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Molecor´s Application for Digitalizing and Geolocating Water Infrastructure Networks

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ABSTRACT

MOLECOR continuing with its line of leading water infrastructure sector with its technological products, has recently developed a software that can be used through a mobile application or web browser with which users can digitalize and geolocate the different pieces that form a water infrastructure network.

Short Summary: Water infrastructure management has been a challenge due to its complexity, dynamism, and the multiple stakeholders involved. The emergence of new technologies such as Apps, AI, IoT, and sensors opened up new opportunities for water network management. The digitalization and geolocation of the network is the steppingstone for further developments, providing significant advantages such as reducing costs, improving traceability and accountability, and increasing environmental friendliness.

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This is a new tool that allows to digitalize and geolocate, of course PVC-O pipes and fittings, but also all the rest of elements within the water infrastructure network, in order to obtain a complete traceability. For the pipes and fittings of the company, the information would be complete, from the creation of the product to its installation and the rest of parts and products in the infrastructure network can be added manually. In this way, all the parties involved in a certain project can have complete and real-time technical information about all the products that form the network.

After being registered in the application, users will be able to add more people involved in the project who, in turn, will be able to add the different pieces to the network until they get the complete layout of it, including images of the products, sending comments, requesting technical support or reporting and following up incidents, among many other possibilities.

This paper covers a brief analysis of the market needs for this kind of tool, the development process of the technical solution, a study case of a test use of the tool, a summary of the multiple advantages and added value that the users will be able to find with the use of this new solution, and some ideas and first insights for a further development and enhancing of this solution in the future.

Introduction

Water is a critical resource that is necessary for human survival, industrial and agricultural activities, and overall, for the adequate functioning of modern society. The water distribution system is complex, and it involves multiple different stakeholders, not only over the fabrication phase, the construction and installation phase, but also on the management phase, and it is essential to ensure that its operation is efficient and reliable. In this sense the digitalization and geolocation of water infrastructure networks have become increasingly important to address all the challenges that may arise in the infrastructure network such as accountability and traceability of the products installed, prevention of leakages, water quality issues, among others. In this sense, the solution presented today is a working progress innovation to address those challenges and is expected to become a supportive administration tool for managing water infrastructure networks, providing great advantages for all the stakeholders involved over the whole water management cycle.

Market Need for Water Infrastructure Network Digitalization and Geolocation

Over the last years, the demand for water has increased significantly due to population growth, urbanization, and industrialization. At the same time, water resources are becoming increasingly scarce, making their adequate management critical. In this context the digitalization and geolocation of water infrastructure networks has emerged as an initial solution that can help in managing water resources efficiently. The digitalization of water networks involves the use of various technologies to monitor, analyze, and optimize the water supply and distribution systems. Digitalization and geolocation are at the core of the solution, enabling the identification of the location of different components of the water network, including pipes, valves, and hydrants serving a key element for having: (i) complete traceability and digitalization

of a project; (ii) real- time technical information of the project; (iii) sustainable management of the water network as it reduced the need of paper based registries; (iv) immediate and effective communication within all the stakeholders involved in the project; among other advantages. This could of course be enhanced with the incorporation of sensors, IoT elements, AI analytical tools, etc. In any case the steppingstone for developing around that enhancements are to have digitalize and geolocated the network.

In the end, a complete digitalized and geolocated network will have great advantages allowing for greater transparency and accountability, making it easier to track progress, identify potential problems, and make informed decisions, and overall improving its efficiency and reducing water and time management loss.

Technical Solution

In view of the urgent need for improving the management of water systems, this tool was developed to enable the digitalization of water infrastructure networks and the geolocation of all the components that form the infrastructure project. The software that can be used through a mobile application or through a web browser allows the geolocation of the company PVC-O pipes and fittings but also all the other elements within the water network, providing a complete traceability. The software provides complete and real-time geolocation and technical information about all the products that form the network, from the creation of the product to its installation [1].

The application allows project leaders to add all the users involved in the project (installers, constructors, suppliers, end users, project promotors, among others) who depending on its permits are able to add the different pieces to the network until they get the complete layout of it. The application also allows users to include images of the products over the installation process, send comments, request technical support, or report incidents, among many other possibilities.

The digitalization and geolocation of the water network infrastructure allow all stakeholders to be able to easily access all the information registered either automatically using QR codes or manually accessing to a complete library where bends, T-branch, T for air valve, shut-off valves, reducers, Special valves, hydrants or flow diversion points, pipes, and any other kind of part can be added with all its correspondent technical information.

For example, for PVC-O pipes and fittings manufactured by the Spanish company the software can show the information as follow: type of product, DN, PN, security coefficient, class, lot number, certificate, regulations, date and time of the installation, country, production center of the piece and production line, so the product can be traceable not just on the project in itself but over the manufacturer production process as well. There is also some auxiliary hardware equipment that is recommended to have for facilitating the uploading of most of the information into the software. In this case a Manufacturing Execution System (MES), a Short Pulse Fiber Laser (LP-RV200P Panasonic), and for safety reasons, a Fume Extraction Solution for Laser Marking (LFE – 180 – PVC) were acquired, synchronized to our MES, put in place in our fabrication facility and adapted to our specific needs.

A short reference to the products specification is the following:

For the Short Pulse Fiber Laser:

Item	LP-RV200P
Laser type	Yb fiber laser λ= 1,064 nm 0.0419 mil Class4 laser
Head protective structure	IP64
Coding functions	Text, logos, barcodes and 2D codes
Supplied software	NAVI software, Logo data editing, logo data conversion, Adobe – Illustrator ® plug-in Export VEC and Font Maker
Marking area	90mm x 90mm; Working distance: 190mm
Laser rated power	20W
Scan speed	12,000mm/s

Source: Panasonic Industry, Short Pulse Fiber Laser catalog FAYb Laser Maker". 2020 [2]

For the Fume Extraction Solution:

Item	LFE – 180 - PVC
Noise level	< 60dBA (at typical operating speed)
Filter efficiency	99.997% @ 0.3 microns
Airflow/pressure	350m³/hr (205cfm) / 96mbar
Maximum flow	160m³/h; Noise level (at 50-100%): 60dB (A)

Source: Intelligent Operating System AD PVC IQ catalog. 2021 [3]

It is also important to state that a common smartphone with GPS is needed to read the QR code once the different parts and elements are placed and installed to be able to get accurate data of geolocation of the different components of the water infrastructure network directly from the QR code, otherwise it would be needed to insert the data manually.

Study Case: Testing the Software

Traditionally, water network systems have been managed using paper-based systems that are difficult to update and maintain and there is no adequate and real-time traceability of projects.

The modernization project of the "Irrigation system of *Pantano de Gasset*" was promoted by Gasset Dam Irrigation Community of *Ciudad Real*, in Spain. The project was carried out in 2022/2023 to establish an efficient irrigation system in its 1,083.8854 hectares of irrigated surface with the objective of use buried pipes with sufficient pressure to directly irrigate the parcels, either through sprinklers or drip irrigation systems, minimizing water loss and optimizing energy consumption, improving the situation in 605 agriculture plots, benefitting more than 305 landowners. The project included suction lines, electric pumps, pumping stations and the piping distribution network system.

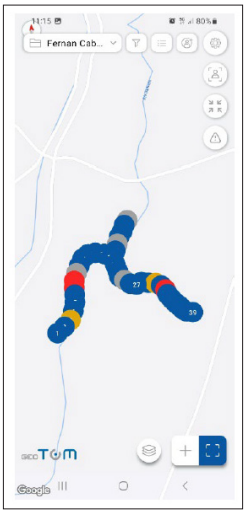
Specifically for the piping distribution system, the project required:

Material	Diameter	Length (meters) or units
PVC-O	400 mm	1,878
PVC-O	500 mm	2,628
PVC-O	630 mm	2,844
PVC-O	710 mm	2,448
PVC-O	800 mm	606
HDPE	160 mm	144
HDPE	250 mm	108
HDPE	400 mm	24
HDPE	500 mm	36
HDPE	1,000 mm	1,863
Valves	150 mm	40
Valves	200 mm	15
Valves	250 mm	4
Other valves	From 300 – 800 mm	16
Air release valves	150 mm	40
Air release valves	200 mm	15
Air release valves	300 mm	4
Other suction cups	From 300 – 800 mm	16
Joints and fittings	Different types	221

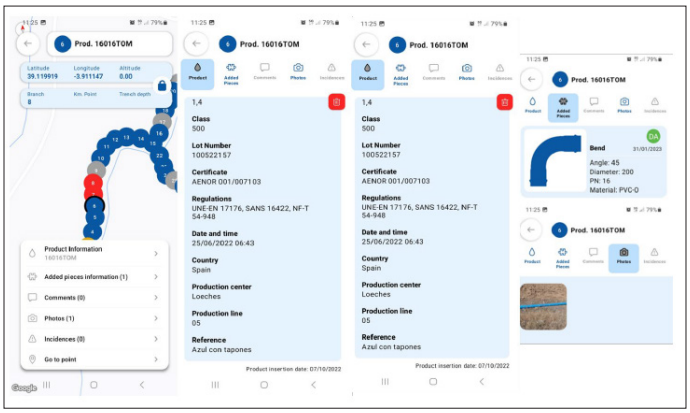
Source: Fernández J.L "Proyecto de Modernización del Regadío de la Comunidad de Regantes Pantano de Gasset (Ciudad Real) [4]

The irrigation community that promoted the project was interested in improving the management of the water network infrastructure, so this project served as a first test for the digitalizing and geolocating water infrastructure network tool, which aimed to improve the management and maintenance of the network and ensure transparency and accountability of the project from a technical point of view in terms of the parts and equipment installed.

The infrastructure network of this project was partially digitalized for the purpose of this test. In specific, 39 points of the piping network near Bañuelo´s river of the *Fernan Caballero* municipality were digitalized so all the stakeholders of the project were able to digitally see the layout of the project in real-time over google maps from their mobile phone or desktop [5-9].



Each point can be individually selected and the geolocation, technical information of the product, added pieces, comments, photos, and incidences will appear on the screen. As an example, we show point 6 of the piping line where a PVC-O TOM was installed and you can easily see all the information regarding latitude, altitude and longitude, technical information about the pipe, the piece that was manually added (a bend) and photos of the of the installation process of the parts.



For the purpose of this test, we added some simulated incidents over the piping line, that is why is possible to see different colors on the layout of the infrastructure network. Red would indicate that there is an incident pending to be solved, yellow if an incident is being taking care of, and grey if the product information is missing or pending to be uploaded.

According to the users of the software, the tool has proven to be very useful for: (i) reducing the risk of information loss; (ii) providing real-live traceability of all the water networks and its components; (iii) enabling easy communication among all the stakeholders involved in the project; (iv) facilitating the location of installed parts; (v) reducing the cost of administrative expenses related to paperwork to register project information; (vi) increasing network efficiency as communication, reports and identification of repairments are easily tracked; (vii) reducing time and energy in the sharing and exchange of information as all the information related to the network is allocated in the software and can be accessed by all parts involved at any time.

Conclusions

Over the last years, several successful innovations and investment have been taking place worldwide for increasing the efficiency of water infrastructure networks focused on improving quality, durability, energy consumption, environmental friendliness, recycling, among others mainly through improvements in the materials used and improvements in engineering techniques. Managing and monitoring water supply networks has attracted less attention and investment even though this is a serious challenge due to the dynamism, uncertainty, complexity and multiple set of stakeholders involved in the management and use of infrastructure water infrastructure networks. The technology revolution that we are experiencing with the strong emergence of AI, IoT, sensor and information management systems opens up a great opportunity for advancing in what is commonly known as "Water 4.0 initiatives", an industrial revolution that will combine the use of emerging technologies with monitoring and control capabilities and computational prediction models to support and provide better information to decision takers optimizing and improving the management of water supply systems.

With that in mind, a starting point in this innovation process was to develop a solution for water digitalizing and geolocating the water infrastructure network. In this case the application presented is a working progress innovative solution that allows you to geolocate all the components that form a water network, thereby reducing the time and cost involved in monitoring and fixing the problems that may arise. The application also provides complete and real-time technical information about all the products that form the network, which helps in ensuring the quality of the products used (accountability). The application also allows users to include images of the products, send comments, request technical support or report incidents, among many other possibilities, thereby improving the efficiency and effectiveness of the water network management.

The application can be used by all the stakeholders involved in the project including water utilities, engineering firms, construction companies, and government agencies.

Overall, this software is a promising solution for water infrastructure network digitalization and geolocation with the potential to transform the water network management by providing complete and accurate information about the network, thereby contributing to the sustainable management of water resources.

Public administrations, private entities and basically all the stakeholders involved in the water management development process are interested in investing and developing well designed long-standing infrastructure projects, being critical to increase the attention in:

- Pre-investment studies (defining the problem and possible solutions, market studies, technical and economic feasibility studies, environmental impact analysis, among others)
- Analyzing and selecting the best alternative for each specific project needs, considering material´s quality, durability, effectiveness, and environmental friendliness.
- Define and stablish a management infrastructure system infrastructure and institutional management of the network.

A good combination of those aspects will be key in having a long-standing infrastructure network working with high efficiency and effectiveness, limiting incidents failures, ensuring traceability and accountability, and providing a better service while saving money for contributors.

In specific, a digitalized and geolocated water infrastructure network can have outstanding advantages. For example:

- Reduce risk of information loss. The technological tool generates backups that ensure the information of projects are safe against the possibility of losing information.
- Complete traceability of the water network system. Knowing all the technical details of each component of the network.
- Facilitate communication among different stakeholders through instant messaging and alert system provided by the application to contact team members and report the current situation of the network.
- Reduction of costs derived from breakdowns. The tool provides you with the information about the characteristics of all the pieces and elements of the network, reducing labor and material costs of possible replacements.
- Rapid resolution of incidents. The possibility of geolocating all the components and pieces of the network in a linear manner makes easier to identify and resolve unexpected incidents.
- Complete control of the network over a unified system. Virtually reducing the need to bring numerous documents to the work area in other to control the project.
- Increase the environmental friendliness. Having all the information of the water network located over the system promote the reduction of paper utilization through digitalization, reduce the carbon footprint as all the information can be reviewed from anyplace without the need of sharing and sending documents either physically or virtually.

Future research can focus on the development of new technologies and applications that can further improve the efficiency and effectiveness of water infrastructure network digitalization and geolocation. For instance, the use of artificial intelligence and machine learning algorithms can help in predicting the potential problems in the water network and suggesting the optimal solutions. The installation of new hardware equipment, such as sensors can also help in improving the accuracy and reliability of water network system.

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