Go! Green

Métodos Experimentais em Energia e Ambiente

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João Pedro, nº 63359 | Mestrado Integrado em Engenharia Mecânica - Ramo de Energia

Rita Rente, nº 79323 | Mestrado em Urbanismo e Ordenamento do Território

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Abstract

Given the wide evidence on the importance of green areas to the resilience of urban environments, it is important to enhance our capability of growing and maintaining them, both outdoors and indoors. Their effect on health (through pollution reduction, and stress reduction) and risk mitigation (through crime reduction, better neighborhood cohesion and runoff reduction), is critical in evolving to a more sustainable city.

***Go!* Green** is a technological device, destined to be used with houseplants, that aims to help people learn more about how to keep their plants healthier while focusing on participative learning. It is a low-cost, energy efficient and eco-friendly device that, when placed in a vase, communicates with the user in case the plant needs to be watered. A prototype of the product was created, tested and demonstrated for a heterogeneous audience who gave a very positive feedback. The aim of Go!Green is to be a fun and simple solution with potential for educational use, and that objective seemed to be well understood by potential users.

With sustainability in mind, part of the sales' revenues are to be destined to funding communitarian urban projects, making the whole project an overall contribution to the improvement of life quality in urban context.

Conceptual Framework

Sustainable cities

The sustainability challenge involves complex interactions between citizens, organizations (governmental or non-governmental) and businesses. Integration across sectors is the only way to create integrated solutions to improve urban life and well-being, especially when considering that sustainability is not a static concept, but a complex and constant interaction between social, environmental and economical dimensions of society. Campbell (1996) calls it the 'planner triangle' with sustainable development placed in the center. This center (sustainable development) can only be reached approximately and indirectly, after a long period of confronting and resolving the triangle's conflict. In the strive for sustainability, integrated thinking must be at the core of the decision process as we face complex transdisciplinary challenges.

With half of the global world population living in urban contexts, it is necessary that cities consume fewer resources and generate less pollution, in order to be more resilient to the impacts of extreme events and more sustainable in general. As the global population rises and demand for goods, food, water, energy and other services increase, the challenge to create more sustainable urban areas is increasing. (Dawson R.J. et al,. 2014: 5)

According to Dawson and colleagues (2014) there are some general goals that every city should be pursuing to increase its sustainability: (i) create the smallest possible footprint; (ii) be environmentally ‘friendly’ in terms of pollution, land use and climate change; (iii) provide economical and social security; (iv) lead to a healthier and higher quality life of citizens; (v) have an inclusive governance system; (vi) allocate resources and define benefits and costs in order to (vii) be resilient to pressures and disturbances.

Benefits of green spaces

There is a well documented relation between green spaces and health. Green spaces have been linked for decades to benefits such as recovery from mental fatigue (Taylor & Kuo, 2009; Berman et al., 2008; Hartig, Mang & Evans 1991; Hartig, 2008), stress reduction (Roe et al., 2013; Thompson et al., 1012), neighborhood social cohesion (Mass et al., 2009), reduction in crime, violence and aggression (Branas et al., 2011; Kuo et al, 2001, Garvin et al, 2012), and better self reported health (De Vries et al., 2003; Van Dillen et al., 2012; Maas et al., 2006).

Besides the aspects above, Urban Green Infrastructures, defined as “a network of decentralized storm water practices, such as green roofs, trees, rain gardens and permeable pavement, that can capture and infiltrate rain when it fails, thus reducing storm water runoff and improving the health of surrounding waterways” (Center for Neighborhood Technology, 2010), also have great potential benefits (p.e. reduce air pollution and greenhouse gas emissions, mitigate urban heat island effect, reduce noise or increase biodiversity and habitats) (Dawson et al. 2014: 135).

Green spaces at home?

Almost every house has, at least, one plant. The benefits of having plants at home are less wide than having a green infrastructure at a city. However, the benefits still exist: the stress-reducing benefits of passively viewing plants in natural settings are well documented (Honeyman, 1992; Moore, 1982; Ulrich, 1984; Ulrich et al. 1991). Having plants in interior spaces also can improve productivity (Lohr, et al. 1996), which can lead to the improvement of individual well-being (Grinde and Patil. 2009). Interaction with plants, both passive and active, can change human attitudes, behaviors, and physiological responses (Relf, 1990).

Children can also benefit from having plants at their house: by the time they are aware of plants as living beings, they are aware that plants should be taken care of (Stavy and Wax 1989).

The Product

The Concept

We wanted to develop a human-nature interface that helps people to learn how to have healthier plants while also creating an interactive experience that is both educational and fun. It must be simple and robust in a way that it can be used by people of all ages while also being low cost and environmentally friendly.

The Solution

To guarantee the health of green areas it is needed to have the adequate light, temperature, nutrients and water. Since the focus is on indoor spaces, we choose to keep control only of the soil moisture. It is not relevant to have that much concern with the other variables: light and temperature have fluctuations along the seasons that are normal to the lifecycle of most domestic plants, and measuring nutrients onsite would be too expensive and unpractical. It was decided to go with a simple and direct interface that informs the user of the plant's watering needs and reacts when the correct soil moisture is reached. In this way, we want people to be an integrated part of the process in a way that would be impossible if we were to create a totally automatic system, as we believe that participation is the best way to learn (Howard/Stein-Hudson, 1996; Warren-Kretzschmar and Tiedtke, 2005).

To make it versatile it was decided to develop a small, smart and portable box that can be installed in the majority of vases and that is "plug and play", meaning that the user can place it in the vase and it is instantly functional. This also means that it can be interchangeable between vases as much as the user wants, by just picking it from one vase and placing it on the other without losing functionality.

The case is to be made of wood, making a statement on sustainability, and with the name ***Go!* Green**, we emphasize the progress towards environmental awareness.

How does it work?

***Go!* Green** will check itself every thirty minutes communicating with the user only if watering is needed and only if there's light in the room. The communication method will be visual and by sound. To make it efficient, it must also stop communicating if the user doesn't react within a given period of time to the water needs (5 minutes). This ensures that energy is not wasted if, for example, there is no one in the room or no one is available to water the plant. In case this situation occurs, ***Go!* Green** will go to sleep and communicate again in thirty minutes. There will also be the option for the user to check for the plant's water needs at all times.

How much water does a plant need?

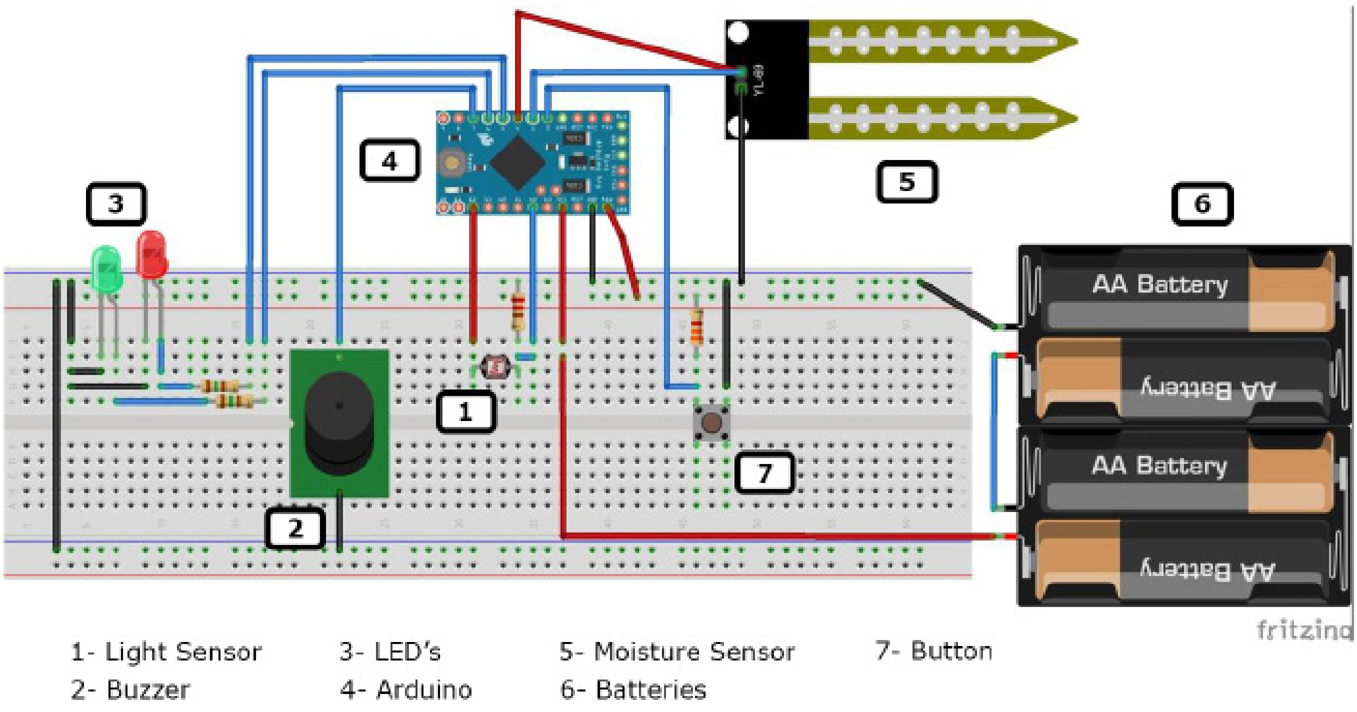
The amount of soil moisture that a plant needs, usually measured in volume percentage, varies with a lot of variables but, for this type of application, the main variable is the soil type. There are two fundamental factors that influence the plant available water, being them the field capacity (FC) and the permanent wilting point (PWP). FC is the maximum amount of water a soil can have without draining occurrence. When one waters the soil there's always some leakage from the bottom of the vase, and when leakage stops we reach the FC. The PWP is the minimum amount of water in a soil at which the plants can use the water. Below de PWP the soil still has water but the plants can't access it anymore. It is desirable to keep the soil between these two points as much as possible so that plants can have usable water. FC and PWP vary greatly with the soil type, being minimum for sand and maximum for clay. This means that a good water percentage in a sand soil would be between 5% and 10% but in a clay soil 10% would be far below de PWP. The challenge here is to assess what is the optimum value that guarantees that the soil moisture is adequate in the majority of houseplants' soil. Usually the soil used is called potting soil and is a mixture of several vegetable components, in which there is actually no soil, and in the literature there is no clear reference to its FC and PWP values. An accurate measure of the optimum values for this application would have to be obtained through experimentation with samples of the most used potting soils in the market. Even then, it must be clear that whichever way the sensor is calibrated, the information given by this product must be taken as indicative as it just guarantees that the soil is not below the PWP.

The Prototype

The prototype has been built as a first approach, both to the design and to the interface, and as a mean to test for people's receptivity to the product. It was also very useful to detect conceptual flaws and to gather further development ideas from people's feedback.

Electronics

The electronic system designed for this prototype is Arduino based, consisting of a microprocessor board running Arduino code that processes the information given by a resistive soil moisture sensor, a button, and a light sensor, while managing the interaction with the user. In this case, the interface is composed by two LED's, one green and one red, a buzzer and a button. The power comes from 4 AA batteries, and a simple ON/OFF switch is used to control the device's power. Besides the main components, some resistors make also part of the circuit (to control the power delivered to the LED's and the buzzer and as pull-ups). This prototype doesn't work exactly as described in the product chapter for two main reasons: on one side, proper calibration of the sensor would be needed for the final product, this not being fundamental for demonstration purposes. On the other side some timings were deliberately changed so that they would fit the demonstration objectives (instead of checking for water every 30 minutes, the prototype checks for water every 16 seconds). The interaction with the user, however, works like in the final product: If there is light in the room and the plant needs water, the prototype bips a sad melody and starts blinking the red LED. When the soils moisture reaches a given value, it bips a happy melody and blinks the green LED once. At any time, the button can be pressed and the device will act as above, according to the soil moisture value at that time. In terms of energy efficiency, the performance of this prototype is similar to expected on the final product in that the 4 batteries can last to approximately half a year in continuous use.



(this scheme is merely ilustrative as some of the components aren't exactly equal to their real counterparts)

Design

It was decided to go with an inverted U-shaped design for the casing meant to fit a vase's edge. One of the legs of the U has the sensor and is on contact with the soil, whereas the other leg hangs on the outside of the vase having all the interface components on the front and all the power related components on the back. It is made of plywood and coated with water resistant lacquer, making it fairly resistant, both structurally and to water.

Costs

The cost of the prototype was approximately 37,5€ of which 30€ were for the electronic circuitry and 7,5€ to the case. A detailed description of costs can be found in annex I.

Testing, feedback and future developments

The prototype had the objective of checking for the validity of the initial concept by gathering feedback from potential users as they tested it. This objective was successfully accomplished as all the projected functionalities worked as expected. In this way it was possible to collect a good set of opinions and suggestions concerning the perceived flaws and desired future developments for this product.

The main constraints most people pointed to were design flaws. Mainly the fact that it was too big, didn't fit on round vases and that the soil side should be adjustable so that it could fit vases with different soil heights and different edge thicknesses. The fact that the case is made of wood was definitely a good decision, since almost everyone mentioned that as a positive thing. However, some people mentioned that it being powered by batteries was not in line with the sustainability the project advocates and that some more sustainable power source could be considered. In general, people who are more connected to gardening, and already know a lot on the subject, considered this a useless product for them since it was too simple for their needs. On the other side, people for whom gardening is not a hobby, but that have plants in their houses, stated that it would be very useful to prevent them from forgetting to water their plants. The educational potential of the product was widely referred to as a good end use, not only at home but also at schools.

Most of this opinions and advices are very useful and should definitely be incorporated in a future prototype. The only thing one that probably would not change is the power source since, despite that part not being environmentally friendly, the product spends very little energy and the use of, for example, a solar panel, would increase the costs so much that the product would become too expensive and people would end up not buying it at all. Besides that, solar power would be very inefficient as this is designed to mainly be used indoors.

The Business

There are several solutions in the market that monitor the soil moisture. Most of them are industry oriented but some are meant for home gardens. The main objective of these systems is to make it so than the garden is automatically watered based on the measured soil moisture making them very useful for houses with large gardens. A solution like this, only with the purpose of automatically watering houseplants and preventing them from perishing by lack of water would not be very appealing: on one side, houseplants are usually spread around the house and it would be very expensive to have an independent system per vase that would do the watering. On the other side, and with few exceptions, houseplants are usually easily replaceable and without great costs. Besides that, it would be very intrusive to change the appearance of every vase with a watering device when a big part of having plants inside a house is precisely aesthetics.

Because of all this, such a system would certainly have very few potential buyers. Go! Green, on the contrary, pretends to be a fun and educational device that lets people learn directly from the plants on how to water them properly, by providing real-time feedback on the plants' water needs. What makes it appealing is being a simple, low cost and fun way of interacting with nature.

With a growing public opinion focus on environmental and health related issues, the market for "green" products is already a large one. Apart from this, the market for "high-tech" products is also very big as we live in an increasingly information-intensive society. In the last years we could observe the proliferation of products whose marketing is solely based on sustainability advertisement. Expressions like "Eco-Friendly", "100% Natural" or "Made from Sustainable Sources" are all around. We can also observe several brands that exhibit the seal of recognized sustainability oriented organizations such as "Rain Forest Alliance" and "Fair Trade Foundation". This means that from the business point of view there is a very clear message: sustainability sells. Sustainability advertisement will be the desired path for this product's marketing strategy.

In financial terms, it is estimated that the product cost would drop substantially compared to the prototype, and that the final price would probably be close to 25€.

We believe that helping the community is a fundamental part of a corporative view and that sustainability must also come from the business side and not only from the product's functionalities. With this in mind we propose a business plan in which part of the profit is used to help fund communitarian projects that strive towards urban sustainability.

Bibliography

Berman, M., Jonides, J., & Kaplan, S. (2008). The cognitive benefits of interacting with nature. Psychological Science , 19, 1207-1212.

Bjørn, G., & Patil, G. G. (2009). Biophilia: does visual contact with nature impact on health and well-being? International Journal of Environmental Research and Public Health , 6.9, 2332-2343.

Branas, C., Cheney, R., MacDonald, J., Tam, V., Jackson, T., & Have, T. (2011). A difference-in-differences analysis of health, safety, and greening vacant urban space. Amer. J. Epidemiol , 174, 1296-1306.

Campbell, S. (1996). Green Cities, Growing Cities, Just Cities?: Urban Planning and the Contradictions of Sustainable Development. Journal of the American Planning Association , 62, 296-312.

D, R. (1990). Psychological and sociological response to plants: Implications for horticulture. HortScience , 25, 11-13.

Dawson, R., Wyckmans, A., Heidrich, O., Köhler, J., Dobson, S., & E, F. (2014). Understanding Cities: Advances in integrated assessment of urban sustainability . Newcastle, UK.

De Vries, S., Verheij, R., Groenewegen, P., & Spreeuwenberg, P. (2003). Natural environments-healthy environments? An exploratory analysis of the relationship between greenspace and health. Environ. Plan , 35, 1717–1732.

Garvin, E., Cannuscio, C., & Branas, C. (2012). Greening vacant lots to reduce violent crime: A randomised controlled trial. Inj. Prev. , 19, 198–203.

Hartig, T. (2008). Green space, psychological restoration, and health inequality. Lancet , 372, 1614-1615.

Hartig, T., Mang, M., & Evans, G. (1991). Restorative effects of natural environment experiences. Environmental Behaviour , 23, 3-26.

Howard/Stein-Hudson Associates, I. (1996). Public Involvement Techniques for Transportation Decision-making. U.S. Department of Transportation .

Hudson, B. D. (1994). Soil organic matter and available water capacity. Journal of Soil and Water Conservation , 49.2, 189-194.

Kuo, F., & Sullivan, W. (2001). Aggression and violence in the inner city. Environ. Behav. , 33, 543–571.

Lohr, V. I., Pearson-Mims, C. H., & Goodwin, G. K. (1996). Interior plants may improve worker productivity and reduce stress in a windowless environment. Journal of Environmental Horticulture 14 , 97-100.

M.K., H. (1992). Vegetation and stress: A comparison study of varying amounts of vegetation in countryside and urban scenes. In D. Relf (Ed.), The Role of Horticulture in Human Well-Being and Social Development: A National Symposium (pp. 143-145). Portland, OR: Timber Press.

Maas, J., Verheij, R., Groenewegen, P., de Vries, S., & Spreeuwenberg, P. (2006). Green space, urbanity, and health: How strong is the relation? J. Epidemiol. Community Health (60), 587-592.

Maas, J., Verheij, R., Groenewegen, P., de Vries, S., & Spreeuwenberg, P. (2006). Green space, urbanity, and health: How strong is the relation? J. Epidemiol. Community Health , 60, 587–592.

Moore, E. (1982). A prison environment's effect on health care service demands. J. Environ. Systems , 2, 17-34.

Rao, N. H. (1987). Field test of a simple soil-water balance model for irrigated areas. Journal of hydrology , 91.1, 179-186.

Roe, J., Thompson, C., Aspinall, P., Brewer, M., Duff, E., Miller, D., et al. (2013). Green space and stress: Evidence from cortisol measures in deprived urban communities. Int. J. Environ. Res. Public health , 10, 4086-4103.

Stavy, R., & Wax, N. (1989). Children's conceptions of plants as living things. Human development , 32.2, 88-94.

Taylor, A., & Kuo, F. (2009). Children with attention deficits concentrate better after walk in the park. JAD, (pp. 402-409).

Technology, C. f. (2010). The Value of Green Infrastructure. A Guide to Recognizing Its Economic, Environmental and Social Benefits.

Thompson, C., Roe, J., Aspinall, P., Mitchell, R., Clow, A., & Miller, D. (2012). More green space is linked to less stress in deprived communities: Evidence from salivary cortisol patterns. Landscape Urban Plan , 105, 221-229.

Ulrich, R., Simons, R., Losito, B., Fiorito, E., Miles, M., & Zelson, M. (1991). Stress Recovery during exposure to natural and urban environments. Environmental Psychology 11 , 201-230.

Van Dillen, S., de Vries, S., Groenewegen, P., & Spreeuwenberg, P. (2012). Greenspace in urban neighbourhoods and residents' health: Adding quality to quantity. J. Epidemiol. Community Health , 66.

Warren-Kretzschmar, B., & Tiedtke, S. (2005). What Role Does Visualization Play in Communication with Citizens? A Field Study from the Interactive Landscape Plan. In Buhman, Paar, Bishop and Lange. Wichmann, Germany: Trends in Real-Time Landscape Visualization and Participation - Proceedings at Anhalt University of Applied Sciences.

Electronic components

Component	Quantity	Unit price (€)	Total (€)
Resistencia 150R 5% 250mW	2	0.04	0.08
Resistencia 10K 5% 250mW	2	0.04	0.08
Resistencia 220R 5% 250mW	1	0.04	0.04
Fio de solda 0.7mm 5m	1	1.20	1.20
Fio 1/22AWG 1.8A Preto 1m	1	0.25	0.25
Fio 1/22AWG 1.8A Vermelho 1m	1	0.25	0.25
Fio 1/22AWG 1.8A Amarelo 1m	1	0.25	0.25
PCB Header 40Pin Single Row	1	0.80	0.80
Suporte 4xAA Wire Leads	1	0.85	0.85
Buzzer 5V	1	0.81	0.81
PadBoard	1	2.5	2.5
Tactile Button 12mm Black	1	0.40	0.40
Diffused LED - Green 10mm	1	0.35	0.35
Diffused LED - Red 10mm	1	0.35	0.35
4x LR6-AA 1.5V 2100mAh	1	1.40	1.40
Electronic Brick - Moisture Sensor	1	2.40	2.40
A-Star 32U4 Micro	1	9.80	9.80
LDR - Light Sensor	1	0.74	0.74
Power Switch	1	0.83	0.83
Total			23.33
Total with VAT			28.70

Casing

The cost of the casing cannon be accuratly defined as some materials used were bought in excess and other were already ours beforehenad. Nevertheless, here is a complete list of the materials used, being the estimated overall cost of around 7.5 €.

The materials used were: a 5mm plywood board, water resistant white glue, clear water resistant lacquer, 9 small screws, several bits of wood to make the inside supports for the electronic components, a 4mm rubber rectangle for the moisture sensor protection.

Centro Republicano Almirante Reis in Mouraria welcomes *Go!*Green

On December 18th took place in Centro Republicano Almirante Reis in Mouraria the very first public presentation of Go!Green towards an audience of locals, academics, and stakeholders.

With a transdisciplinar approach and a challenge to raise awareness for environmental causes, Rita Rente and João Pedro, Master students from Instituto Superior Técnico, created Go!Green.

Go!Green is a small and portable device that tells the users when their house plants should be watered in a fun and simple way. After the short presentation (around 15 minutes) a man in the audience, that claimed to be Botanic, expressed his opinion by saying that Go!Green was not usefull for experts. Go!Green is educational-oriented and meant to be used by people of all ages. The rest of the audience gave a very positive feedback essentialy on what concerned the communication with the plant, the design and the usefullness of Go!Green.

Annex III - Social Media - Facebook page and Youtube Link for promotional video.

Youtube Video: https://www.youtube.com/watch?v=UBOiEgwE6cs

Facebook Page: https://www.facebook.com/gooooogreen