# *LUMIÈRES SONORES*. A NEW DIGITAL PARAMETRIC APPROACH FOR URBAN RENEWAL OF ABANDONED AREAS

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**Abstract**

The paper presents a new parametric approach for the renewal of blighted urban areas through the design and the implementation of interactive installations. Said installations are based on a precise algorithm able to capture the sound waves, emitted by the visitors, and to translate them in light signals. The syntesis process is elaborated with digital computation: microcontroller Arduino for the correlation between the sound impulses acquired (input) and the coloured lights emitted (output); parametric software Grasshopper for the control of the output variability. The digital technological system allows users to customize the installation by tuning the colours and the intensity of the lights. The model designed through such a parametric approach (envisaging these fields: technical and technological; social; economic; environmental) could be implemented in different social and urban context, guarantying versatility, repeatability and sustainability.

**Keywords**

Parametric design approach, urban renewal, interactive installation, generative algorithm, digital technologies for social aims, open source, IoT

## 1. Introduction

The urban forms originated by the architecture have made the city habitable in all the meanings of the term. They represent a fundamental part of its charm, by contributing to the urban quality of its public spaces and ensuring the comfort of its inhabitants (residents, workers, students, tourists) (Terrin, 2015).

Often, though, the generative processes deriving from architectural transformations have led to the configuration of urban areas that can be defined as "empty spaces", deserted urban zone, which have remained detached from the transformation of the city over time, reaching ever higher levels of degradation.

Abandoned and blighted areas are social fields that are socially and physically deteriorated. These areas could be the specific location for social functions and gatherings, or sites with historical, economic, and cultural significance. Their deterioration and consequent alteration of their urbanistic identity generate disaffection and rejection and can erase the place's symbolic importance within the local urban context (Punziano & Terracciano, 2017).

With the global crisis (economic, energetic, environmental) we crashed into a condition of post-development, characterized by a progressive removal, both physical and mental, from the territory in which we live. As a consequence, our land, which was originally built in the lively dialogue between man and nature, has suffered more and more a systematic dispossession, reducing itself to the shapeless support of works and functions, and sometimes even transforming itself into a collector of poisons (Magnaghi, 2010).

This progressive expansion of a declining territory is the result of a society that is alien to a complete and unitary vision of the urban space and all the fields involved in its transformation: *technical-constructive*; *social*; *economic*; *naturalistic and landscaped fields*.

This scenario imposes new strategic visions for the renewal of the landscape that must be based on the criteria of self-sustainability. The direction to be pursued must be focussed on the enhancement of the public space through new cooperative and trans-disciplinary processes, participatory approaches and new methods to

better manage complexity, based on a "local conscience" aimed at protecting the common assets (cultures, urban landscapes, productions, knowledge) within a solidary and participatory horizon (Magnaghi, 2010).

The famous expression "from the spoon to the town" pronounced by E. N. Rogers during the CIAM's[1] debates, leading to the last version of *The Athens Charter* (Le Corbusier, 1957), well represents an approach that every architect should adopt. Hence the adequate resolution of this situation requires some radical changes in the methods of designing, implementing and maintaining architectural works, infrastructures or urban spaces. These considerations are closely related to the evolution of the role of designer, as mediator between nature and man, numbers and matter, products and process (Terrin, 2015). All these qualities must necessarily be supported by an adequate technical and architectural training, as well as ethical and social, for a conscious application of intervention strategies for the renewal of cities, in order to struggle urban degradation.

## 2. *Purpose of the research*

The wide concept of *renewal* can be understood as the transformation process of an area, usually with a residential, industrial or public destination, characterized by phenomena of environmental, physical, social and economic decline (Evans & Shaw, 2004).

According to this definition, the research here presented is positioned within this complete vision of urban landscape, in order to promote an innovative integrated design process of these interventions, based on differing nuances: *renewal, regeneration* and *recycle* (Punziano & Terracciano, 2017). The *renewal* concerns the technical and constructive field and tackles the territorial interventions aimed at the physical filling of the urban voids or the spatial reconversion of areas. The *regeneration* takes into account the social field and suggests the importance of the development of relationship and consequently of ways of living for the

improvement of life quality, intrinsic to the urban system dimension. The *recycle* implies the economic and naturalistic field, suggesting the need of reaching the sustainability of the transformation intervention, in terms of cost-effective and environmental impact.

In particular, urban cultural requalification occurs when culture drives the transformation of urban areas, the development of infrastructure and services and the attraction of residents and visitor flows. This process is built with immaterial assets, including technical knowledge embedded in local realities, people's creative skills and Information and Communication Technology (ICT) solutions, to enhance urban areas through the diffusion of knowledge, experience and digital economy (Della Lucia & Trunfio, 2018).

A number of researchers and commentators have been debating for almost two decades that globalization, especially driven by the revolution in ICTs, signs the end of geography (O'Brien, 1992) and the death of distance (Cairncross, 1997). Contrary to these past predictions, recent researches demonstrate that, despite the technological innovations have caused the death of distance, geography is still important (Clare 2013). The need to be in certain places and spaces is identified in the practices of learning, employment, as well as in socialising, relaxing or just feeling the buzz of the city (Drake, 2003).

The diffusion of iconic architecture and events is currently among the most important cultural promoters for renovating the urban identity, increasing vibrancy and attracting creative people and tourists (Zenker, 2009). Nevertheless, this factor may also entail the risk of the loss of the landscape's authenticity (Smith, 2007).

To avoid this risk and then reach an extensive and sustainable urban cultural regeneration, same time faithful to their sense of place, it is necessary that tradition and past are integrated and merged with innovation and future (Landry, 2000).

In this context, the research project here presented is grounded on the link between past and future, in order to conserve the city's identity, as well as on the creativity process for an innovative renovation of urban and social image.

The paradigm of the research is strictly related to the definition of actions and tools for innovative design strategies, with respect to compatible uses (temporary or long-term), aimed at upgrading the deserted urban areas.

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[1] The *Congrès Internationaux d'Architecture Moderne* (CIAM), or International Congresses of Modern Architecture, was an organization, active from 1928 to 1959, composed by the most important architects of the time, with the objective of spreading the principles of the Modern Movement in all the main domains of architecture (landscape, urbanism, industrial design, …).

According to the abovementioned research paradigm, the project born to solve the problem of urban regeneration of a specific case of study. In particular, the problem to be resolved concerned the sector located inside the historic city walls of Bologna, in correspondence with the green area included between Viale A. Silvani, Via M. De 'Luzzi and Via L. Calori, near the Cinema Lumière complex and the MAMBO Modern Art Museum. Currently, this area – hereinafter called "the Project Area" – represents an urban void, today abandoned and considerably degraded. (Fig. 1)

The solution to the problem proposed by the research project envisages the rehabilitation and repopulation of the public green area through the application of an innovative parametric design strategy, based on the implementation of digital techniques. In particular, the project concerns the creation of an interactive installation able to generate an attraction that pushes citizens and visitors to frequent the area studied. This attraction is aimed at a broad social spectrum, which can subsequently provide the possibility of developing different commercial activities (e.g. kiosks, bars, cultural centres) and therefore generate a new net of social and economic relations.

Therefore the approach proposed allows giving back the social life to the urban area in which the interactive installation is implemented. Hence the installation could stimulate the citizens through the power of innovative technological tools for creative uses, and same time could enhance the local architectural and constructive characters typical of the area (porticos), as well as the cultural and artistic soul of the city (musical tradition).

In line with the paradigm of the research, this strategy permits regenerating the urban voids through integrated design tools based on the respect of historical tradition and innovative future.

Thanks to the parametric approach adopted and the digital tools used for its modelization, implementation and prototipation, the final design solution proposed can be customized and repeated in other urban contexts that present urban and social problems similar to those found in this urban void of the city of Bologna.

The strategy could be easily adopted by the public entities inspired by best practices of urban transformation which could have a significant role in urban cultural regeneration, fulfilling



**Fig. 1:** Aerial photographs of Bologna town: (on the left) definition of the intervention area within the historical centre, encircled by the ancient walls; (on the right) identification of the intervention area insered in the Cinema Lumière complex.

social and physical needs and investing in cultural catalysts and experience based strategies (DCMS, 2004; Tang, 2016).

## 3. State of the art

The use of digital technologies based on the control of lights and sounds for urban purposes spread throughout the world during the last decade. The most interesting examples founded in literature are highlighted in this paragraph.

"LightScraper"[2], designed by ENESS in 2009, is a movable bespoke aluminium structure, covered by a layer of translucent mesh on which a single computer and two projectors reflect real-time 3D graphics. Visitor's positions are tracked through an infrared camera and transposed into musical melodies, so that the artistic multimedial opera acts as a giant musical instrument influenced by people's location.

Also in the "Light Waves"[3] installation, designed in 2011 by Creatmosphere, the public interacts with the animated light and video projections. The opera is conceived as an intervention of urban upgrading of a neglected part of the waterfront in the city of Ipswich (UK) and allows citizens to influence a wave of coloured lights pulsing across three adjacent buildings.

Lights are also used for the concept of a new landscape element, i.e. the "Granary Square fountain"[4], at King's Cross (London), designed in 2012 by The Fountain Workshop in collaboration with Speirs + Major. This fountain is composed by thousands of choreographed jets, each individually controlled. The jets splash in patterns, surprising visitors, and the random variation of their intensity creates a suggestive urban performance made of sounds and lights. Furthermore, thanks to the app "Granary Squirt", visitor's can switch on/off the lines of jets by using their smartphone as a fountain remote control.

The "Murmor Wall"[5], designed in 2015 by J. Kelly Johnson and N. Gattegno for *Future Cities Lab, San Francisco (CA)*, is composed by a complex steel frame and acrylic tubing, digital displays and electronics. This artificially intelligent architecture allows visitors to observe datastreams related to the whispers, thoughts and feelings, expressed by the citizens through a dedicated web platform, and translated through the wall in the form of animated LED lights and digital text displays. This installation provides a social urban place for the city to share, indulge and reflect on the real-time desires and anxieties of its citizens.

The "Lightwave"[6], prototyped in 2016 by the same authors, translates ambient sounds typical of the site (noise and vibration of passing trains, cars and other sounds from the neighborhood) into dynamic auroras of patterned light, with variable intensities of illumination. This multimedial installation creates dynamic visual mapping, whose light overlaps ensure visibility of pedestrians and inspire a safety and comfort ambiance for the urban area.

In 2015, D. Yordanova and and KOTKI Visuals designed and presented a sound responsive light installation called "Urban Constellation"[7]. The very simple concept consists in a group of LEDs hung to the tree brushes in the city of Bucharest: these lamps could light up in response to the emission of sounds and noises (e.g. hand-clapping, whistling, screaming).

In 2016, J. Kelly Johnson, N. Gattegno, and R. DeLeon for *Future Cities Lab, San Francisco (CA)*, designed "Lightswarm"[8], with the aim of renovating existing buildings by giving them a new intelligent façade. The smart surface is constituted by a collection of light modules connected together and hooked up to sensors that take the sounds from outside and translate them into different patterns that are displayed on the external wall.

The prototype here presented has several characteristics in common with the aforementioned gathered projects, which are all based on the digital control of inputs (i.e. geolocalization, movement, noises, script) and the emission of related outputs (i.e. visual maps, lights, colour waves, water jets, sounds). In this context, "Lumières Sonores" distinguishes itself because it has been conceived properly as a new digital parametric approach for urban renewal of abandoned areas. Moreover it introduces the innovative direct interaction between visitors and the emitted lights, through a precise algorithm

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[2] http://www.eness.com/i.php?r=Project&p=3&c=
[3] https://creatmosphere.com/1109_lwav/
[4] https://www.fountains.co.uk/?s=granary
[5] http://www.future-cities-lab.net/murmurwall/

[6] http://www.future-cities-lab.net/lightweave/
[7] http://kotkivisuals.com/portfolio-items/urban-constellation/
[8] http://www.future-cities-lab.net/lightswarm/

able to translate the sounds produced (music melodies, voices and songs) in different nuances and intensities of coloured lights, precisely dislocated around the area and oriented towards specific architectural and urban element.

Music can be a powerful instrument for the social involvement of citizens, especially for a cultural urban context like Bologna, and therefore it is suitable for the creation of an artistic multimedial performance aimed to the urban renewal of a dismissed urban area as the one herein considered.

## 4. Methodology

The integrated design process proposed in the paper is based on the following consequent phases: (i) definition of the main qualities requested for the solutions to the problem; (ii) development of the concept; (iii) modelization; (iv) implementation of the model; (v) prototipation for the validation of the model. (Fig. 2)

### 4.1 Definition of the main qualities

The main qualities that the final solution must present are synthetized and shown below:
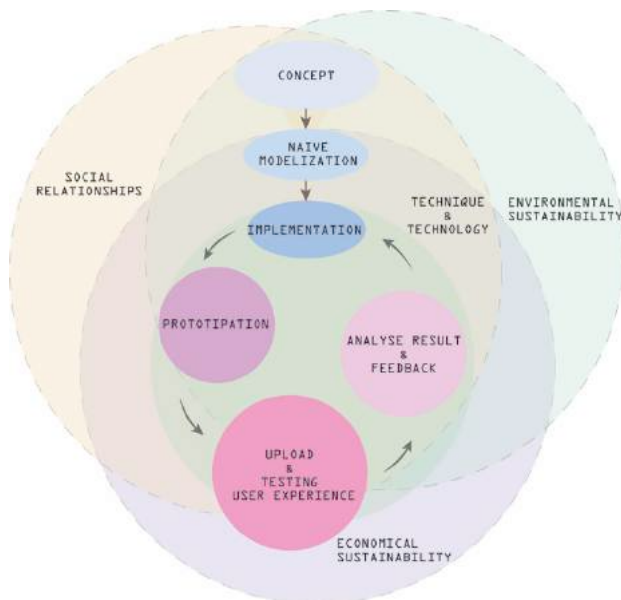


**Fig. 2:** Flowchart representing the methodology used in the research project, based on different phases to be envisaged according to the main qualities defined during the beginning phase.

- *technical* and technological requirements suitable for the flexibility, reversibility, repeatability of the installation in other urban contexts from other public actors in this sector (i.e. open source);
- *social* attractiveness and facilitated accessibility for all the classes of users for transforming a urban blighted area and convert it in a creative populated space;
- *economic sustainability* of the components used for the implementation of the installation and for its maintenance over time;
- *environmental sustainability* of the intervention, both in terms of environmental impact, respect of the territory's identity, integration of the work within the naturalistic/urban context, and in terms of recyclability of the components implemented.

Taking into account these main characteristics, the research involves the development of a design method based on a parametric approach.

### 4.2 Development of the concept

The project is based on a very simple idea - a game of sound and visual impulses - resulted from a creative process that has led to an intuition: an interactive installation in which citizens can actively participate as players, listeners and spectators of a visual and perceptual representations of their own creativity.

Every sound generates a light. As the tone and the dynamics of the sound vary, the colour and intensity of the light vary. From these suggestions and grandeurs comes the idea of an interactive installation for regenerating an urban blighted space in the respect of its territory's identity and local characters.

The strategy averages to create a musical area inside an urban zone, in which the citizens could play and make noises and then consequently activate an interactive installation. Those installations, by analysing the melodies produced, give life to a suggestive and captivating lighting of the location, attracting people and enhancing the urban context.

**Fig. 3:** Design graphic arts of the renewal intervention of Project Area: (top, on the left) photograph of the existing brick arcades delimiting the zone; (top, on the right) image representing the final suggestive aspect of the ancient walls coloured by the interactive installation proposed; (down) section representing the final design state.

For example, the Project Area is surrounded by the historical arcades, belonging to a portion of the ancient walls in red bricks, which constitute a suggestive background to the gentle hilly profile. Thanks to the interactive installation proposed, this architectural element could be lighted and coloured by LED-lights linked to the technological components implemented. (Fig. 3)

This technological strategy will stimulate the citizens with the desire to play with musical notes to create melodies and to use them to give life to a visual translation of the music, made of colour's gradations, thus attracting also audience for an audio and visual-perceptive performance.

In general, researches and studies demonstrated the relevance of music and emotions related to it, with regards to social and psychologic sphere (Huron, 2006). In particular, in a city like Bologna, where the musical scene has always played an important role for urban life, the project intends to propose the generation of a new space in which to channel the creative activities. This intention is addressed both to professional and amateur musicians, and to citizens who wants to play, practice, experiment and express themselves in this area, interacting actively with the installation through the sounds produced.

For this purpose the research intends to install audio devices (microphones) in the area and a microcontroller (Arduino), which analyses the audio tracks imported from the microphones and which governs external peripherals through precise algorithms. Through the analysis of the sound waves produced by music and noises emitted by citizens, the lighting system generates patterns and reproduces them in the form of LED lighting. This type of lighting, besides responding to the energy saving requirement, allows the reproduction of a very wide range of shades.

Finally such an interactive multimedial installation poses itself in a position of total

respect with the surrounding environment, in agreement with the principles of reversibility, economic feasibility, acoustics impact, elimination of architectural barriers, economic and environmental sustainability.

The intervention therefore wants to represent the real possibility of using new digital technologies for social and urban regeneration purposes, acting contrary to the wide actual use of these numerical tools, which often lead to a strong depersonalization of the territory and marginalization of the individual.

### 4.3 Modelization

The project consists of both a hardware component and the use of different software.

The project could be broken down into these elements: (i) a passive component; (ii) an active component; (iii) an actuator. The passive component is the one dedicated to the acquisition of data and information; the active component is the one used for the re-elaboration of these; the actuator is the element that performs a function established by the active component.

The processing of these data will then be used in combination with a microcontroller (Arduino), positioned in a sealed box in a strategic position within the urban area. This dispositive is able to manage a sufficient number of data for this use, with a small encumbrance, by significantly reducing at the same time the costs related to the purchase of the microcontroller and its maintenance.

The sound waves that are picked up by the microphones, after being pre-processed locally, will be used by the active components to control the colour of the lights and the intensity of each single LED lamp placed. The created lights, shadows and chiaroscuros are directly influenced by the degree of intensity of the sounds and the frequencies generated by the complex of instruments and noises. The link between melodies and lights' tuning can therefore act more on gradations or on punctual colours, depending on the sensibility of the artist who will create the specific experience.

It is important to highlight that the parametric approach used for the design of this installation permits to easily and rapidly change the control's variables of this process, adapting them to the users preferences.

It also intends to control the switching on and off of the installation's interactivity, so as to check its operating hours, thus entrusting the lighting of the area during the deep night hours to the interaction with different urban sound sources (e.g. cars and motors, urban noises). On first hand it has been developed a naïve model, based on low-cost components, that has permitted to test and tune the operative possibility of realization of the concept within the hardware and processing limitations of the chosen components as well as the quantitative estimation of the incoming and
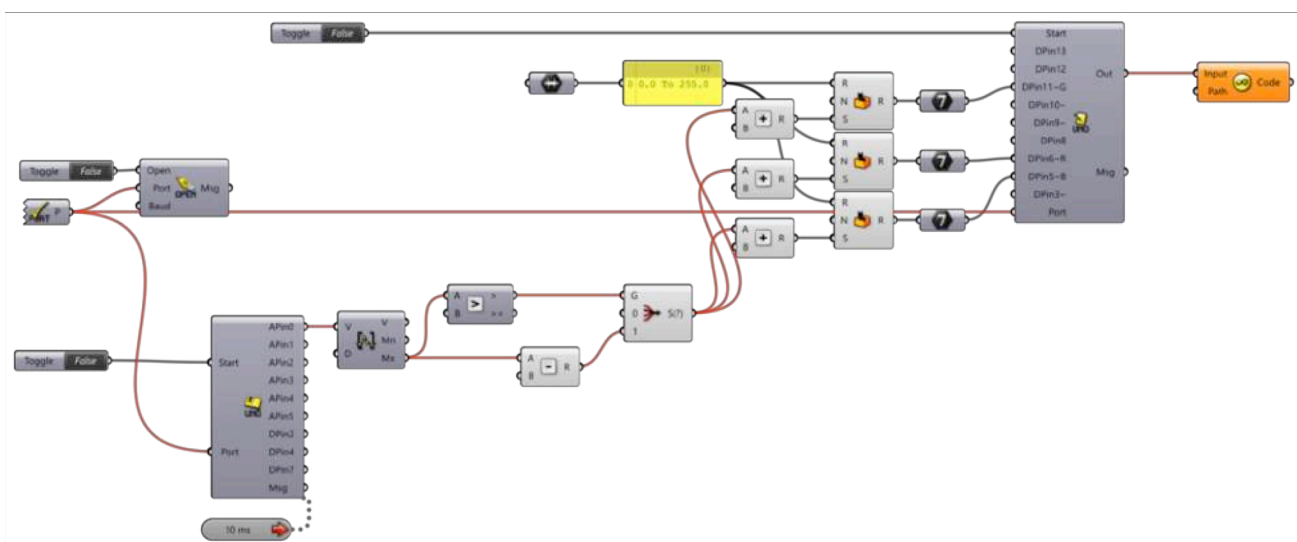


**Fig. 4:** *Parametric process of modelization with Grasshopper's generative algorithms. Each box represents a specific operation between the input (on its left) and the output (on its right). The sequence of these operations allows translating the sounds captated by microphones (input) in light signals emitted (output).*

outgoing fluxes of data for a public prototype.

In (Fig. 4) a view of the algorithm implemented is shown as developed by using Grasshopper[9] (Zubin, 2012) and another component by Firefly[10] (Payne & Johnson, 2018) in order to connect Grasshopper's capabilities with the microcontroller board Arduino (Margolis, 2011). Thanks to this setup it has been possible to find and test the colour's range to use for the implementation (Albers, 2013) without been restricted by hardware of software limitations.

### 4.4 Implementation of the model

The modelization process has led to a concrete design idea to be implemented as a physical prototype. The sketchy mechanics of the prototype is the following: a number of RGB coloured LEDs (led array) are connected, with the aid of a microcontroller board, to a digital microphone. The unperturbed behaviour of the LEDs is to display a sequence of colour smoothly varying in time according to some pre-defined scheme. The microphone then captures the neighbouring sound and, according to some triggering algorithm, a deviation to the base colour scheme is then initiated. Once the sound input ceases the LEDs array returns to the unperturbed scheme. The user experience is therefore the possibility of controlling the colour pattern of the led array by playing with the sounds surrounding the device.

Motivated by the aforementioned requirements (low cost, user friendliness, scalability) the components have been chosen to be: an *Arduino UNO Board*[11]*,, Linker Kit Multi-Color RGB LED*, KY-038 Keyes Microphone Sound Detection Sensor for Arduino. The wiring diagram of the device is displayed in (Fig. 5).

The Arduino microcontroller is well known as a prototyping board for physical computing (Banzi & Shiloh, 2015). Its popularity has grown in the last decade to a wide-spread state-of-art in

the field due to its main features: low cost, small size, prototyping easiness. If compared to other DSP (Digital Signal Processor) (i.e. Raspberry Pi, Nvidia Jetson), it possesses lower computational resources, but on the other hand it has lower requirements (e.g. no operating system required, self-contained IDE). Furthermore, due to its small size, it is the ideal device to be embedded in small physical object or installation, becoming a hidden layer of computation transparent mainly to the final user but also to mid/high level developer.
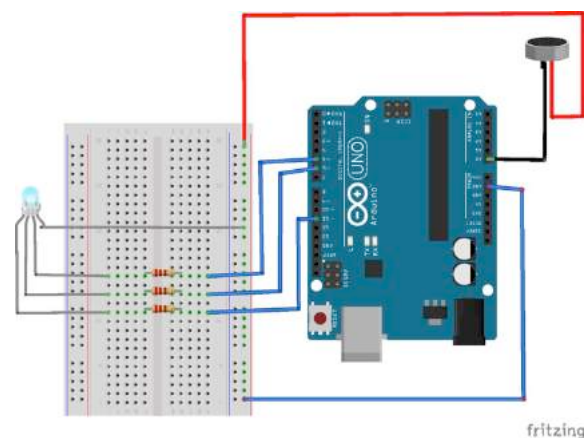


**Fig. 5:** Wiring scheme of Arduino prototype (image obtained with "Fritzing" software).

To ensure scalability and to improve the small number of pins available on an Arduino board, a led strip seemed the most efficient choice since it allows the possibility of exploiting a triplet of pin as controller for more than one RGB led. The power damping along the line can be adjusted by simply connecting the device to a suitable power source. In this sense the low-level driver has been chosen to be the well-known FastLED[12], which takes care of the PWM digital synchronization.

For what concerns the code implementation, the scalability and repeatability have motivated the creation of an open source mid-level interface library. The purpose of the library is to provide a collection of C-like API (Application Programming Interface)[13] which constitutes a layer between the low-level Arduino's API and the programmer. The

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[9] Grasshopper is a free plug-in for Rhinoceros' developed by David Rutten at Robert McNeel & Associates.

[10] "FIREFLY is a set of comprehensive software tools dedicated to bridging the gap between Grasshopper, the Arduino microcontroller and other input/output devices like web cams, mobile phones, game controllers and more. It allows near real-time data flow between the digital and physical worlds – enabling the possibility to explore virtual and physical prototypes." (Retrieved from http://www.fireflyexperiments.com/#home).

[11] https://www.arduino.cc

[12] https://www.arduinolibraries.info/libraries/fast-led

[13] https://www.arduino.cc/reference/en/

code is open and available at OCRA[14]'s github page[15].

The main design idea is to take advantage of the hardware addressability of a specific led of the led strip together with the possibility of having a number of these strips connected at once on the same board. This factor allows to create a library around the representation of a physical multi-strips led configuration as a collection of POD (Plain Old Data) structures arranged in a variable-size array $L[i][j]$ with $i = 0, …, N_{strip}$ and $j = 0, …, N_{led}^{(i)}$. According to this, a colour pattern is the specification of the colour for each RGB led of the configuration. Since each colour is represented internally as a collection of 3 bytes, corresponding to the RGB channel values from 0 to 255, a colour pattern is represented internally as a collection of 3 bytes arrays arranged in a matrix-like fashion $L[i][j]$.
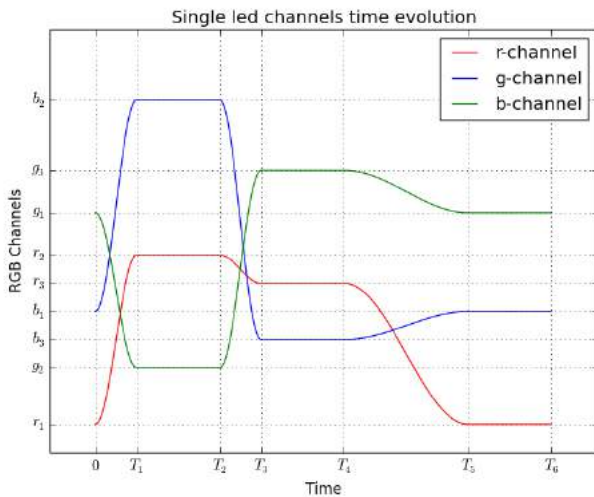


**Fig. 6:** Time evolution of the RGB channels in a single led.

The time transition between u patterns is handled by a transition function whose behavior is displayed in (Fig. 6) and it is designed to be easily manipulated for what concerns the number of states, their rest times, the transitions profiles and their timings.
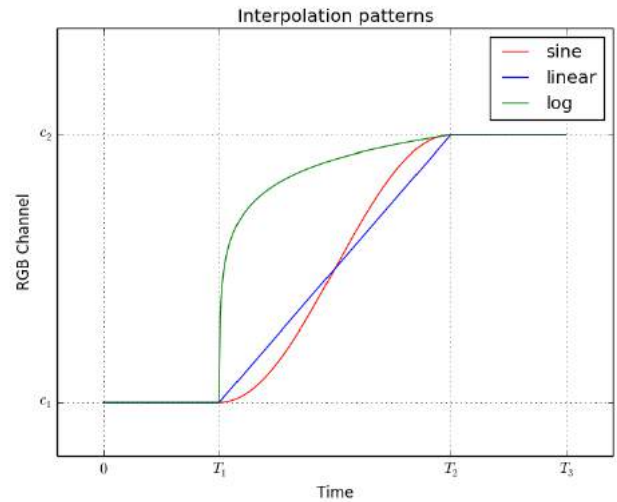


**Fig. 7:** A view of the possible interpolation shapes.

The interpolation profile of the values for a single led channel is evaluated according to the following equation:

$$c_{now}(t) = \left(c_{stop} - c_{start}\right)x(t) + c_{start}$$

where $x(t)$ is a suitably defined function of time $t$, assumed to vary in $[0, T]$, whose values range in $[0,1]$. As depicted in (Fig. 7) the actual form of the function $x(t)$ has been designed according to several possibilities:

- Linear Interpolation
$$x(t) = \frac{t}{T}$$

- Sinusoidal Interpolation
$$x(t) = \frac{1}{2}\left(1 - \cos\left(\frac{\pi\,t}{T}\right)\right)$$

- Logarithmic Interpolation
$$x(t) = \ln(1 + t)\ln(1 + T)$$

Each interpolation profile produces a different light effect as output of the device and can be selected according to the user purposes to recreate a specific feeling.

The sound input has been handled by means of an ADC (Analog to Digital Conversion) sound sensor. Due to extreme intrinsic noisiness of this type of MEMS's (Micro-Electro-Mechanical Systems) together with their high sensitivity to external conditions such as pressure, humidity

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[14] *OCRA - Opera CReativa Artigianale* is a small Italian association, formed by young designers, engineers and architects, dealing with the conception and realization of works of social design.

[15] https://github.com/ocra-aps

and temperature, a simple sound acquisition scheme was in order.

The sound is sampled every 100 ms and the maximum value in the period is stored. In this way the fast-varying spectrum of values is somehow smoothed out and only relevant variation from the environmental noises are captured.

Every 25 cycles the acquired maximum value is tested to belong to a certain value range, which has to be carefully tuned on a per installation basis due to the aforementioned sensitivity of the microphone: this has been done through extensive test during the Grasshopper prototypation phase.

This sound "event" triggers the selection of a random u pattern picked from a palette defined by the user which alters, by means of the same functions described above, the base colour wave.
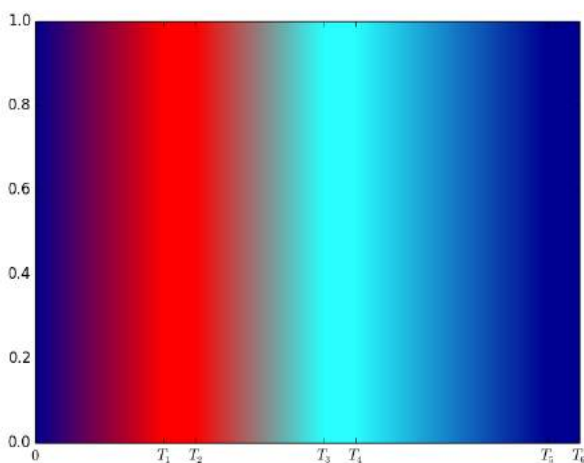


**Fig. 8:** A graphical view of the colour nuances as generated by prototype.

Once this colour pulse has exhausted, the device resumes its state, in the base colour wave, where it was left originally giving the feeling of a continuous process.

The final effect, once the LEDs are connected, is illustrated with a graphical representation of the base colour wave (blue nuances) and a sound-triggered pulse (red nuances) in (Fig. 8).

### 4.5 Prototipation and model validation

The final phase of the process consists in the realization of the physical prototype in scale. This stage is essential for the validation of the model, in order to understand the feasibility of the technological process and to validate the effectiveness of the result.

In particular, the prototype called "Lumières sonores" has been realized and exposed on the occasion of the international exposition entitled "Les cinq premières minutes / The first five minutes", organized by *Art-cade\* Galerie des Grands Bains Douches de la Plaine*, Marseilles, edited by Prof. Arch. Jean-Jacques Terrin (Mazzoli & La Piccirella, 2017).

The microcontroller Arduino is used to realize the multimedial installation, by interconnecting the input data (sounds) and the output data (coloured lights).

In this context, the sound must be produced by visitors by playing a small metallic xylophone, then it is captured by the microphone nearly positioned, and transmitted to the microcontroller for the translation of the sound waves in coloured light emissions.

The historical urban context to be lighted up and transformed, characterized by the arcades in brick, is symbolically represented by three bell jars containing different LED-lights (Fig. 9, 10).



**Fig. 9:** Rendering of the Project Area after the intervention: (on the left) the installation box hosting the visitors who want to interact with the urban context; (on the right) the ancient walls encircling the historical area, whose arcades are lightened by the LED according to the colour nuances generated by the invented algorithm, as reported in Fig. 8.

The small prototype demonstrates the feasibility, the speed and the simplicity of the installation, confirming the repeatability of the action for urban regeneration uses.

Furthermore, the interest and the surprise observed in the visitors experimenting the prototype demonstrate the effectiveness of the solution and the real possibility of adopting this creative technological strategy for social involvement aims. This artistic and participative involvement could constitute the social phenomena to be implemented for an innovative digital and parametric strategy in urban renewal.

## 5. Conclusions

The project aims at promoting a new digital parametric approach for the urban renewal of abandoned area through the implementation of interactive installations, which could socially involve the citizens and consequently repopulate and upgrade the area.

Despite the past researches deem that the actual use of the numerical tools has led to a strong depersonalization of the land and marginalization of the individual, this project promotes the possibility of using technological innovations for social and urban aims. The technological strategy proposed could strengthen the social relations between citizens, as well as their relationship with the urban territory and its identity.

The main qualities researched for the final solution envisage different fields, defined as essential for the project: *technical and technological*; *social; economic; environmental* (above the others).

The technology implemented for the installation design is based on the use of innovative technological tools: a parametric design software (Grasshopper) for the modelization and a microcontroller (Arduino) for the realization of the physical model and prototyping. These tools are both characterized by main features that totally agree with the paradigm of the research: cost-effectiveness; limited size; prototyping facility.
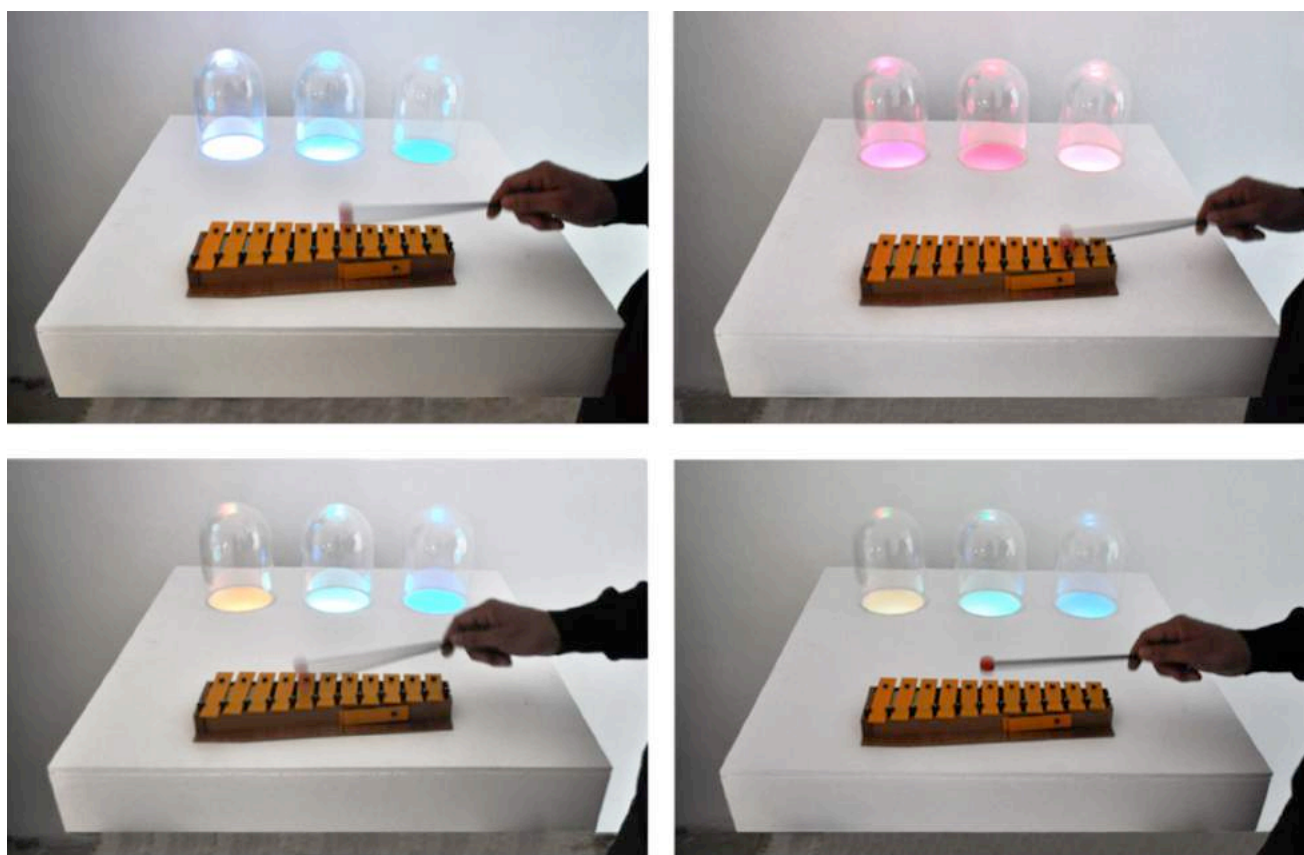


**Fig. 10:** Images from the exposition ""Les cinq premières minutes / The first five minutes", organized by Art-cade* Galerie des Grands Bains Douches de la Plaine: different nuances colour obtained by playing melodies by xylophone.

With reference to the sustainability requirements – in economic and environmental terms – the technology proposed is based on the use of LED. This type of lighting presents a remarkable luminous efficiency (more light for less Watt consumed, therefore less consumption), a long duration that thins the maintenance interventions, an instant lighting/extinction, the possibility of dimming from 0 to 100% in continuous, and also allows deciding the colour temperature of each individual LED element.

The proposed idea is also aimed at further stimulating the passage of urban LED lighting, to go increasingly in the direction of energy saving on a city scale, in accordance with research conducted in this field by other European countries (especially the Northern ones).

Definitely, the project promotes the conscient use of new digital technologies for social and urban aims, considering that citizens' creativity and innovative artistic systems could be able to repopulate and then upgrade the blighted urban spaces.

The prototype and its hardware/software components have been developed with the idea of modularity and with the scalability of the project as key feature. With these tools the possibility of connecting a series of these devices together in a IoT fashion is straightforward.

This in turns allows imaging the easy and fast implementation of this technology at an enlarged scale (i.e. buildings, urban areas, cities).

## 6. Acknowledgements

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