UNIVERSITÀ DEGLI STUDI DI BRESCIA
DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

Electronics and Telecommunications Engineering

INTEGRATION AMONG EMBEDDED SYSTEMS AND SMARTPHONES

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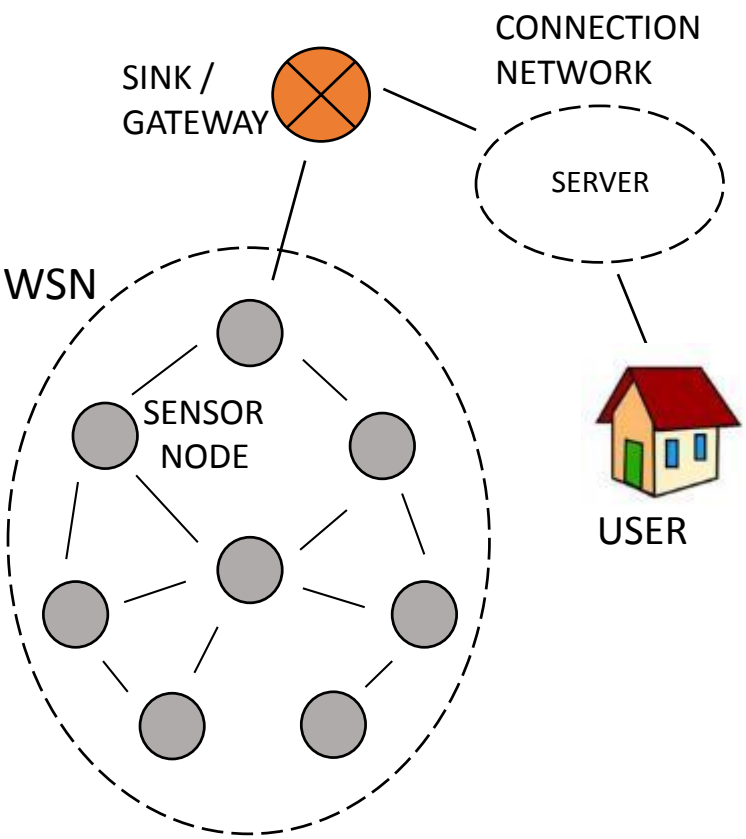
HOME AUTOMATION

- Analysis of the technologies exploited to improve in-home time
- Devices and systems used for automatizing action in home environment
- Centralized control system
- HMI for user supervision
- Heating; security systems; water, gas, and energy distribution control; smart appliances; lighting, handling of doors and windows

WIRELESS SENSOR NETWORK



- LOW ENERGY CONSUMPTION
  - Battery powered
  - Limited life
  - Idle state
- COVERAGE
  - WPAN (Wireless Personal Area Network)
  - Multi-network connections
  - High node density
- APPLICATIONs
  - Military apps
  - Environmental monitoring
  - Home automation
  - Biomedicine

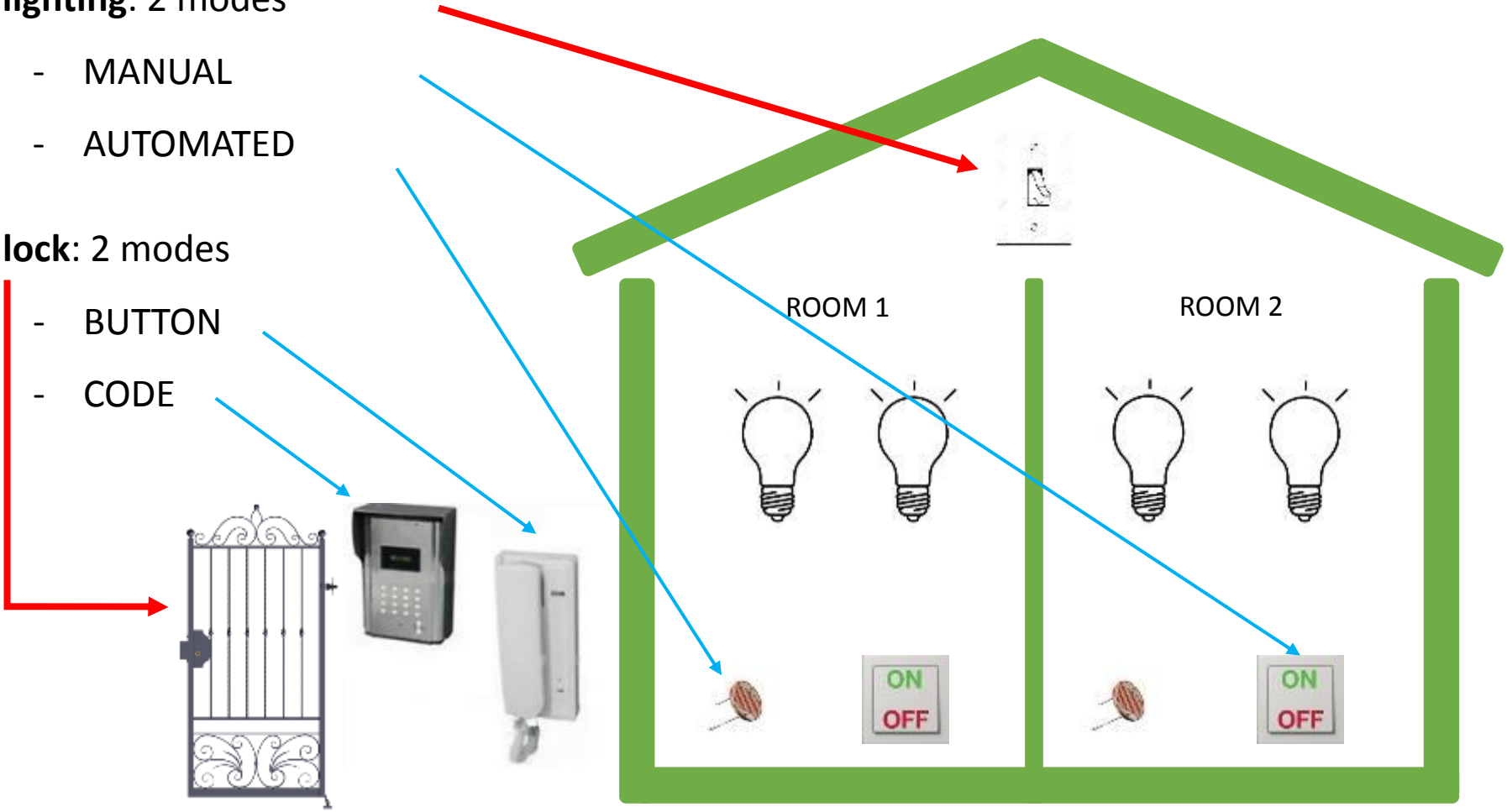
INTERNET OF THINGS

- Real things connected to the Internet
- Interact through the internet network to control and send information in order to take consequent actions
- Application fields
  - Home automation
  - Smart grid e smart city
  - Automotive
  - Biomedicine
  - Transportation and traffic control
  - Embedded system
- Privacy and security issues

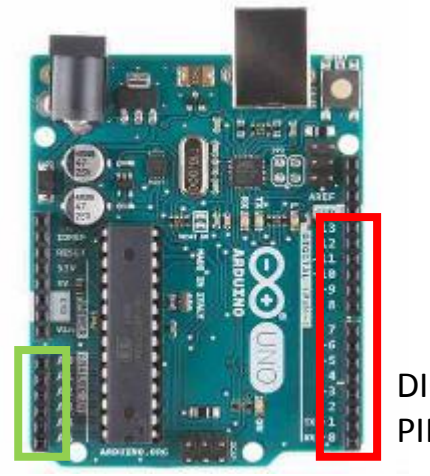
SMART HOME

Schematic description of the system

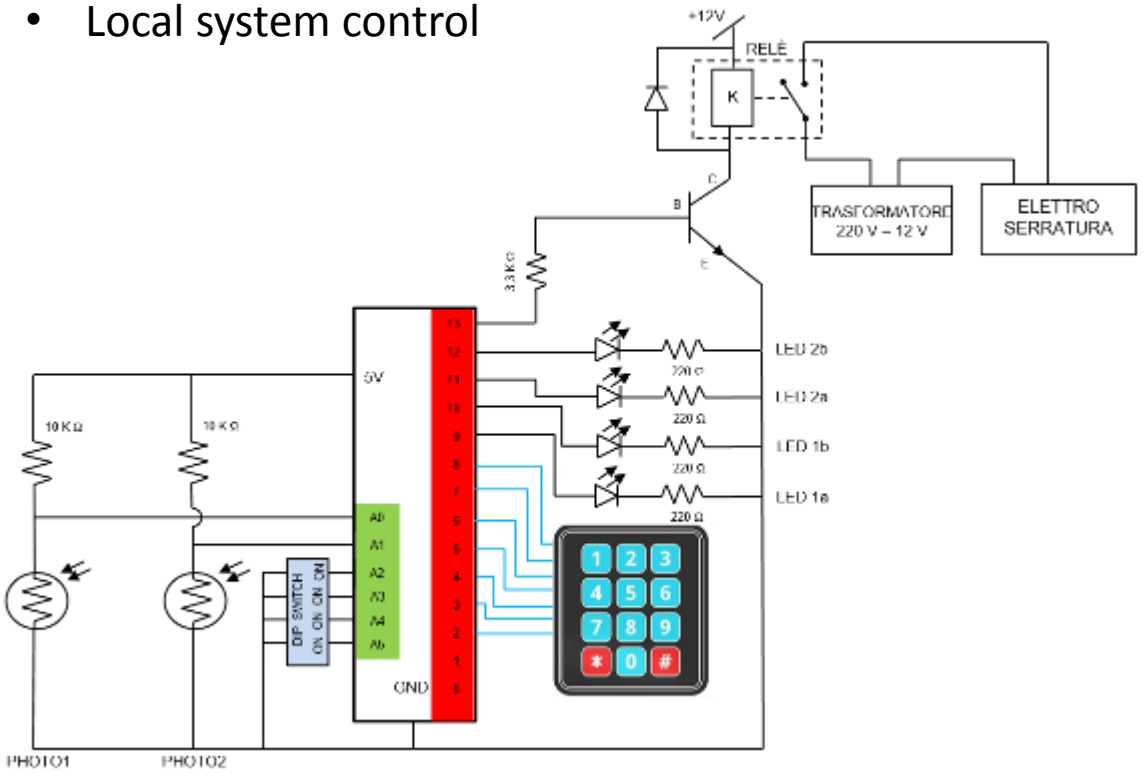
- **lighting**: 2 modes
  - MANUAL
  - AUTOMATED
- **lock**: 2 modes
  - BUTTON
  - CODE



ARDUINO-ONLY REALIZATION



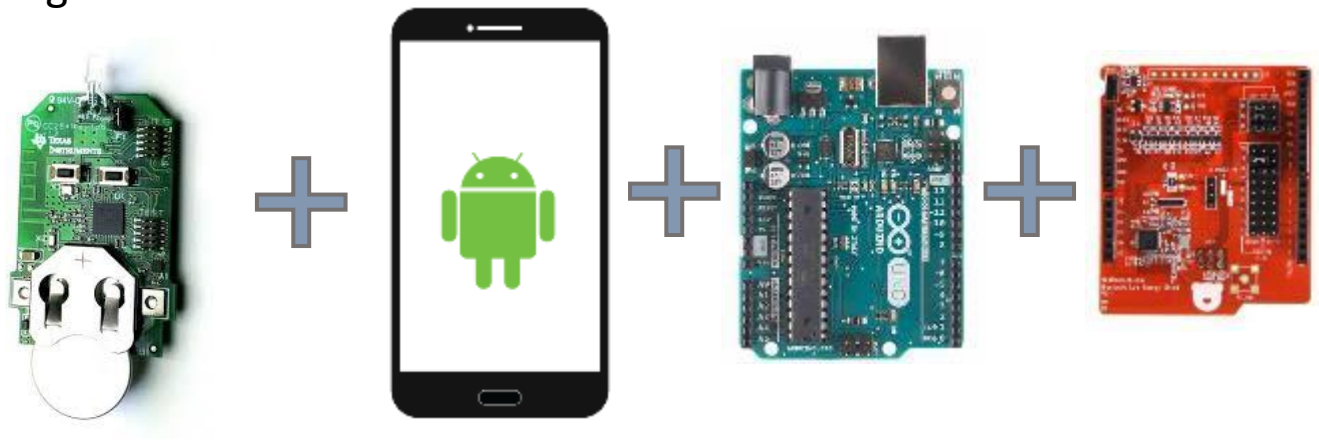
- Arduino is the core of the Home Automation system (custom sketch developed)
- All PINs available
- Local system control



- Microcontroller ATmega328P
- Power supply voltage: 6-20 V
- Regulated voltage: 5 V
- 14 digital I/O (6 PWM)
- 6 analog inputs

ARDUINO-ANDROID REALIZATION

- The Android Application is the core of the system
- Arduino is programmed with a generic sketch furnished by the shield manufacturer
- SAndroidE framework used to develop the Android Application
- Remote control of the home automation system through Bluetooth Low Energy
- Added features:
  - Lock control using a remote button
  - Wrong code alarm



SAndroidE
(Sensors for Android Embedded)

The frameworks allows developers to handle external resources (sensors and actuators) in the same way of embedded ones.

The external devices are programmed with a general firmware, known and supported by SAndroidE.

- **LIBRARY**

  supports the Android programming to easily reach the external devices

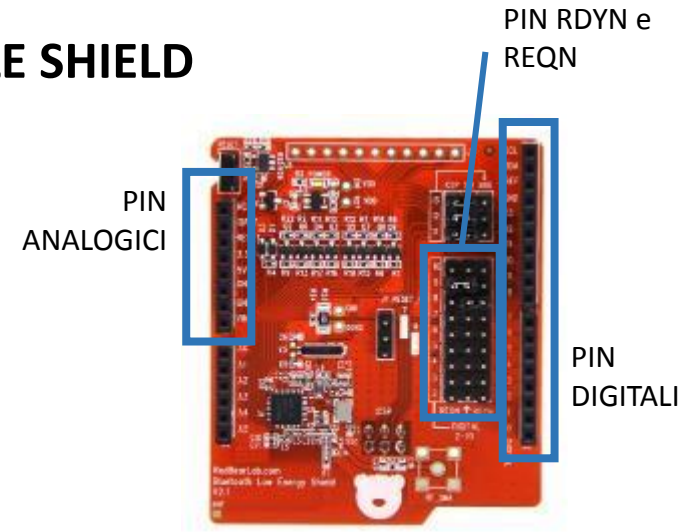
- **APP**

  identifies, configures and names the external devices' resources

BLUETOOTH LOW ENERGY

- Standard protocol
- Data exchange + connection idle
- 40 channel of 2 MHz
- Two device types: MASTER and SLAVE
- GATT (Generic ATTribute Profile)
  - Profile
  - Services
  - Characteristics

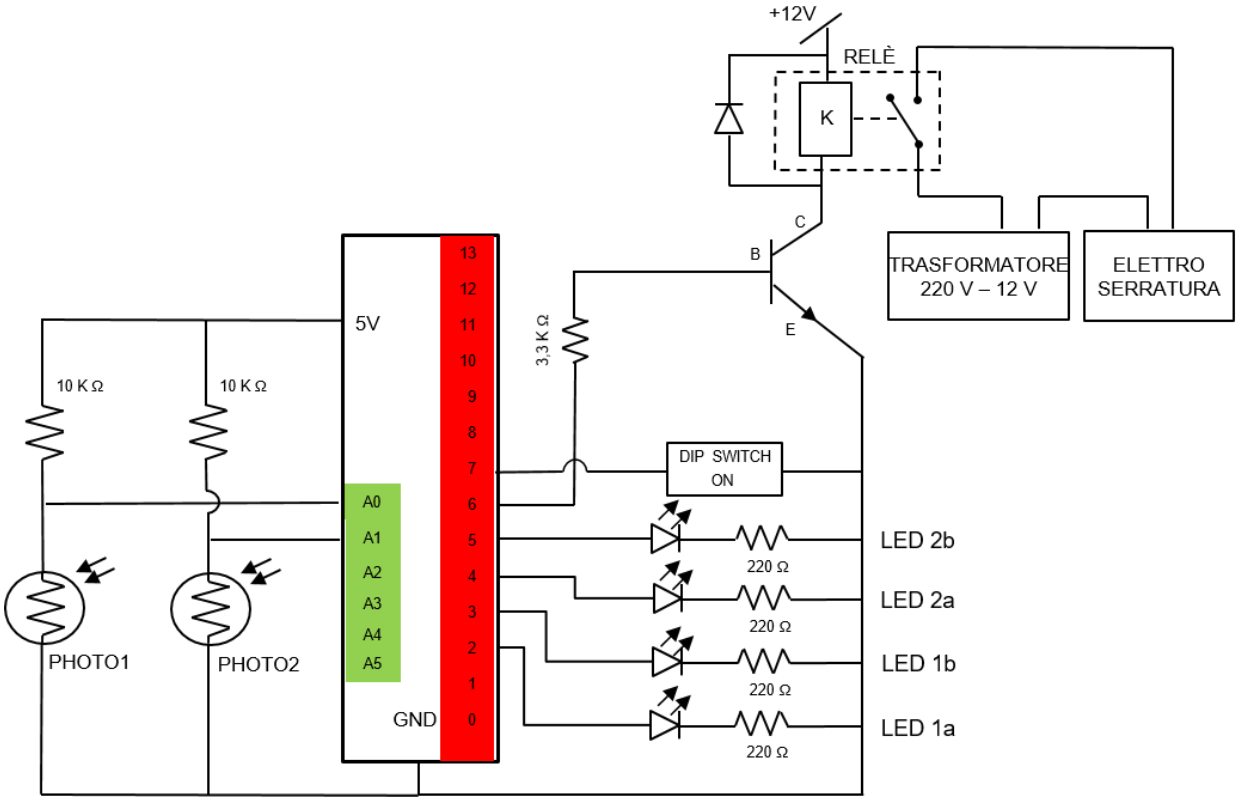
BLE SHIELD



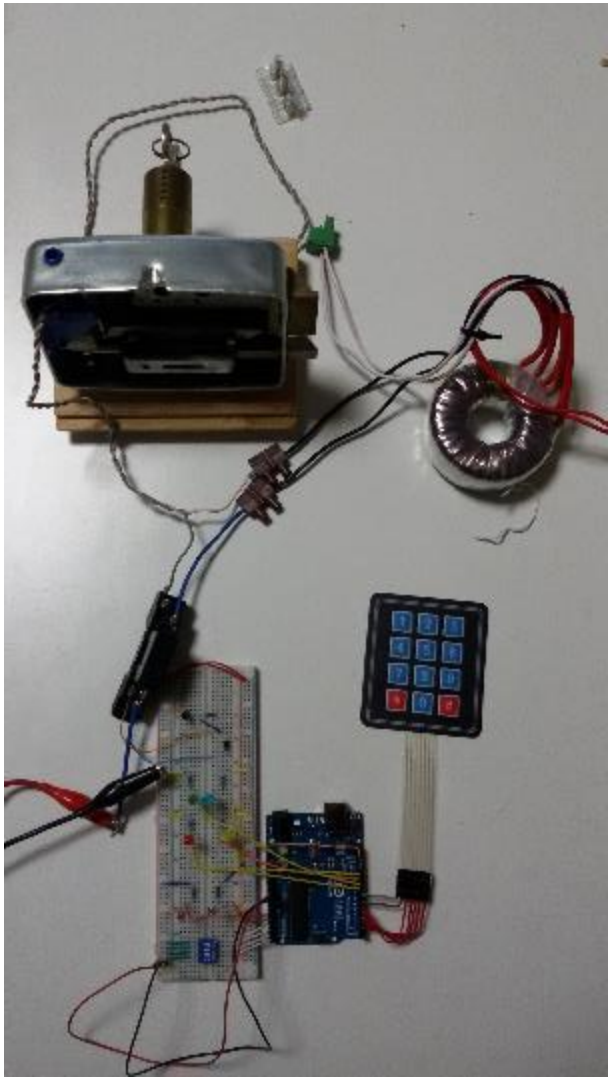
- Some PINs reserved for communication with Arduino: SPI + RDYN e REQN
- Integrated Antenna
- Library (Arduino FW) and application furnished by the producer

CONTROL CIRCUIT SCHEMATIC

- Arduino UNO r3
- BLE Shield
- Samsung Galaxy S5 mini
- n. 2 keyfob TI CC2541
- n. 2 fotoresistors
- n. 2 10 KΩ resistors
- n. 4 leds
- n. 4 220 Ω resistors
- n. 1 3,3 KΩ resistor
- n. 1 npn transistor BC527b
- n. 1 12 V relays
- Electro-locker powered at 12 V
- Sipacom transformer 220 V to 12 V
- Power supplier Farnell Triple Output Tops 4D
- Keyfob TI cc2541



REALIZATIONS



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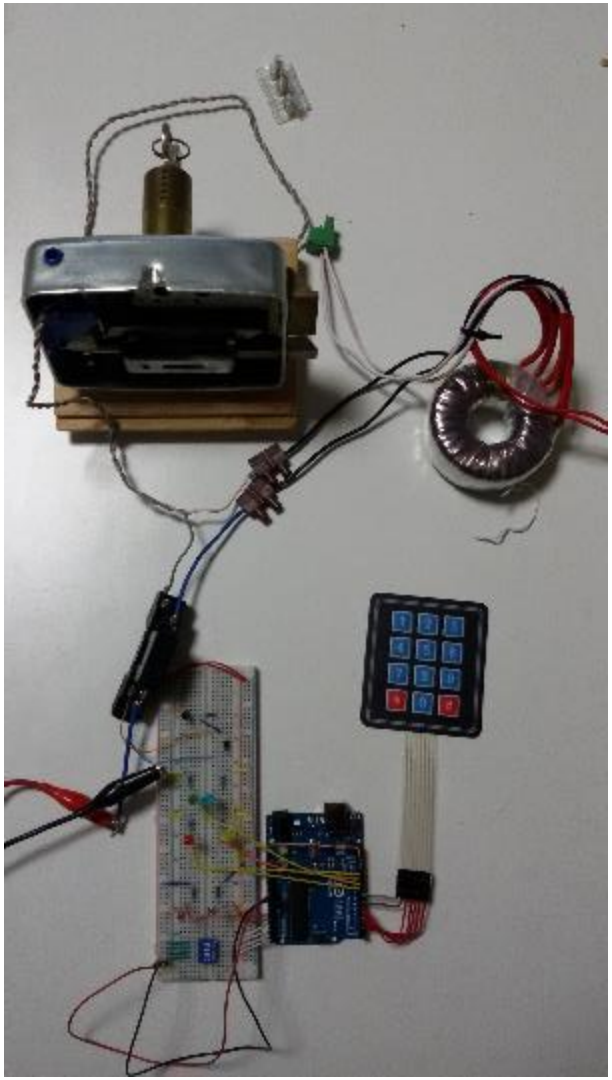

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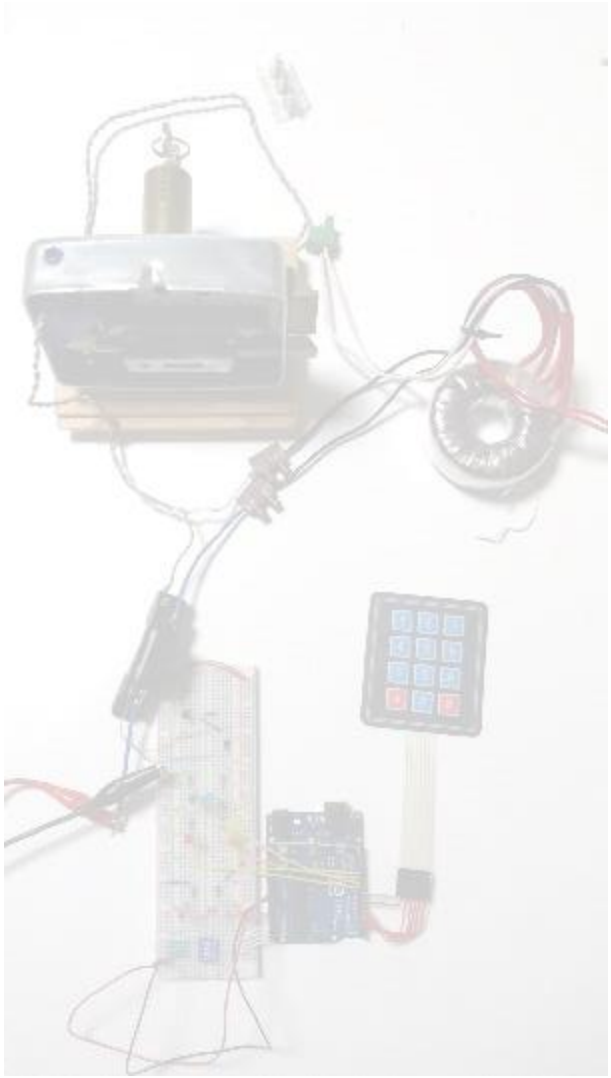

RESOURCES' CONFIGURATION

See Clip 1: Resources' acquisition and configuration

HOME AUTOMATION APPLICATION

See Clip 2: Home automation example

CONCLUSIONS

- 2 realizations of the same Home Automation sytstem developed
  - Local control (Arduino-only system)
  - Remote control (Android with SAndroidE + Arduino)

FUTURE WORKS

- Improving the realized system with more home automation features
- Including smart appliances into the home automation system (IoT)
- Developing a very remote control sytsem (via Internet)