycles
- Bicycle fleet management techniques



China

Source: wikipedia

BIKE SHARING

Disadvantages of actual bike sharing systems:

- **Need of automatic bike vending stations in the city**
- **Leave the bike at a docking station**
 - Docking stations can already be full.
 - Need of huge structures for docking stations.
- **Loss from theft**
- **Hard to reallocate or install docking stations during special events**
- **User acceptance when city's land topography varies**
- **Know the location of nearest bicycles**

BIKE-SHARING NEW CONCEPT

- **Use of electric bicycles (e-bikes)** ✓ Topography problems
- **Assisted pedal-power (pedelec)**
 - Use rechargeable batteries
- **Wheels blocking system in the bicycle** ✓ Less expensive docking stations and structures
- **GPS module** ✓ Theft reduce.
Allows geofencing – virtual docking stations
- **GSM module** ✓ Bicycles management,
locate near bicycles using a smartphone.

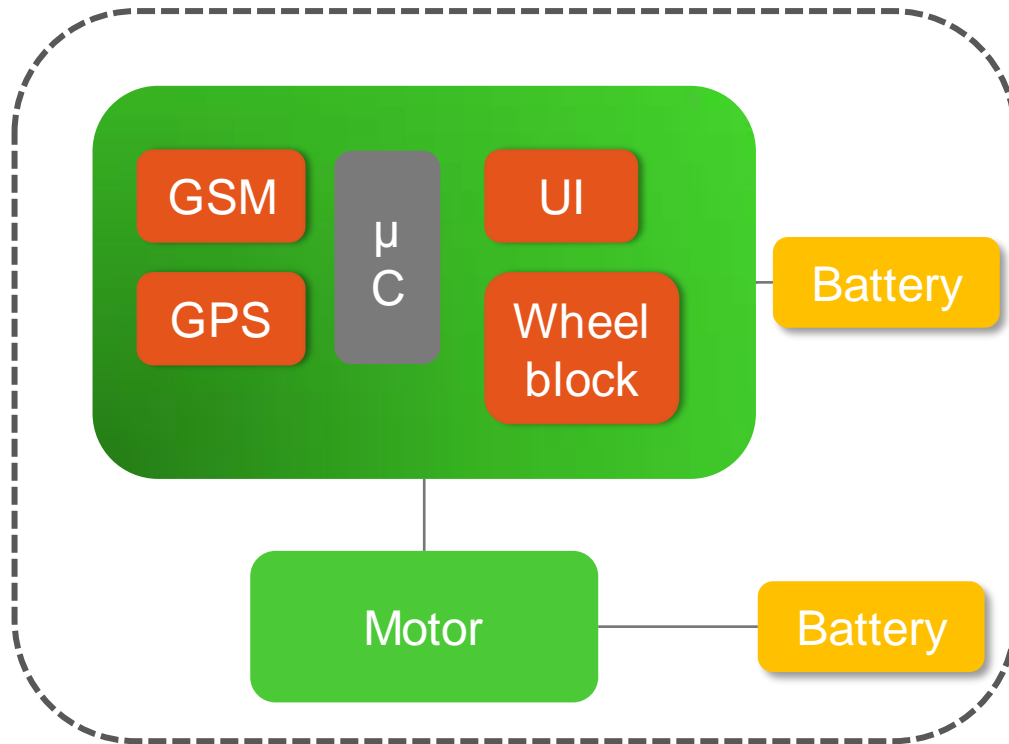
ASSISTED ELECTRIC BIKE



- **Maximum range: 100Km**
- **Charge time: 1 hour**
- **Assisted pedal motor**
- **Reduces the user physical effort**

ENERGY HARVESTING

Bicicleta



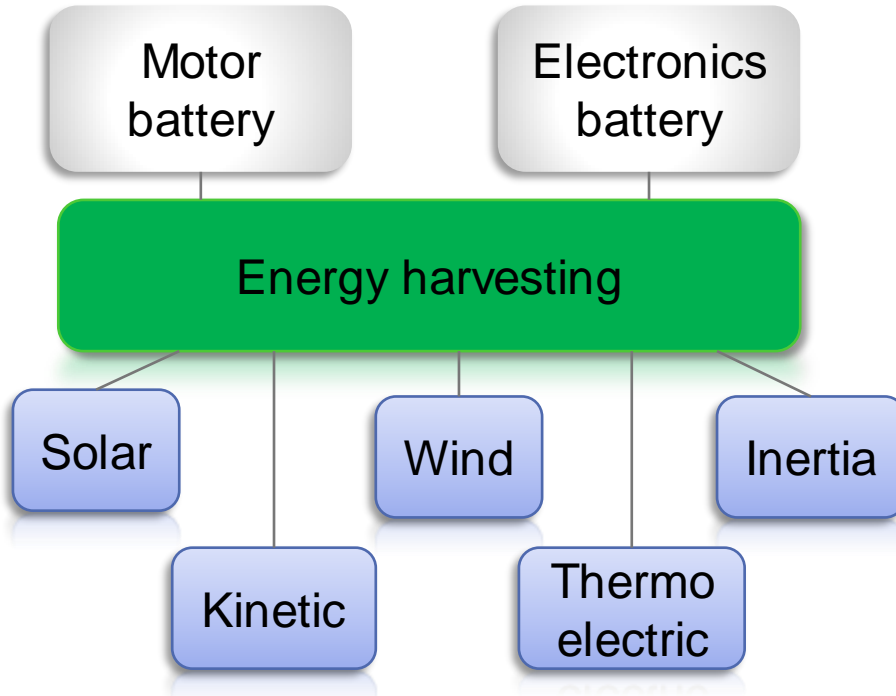
Objectives:

- **Create energy from external sources**
 - Free energy
- **Store energy in batteries.**
- **Have continuous electric power available.**

SOLUTION?

Energy Harvesting

EH SOLUTIONS



Case study research:

- **Ensure energy for electronics**
 - Continuous bicycle location, management and availability.
- **Motor battery recharge**
 - at bike or docking stations
 - Battery replacement?

STATE OF THE ART

“Bicycle management systems in anti-theft, certification, and race by using RFID” [1]

- **System for effective bike management**
 - Production management
 - Sales management
 - Theft management
- **Use of GSM and RFID**

STATE OF THE ART

"Solar energy powered bicycle for wireless supervisory control and remote power management applications," [2]

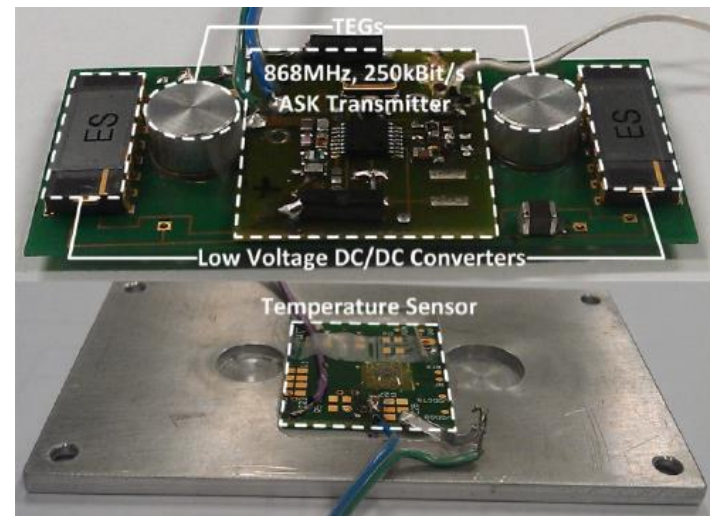
- Experimental application of a solar panel in electric bicycle.
 - 50W solar panel
- Charges two Lead-acid batteries pack.
 - 36Ah batteries
- Summer: 36km -> 54km
- Winter: 36km -> 46km



STATE OF THE ART

"Using thermoelectric energy harvesting to power a self-sustaining temperature sensor in body area networks," [3]

- Thermoelectric energy harvester (TEGs)
 - Extract energy from 1kelvin temperature variation
- Generates enough power for a temperature sensor and data transmission.

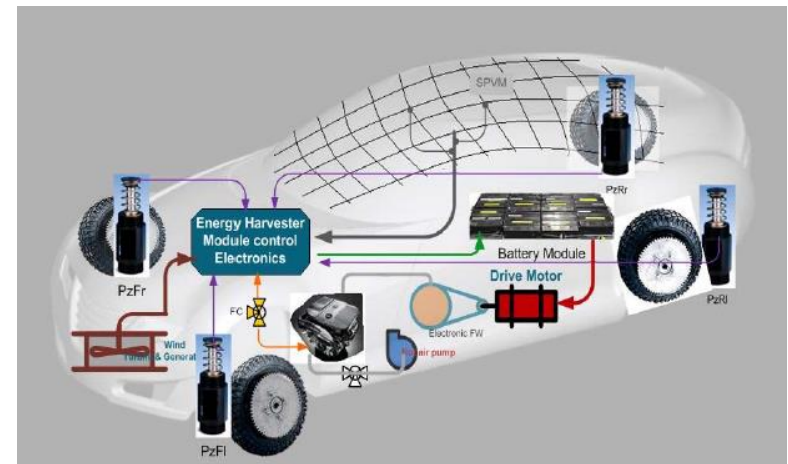


STATE OF THE ART

"Kinetic Energy Harvesting Using Piezoelectric and Electromagnetic Technologies — State of the Art," [4]

"Energy Harvesting & Intelligent load sharing for Electric Hybrid Vehicles," [5]

- Analysis of several piezoelectric energy harvesters
- Generates energy from vibration
- Piezoelectric technology for electric car



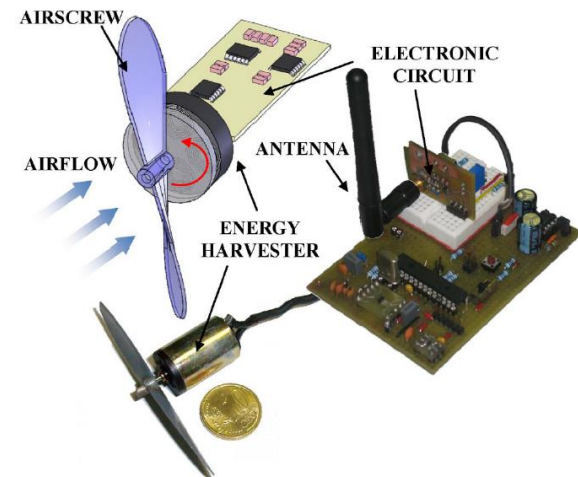
STATE OF THE ART

“Sun, wind and water flow as energy supply for small stationary data acquisition platforms” [6]

“Self-Powered Wireless Sensor for Air Temperature and Velocity measurements With Energy Harvesting Capability” [7]

"Development of micro air flow generator for electrical charging system," [8]

- Wind harvesting solutions applied in agriculture and in motorcycles.
- Generates power with winds at 15km/h
 - Perfect speed for a bike
- Great results to apply for low cost systems.



CONCLUSIONS

- **Bike-sharing will change with the introduction of e-bike.**
 - Easier to use... more users... less traffic... healthy people!
- **GPS and GSM will allow to:**
 - Apply geofencing
 - reduce docking station units
 - Simple to process when cultural events or seasons with more demand
 - Easily locate of the nearest bikes through smartphones
 - Ease bike management process
 - Reduce theft occurrences.
- **Energy harvesting applied in bikes will create possibilities for new applications.**

CONCLUSIONS

- **Several energy harvesting technologies**
 - Solar and wind have good research results.
 - Thermoelectric and kinetic not tested in bicycles yet
 - Good results in cars and human body.
- **Guarantees location and management system always on.**
- **May also allow to charge bicycles' motor batteries at the docking stations or during bicycle use.**
- **Next step**
 - Define all electronics consumptions to decide what harvesting technologies to adopt.
 - Research if harvesting for motor battery is a good solution and the best solution to charge them.

END

Next slides: references

Thank you for your attention

Questions?

REFERENCES

[1]

Kun-Ying Lin; Ming-Wei Hsu; Shi-Rung Liou, "Bicycle management systems in anti-theft, certification, and race by using RFID," Cross Strait Quad-Regional Radio Science and Wireless Technology Conference (CSQRWC), 2011 , vol.2, no., pp.1054,1057, 26-30 July 2011

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6037138&isnumber=6037086>

[2]

Chung-Hsing Chao; Jenn-Jong Shieh, "Solar energy powered bicycle for wireless supervisory control and remote power management applications," *Electrical Machines and Systems (ICEMS), 2010 International Conference on*, vol., no., pp.660,663, 10-13 Oct. 2010

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5664331&isnumber=5662269>

[3]

Kappel, R.; Pachler, W.; Auer, M.; Pribyl, W.; Hofer, G.; Holweg, G., "Using thermoelectric energy harvesting to power a self-sustaining temperature sensor in body area networks," *Industrial Technology (ICIT), 2013 IEEE International Conference on*, vol., no., pp.787,792, 25-28 Feb. 2013

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6505772&isnumber=6505636>

REFERENCES

[4]

Khaligh, A; Peng Zeng; Cong Zheng, "Kinetic Energy Harvesting Using Piezoelectric and Electromagnetic Technologies—State of the Art," *Industrial Electronics, IEEE Transactions on*, vol.57, no.3, pp.850,860, March 2010

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5071287&isnumber=5410131>

[5]

Chinta SS Sarma, “Energy harvesting & Intelligent load sharing for Electric Hybrid Vehicles”

[6]

Raul Moraisa, Samuel G. Matosb, Miguel A. Fernandesb, António L.G. Valentea, Salviano F.S.P. Soaresa,b, P.J.S.G. Ferreira, M.J.C.S. Reisa, “Sun, wind and water flow as energy supply for small stationary data acquisition platforms”

REFERENCES

[7]

Sardini, E.; Serpelloni, M., "Self-Powered Wireless Sensor for Air Temperature and Velocity Measurements With Energy Harvesting Capability," *Instrumentation and Measurement, IEEE Transactions on* , vol.60, no.5, pp.1838,1844, May 2011

URL:

<http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5629365&isnumber=5742736>

[8]

Shabri, A S A; Ibrahim, T.; Bin Mohd Nor, N., "Development of micro air flow generator for electrical charging system," *Power Engineering and Optimization Conference (PEDCO) Melaka, Malaysia, 2012 IEEE International* , vol., no., pp.329,332, 6-7 June 2012

URL:

<http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6230884&isnumber=6230825>