IJFANS International Journal of Food and Nutritional Sciences

ISSN PRINT 2319 1775 Online 2320 7876

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Research paper

Intelligent Irrigation Systems: IoT-Based Monitoring for Efficient Sprinkler Watering

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Abstract.

In the present era, continuous monitoring of individual sprinkler points has become imperative, with personal inspections being a standard practice. Addressing the need to prevent water waste at specific locations within the sprinkler system, it is essential to find a solution that not only eliminates the necessity for constant human oversight but also proactively identifies and prevents potential hazards. This study proposes a novel approach employing Internet of Things (IoT) technology and various sensors, including proximity and soil temperature sensors, as well as on/off/adjustment sensors based on water flow and land wetness. The envisioned system integrates these technologies into sprinklers to achieve optimized water management. The anticipated outcomes encompass the prevention of water wastage at targeted locations, comprehensive water level management, dynamic activation and deactivation of sprinklers based on soil moisture content, reduction or elimination of human intervention, and real-time notifications to the management team regarding system changes.

1. Introduction

In contemporary horticulture and agriculture, sprinklers have become integral tools for embracing new machinery and technology. The introduction of sprinkler systems aimed to alleviate the burden of human labor in these fields. The water spray pattern of the sprinklers is contingent upon the specific type being employed and the distance it is designed to cover. The manual operation of the sprinkler system involves the initial creation of a waterline at a specific ground level, facilitating efficient plowing while necessitating personnel intervention for removal and refitting during the plowing process. Once the pipeline is appropriately

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buried, the subsequent steps include marking the locations for sprinklers and determining the suitable types for each designated location.

The igniting concept's debut sparked a revolution in both horticulture and agriculture. Farmers had to manually supervise the sprinklers before this one, and their labor was needed the entire time the motor was operating. In this process, human labor is required continuously because of a lack of technology. How could humans process this so that they could watch the power outages while watering the lawn? The first user and another user could be involved in such a way that one is watching the area that needs watering, while the other is at the motor area to turn it on whenever it goes off or to watch how it functions.

Here, a few things are seen as drawbacks of the conventional method: it takes longer, requires human labor, lacks technology, and occasionally results in improper watering due to farmer neglect and incorrect timing of when to water a particular area. These elements contribute to the development of sprinklers, a new stage. Through subsidies, the relevant governments and agencies are promoting the use of this. Sprinklers are now used more often in agriculture and horticulture as a result of subsidy programs. Rather than investing more time in watering their fields, farmers are instead allocating their time to other everyday tasks.

While sprinklers contribute to manpower savings, the necessity for manual monitoring persists, particularly during activation and deactivation. Despite being a result of agricultural technology advancements, sprinklers still rely on periodic human oversight, presenting a logistical challenge. The system requires an update to integrate technology that minimizes monitoring and introduces automation across the entire process—from initiating the motor and irrigating specific areas to shutting off the sprinkler once the ground and crops receive adequate water coverage. This entails a systematic approach of activating and deactivating sprinklers in different areas sequentially, ensuring optimal water distribution without the need for continuous human intervention.

Upon reaching capacity in the designated area, both the sprinklers and the engine will deactivate automatically. Consequently, the implementation of an automated system becomes crucial to minimize human intervention and system monitoring, aiming to save valuable time compared to traditional and semi-traditional watering systems. In the context of semi-traditional systems, which involve some human effort and monitoring albeit minimized, the proposed solution addresses the significance of time as a driving force for innovation. By

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automating the operation of the sprinkler motor and usage, the suggested solution not only streamlines the workload but also reduces human effort in the process.

2. **Literature Review**

While there were certain strategies that might be used to operate the sprinklers, none of them were designed to reduce the amount of labor required by humans or to prevent water waste. A couple of the existing approaches are unable to accurately sprinkling water on any given specified shape region provided as input. A few irrigation techniques are covered in [1], along with a list of accessories that make it easier to sprinkle when utilizing those techniques. Here, scattering could be done in a regulated manner; nevertheless, human labor and system automation are not explored. A few distinct watering models, including bedding, propagation, and ground cover systems, are covered in [2], but automation and the reduction of human labor are left out.

A wide range of accessories are covered in [3], along with a feature list and discussion. They can be viewed by anybody and are accessible online. A lot of work is cut down in [4] in order to maximize crop revenue by adjusting a few key elements, like sprinkler drop size, application rate, and wetting pattern. A few irrigation techniques are discussed in [5], where it is shown that sprinkler and micro approaches outperform surface irrigation in terms of crop growth rate and support automation. In [6], several elements and metrics are detailed to stop soil erosion using surface or sprinkler techniques. By employing techniques like raising wetting diameter parameters, runoff measurements, and others, the soil would be stabilized for growth.

In [7], different systems based on timers and sensors that apply water dynamics, quality, and quantity to the plant root zones in soilless cultivation are discussed. The case study of a single municipality in an Indian state is examined in [8], where a strategy that uses specialized software and ongoing historical observation is suggested to prevent water scarcity. The groundwater in [9] is contaminated and contains iron particles, or leads, which can be eliminated by employing particular absorption techniques that involve combining sulfate and alginate. This work could be useful in preventing sprinkler rust. A particular improved filter is suggested in [10] that functions similarly to a nonlinear particle filter and aids in target tracking.

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The study in [11] assesses nineteen out of a total of one hundred and ninety samples of Vijayawada's water to determine its suitability for drinking based on Water Quality Index (WQI) and a limited set of chemical components. Meanwhile, [12] explores the extraction of phosphate from polluted water for potential future use. The process involves employing a combination of calcium alginate and active carbon components derived from the A. aspera plant. In another study, [13] highlights a notable concentration of heavy metal particles in industrial effluents generated during the production of these components. Consequently, it is emphasized that precautionary measures, such as the utilization of coconut coir, should be implemented to effectively remove these contaminants from industrial wastewater.

This leads to the contamination of groundwater and the extraction of subterranean water using motors that corrode equipment and pose health risks. In [14], an examination of water surfaces in several rivers is conducted based on drainage and morphology. When these variables are purified, the positive impacts include improved quality of life, enhanced fisheries, and the facilitation of electricity production from these rivers. The waste produced by the Kothagudem Power House is scrutinized in [15], and the resulting wastewater is mixed with dam water, posing significant risks to the local population. The findings from this analysis could contribute to the development of a device designed to extract harmful elements from the water.

In [16], the study delves into a specific rainfall event employing the SCS-CN method and geo-informatics tools such as remote sensing and GIS. The analysis aims to discern the factors influencing agriculture negatively and those contributing to crop growth. Simultaneously, [17] focuses on monitoring the health of agricultural crops through the development of an IP-based web camera prototype. This innovative approach reduces the necessity for human intervention by incorporating a device designed for insecticide application. Furthermore, the concept of "smart farming" is explored in [18], advocating the adoption of wireless sensors and Internet of Things technologies to keep farmers informed about weather conditions, irrigation requirements, disease outbreaks, and marketing

strategies. In [19], the integration of the Internet of Things (IoT) facilitates the automation of agricultural processes, reducing reliance on human intervention and labor.

The various techniques and strategies discussed underscore the importance of water purification, detection of water leaks, and the modernization of agriculture using effective

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methods to enhance crop growth. Additionally, the discussions emphasize the need for anticipating diseases and providing timely notifications to guide appropriate actions. Within these approaches, there is a partial, though not complete, integration of automation. Specifically, irrigation operations are implemented in a specified dynamic region, the details of which are uploaded to a central device responsible for controlling the sprinkler system.

3. Proposed Approach

In pursuit of the study's goals, a sprinkler system based on the Internet of Things (IoT) has been developed, incorporating specialized sensors. Each sprinkler is equipped with an RFID, allowing the central monitoring system to track and manage individual units. The central system utilizes a laser stick to define the specific region for each sprinkler. This innovative approach ensures that the sprinklers dispense water precisely according to the designated shape. Automation is facilitated through the implementation of reinforcement learning timers, enabling the sprinklers to operate autonomously. The entire watering process is efficiently carried out through these automated actions.

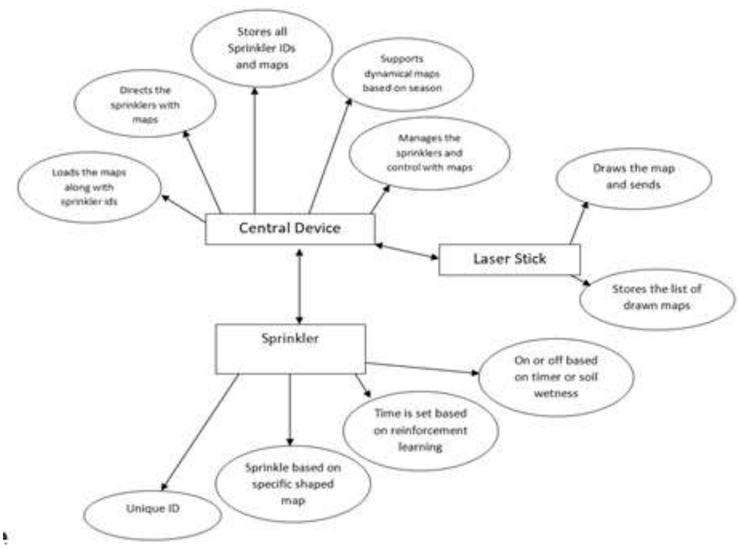

Figure 1. Sprinkler system based on IOT Architecture

In above diagram, the modules identified are

With a laser stick, sketch the area's shape.

Central Device: A device for communicating with sprinklers that takes sprinkler IDs from a laser stick and accepts maps.

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Sprinklers: adjust water and accept map dynamically. stays away from the water on the map's exterior.

This Laser Stick is made using a laser that will be utilized to sketch the area's shape. Sprinklers that are designated for each drawn area must be used, and the central device selects the sprinklers based on the area's shape.

Furthermore, the laser stick incorporates a scanner capable of reading the sprinkler ID within the designated area. This ID information is then processed using the central device, the second module in our system, which functions as a networked device capable of storing, processing, and utilizing specific characteristics. Once the entire map and individual sprinkler-covered maps are obtained, this module monitors the areas and sprinklers, assigning timers and turning off each sprinkler from the central device as needed. The central unit dynamically inputs maps to individual sprinklers based on crop area, demand, and seasonal changes.

The third module consists of the sprinklers themselves, programmed with specific maps to facilitate watering in accordance with information provided by the central unit. Each sprinkler adjusts its watering pattern based on the map input from the central device. With built-in software plug-ins, every sprinkler efficiently sprays water according to the loaded map, controlled centrally. This approach ensures that each sprinkler waters according to the designated shape, preventing water waste beyond the specified map boundaries.

The modules in the proposed system are as follows:

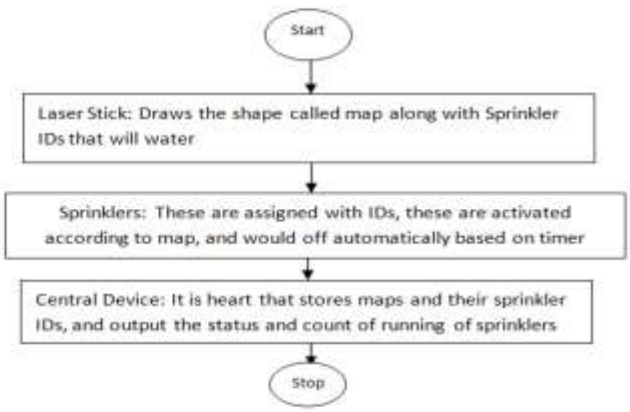

Figure 2. Smart Sprinkler System Flow chart

The graphic above illustrates how the modules interact in chronological order, with their purposes explained in order to provide the intended meaning to the end users.

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The specifics of this suggested system's simulation are shown in the upcoming chapter. Additionally, the performance must be shown in comparison to current methodologies.

4. Results

In this context, the functioning of the envisioned system and the prerequisites for executing its intended function are detailed. The procedural stages involved in the system's operation are regarded as key milestones. The recognized modules encompass the integration of a central device with a weather sensor, the incorporation of a proximity sensor into the sprinkler, and the monitoring of ground moisture through a soil moisture sensor.

A)The central device incorporates a weather sensor to estimate the duration of hot temperatures. Once the predetermined cut-off duration is reached, the central device automatically signals the sprinklers to irrigate the lawn. It is equipped to receive moisture values from specific areas, and if the detected moisture is below the designated cut-off value, the central device directs the respective sprinkler to irrigate until the timer expires. Additionally, the central device receives soil moisture values from soil moisture sensors and considers weather temperature; if the temperature is identified as hot for a specific duration, it instructs the sprinklers to irrigate based on readings falling below the recorded cut-off values.

Surface Temperature Sensor: WE710	**Features**
	Sensor Type: 100ohm Platinum Class A RTD Output: 4-20 mA Range: -58°F to +185°F (-50°C to +85°C) Accuracy: ±0.5°F (±0.25°C) Operating Voltage: 10-36 VDC Current Draw: Same as sensor output current Warm-Up Time: 3 seconds minimum Adhesive Type: 3M #4910 Acrylic Storage Temp: -67°F to +195°F (-55°C to +90°C) Sensing Surface: 0.75x1.5 inch (19x38 mm) Aluminum

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	Housing: 2.0x1.1x3.8 inch (5x2.8x9.7 cm)(WxHxL) ABS Weight: 13oz (368g) with 25 ft of cable

Figure 3 sensor related to weather

b) Sprinklers are outfitted with proximity sensors, specifically designed to dispense water within a maximum distance. The determination of the distance for effective watering is guided by a map fed to the sprinklers. Various types of proximity sensors, including inductive, optical, capacitive, magnetic, and ultrasonic, are available. Among these, ultrasonic sensors stand out for their capability to cover longer distances compared to other sensor types.

Proximity sensor: Ultrasonic	**Features**
	Principle: Based on an ultrasonic source and receiver in the same device Material detected: All material Operating distance: Large:15m Robustness to vibration: Low Cost: High Sensitivity: Air flow & temperature variation Applications: 1.Passage of objects on conveyor: glass bottles, cardboard Packaging 2.Filling level of liquids in a bottle or of granulatesin a plastic injection machine 3. Depth of cavity

Figure 4. sensor related to proximity

c)A ground-level soil moisture sensor assesses the moisture level, and if it falls below the predetermined threshold, it transmits this data to the central device. The central device then

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instructs the sprinklers to water only the areas that require it, thereby preventing unnecessary irrigation of the entire lawn.

Soil moisture sensor: FC-28	Features
	Pins: VCC, A0,D0, and GND are connected to power, analog, digital, and ground pins. Potentio-meter evaluates threshold value and compared by LM393. Required voltage to run is 5V Required current for running is < 20mA Type of interface is analog Required working temperature is 10°C~30°C Applications: 1) Agriculture 2) Landscape irrigation 3) research 4) Gardens

Figure 5. sensor related to soil

The energy state of water that is bound to the soil surface is referred to as water potential when using a soil moisture sensor.

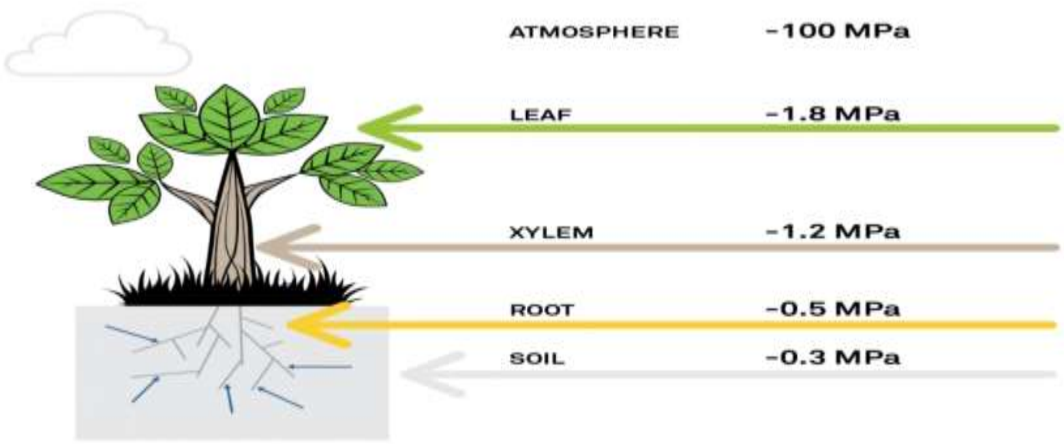

Figure 6 soil potential levels in water with plant leaves

When evaluating the state of turf-grass, two measurements are taken into account: water content and water potential. The standard water content range is established between 12% and 17%, with anything below being inadequate and anything above being excessive. The

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provided range of data is specific.

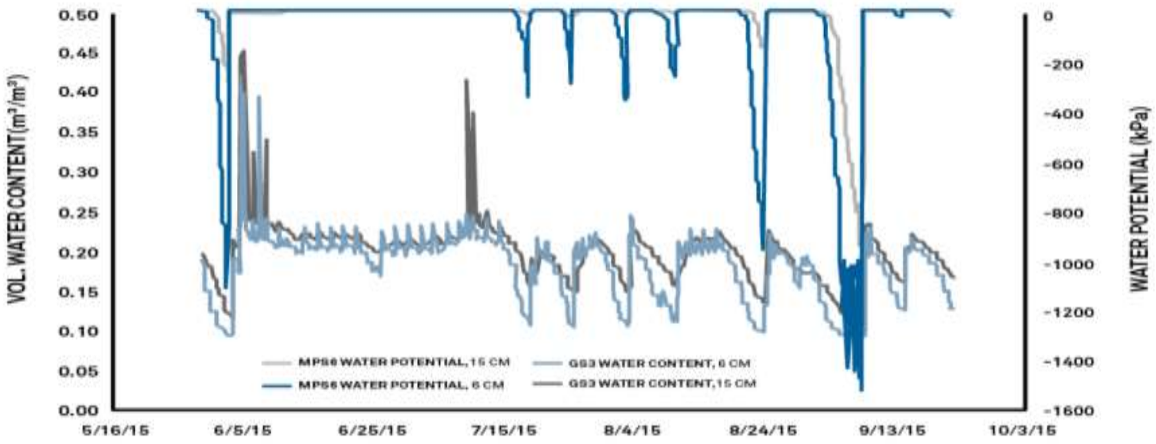

Figure 7 Assessing the state of turf-grass using Water Content and Water potential

The TEROS12 soil moisture sensor comes with specific features that require attention, including its ability to measure volumetric water content, temperature, and electrical conductivity. With a volume of influence extending to 1010 mL, the sensor provides measurement output in digital SDI-12 format. Notably, it boasts a field lifespan of over 10 years, reflecting its durability. To ensure high accuracy during installation, an installation tool is recommended. The subsequent depiction illustrates the soil release curve observed across various soil types.

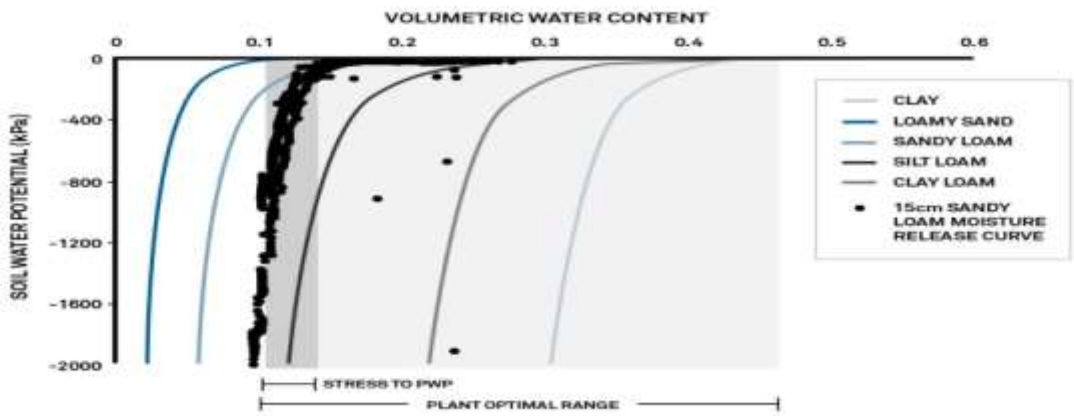

Figure 8. Various colored curves represent soil release curves for turf-grass in different soils.

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The examination of various methodologies employed in sprinkler systems, considering factors such as human involvement, automation, and time parameters, is outlined

	Human Efforts	Automation	Time
Smart Irrigation(Full Automation)	0	95 - 100	Less
Semi-Smart Irrigation	n/2	50	Moderate
Traditional	n	0	More

Figure 9. Different methods for sprinkler system comparison.

The graph below illustrates the performance of the proposed system in comparison to traditional and semi-automated sprinkler systems.

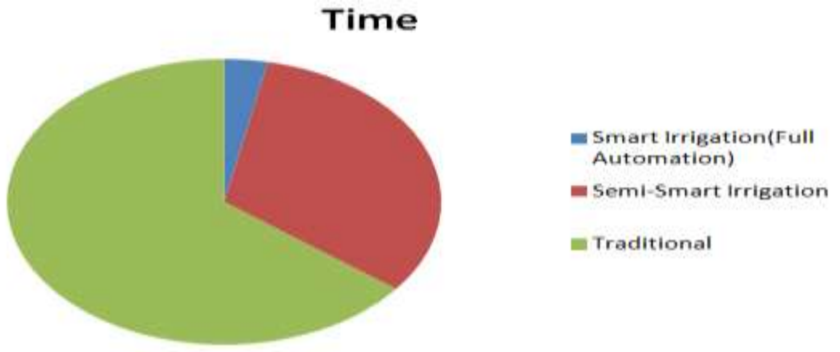

Figure 10. The performance of the Sprinkler approaches is exceptional, as the proposed system is fully automated and operates with remarkable efficiency, requiring minimal time.

5. Conclusion

This involves taking into account and minimizing human labor and water waste as much as feasible. From the beginning to the end, input can take the form of maps and sprinkler IDs. This way, depending on the capacity of the pipeline, particular maps can be activated. The process of activating maps continues until the last map is active, at which point its sprinklers are turned off by a timer. With the central device, the user could always be aware of the sprinkler system's condition. The implementation of IoT technology was crucial in enabling the system to function autonomously. Because this system has sensors that monitor watering and turn off the watering according to a set timer, human intervention and effort would be avoided. Because the entire map is separated into usable zones and superfluous portions are used for vehicle transportation or human labor walking, this could be an example of a divide and conquer approach.

ISSN PRINT 2319 1775 Online 2320 7876

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References

[1] Irrigation: Spray or Sprinkler Irrigation, https://www.usgs.gov/special-topic/water-science-school/science/irrigation-spray-or-sprinkler-irrigation?qt-science_center_objects=0#qt-science_center_objects

[2] Sprinkler irrigation for different horticultural systems, http://ecoursesonline.iasri.res.in/mod/page/view.php?id=8951

[3] Horticultural Sprinklers, https://www.irrigationonline.co.uk/categories/Irrigation-Sprinklers/Horticultural-Sprinklers/

[4] Tanja Folnovic, Top 5 Reasons Why Successful Farmers Use Sprinkler Systems, https://blog.agrivi.com/post/top-5-reasons-why-successful-farmers-use-sprinkler-systems

[5] D.L. Bjorneberg, R.E. Sojka, IRRIGATION | MethodsEncyclopedia of Soils in the Environment, 2005, Pages 273-280, https://doi.org/10.1016/B978-0-12-409548-9.05195-2

[6] G.A. Lehrsch, D.L. Bjorneberg, R.E. Sojka, EROSION | Irrigation-Induced, Encyclopedia of Soils in the Environment, 2005, Pages 456-463, https://doi.org/10.1016/B978-0-12-409548-9.09019-9

[7] J. Heinrich,Lieth Lorence R.Oki, Irrigation in Soilless Production, 2019, Pages 381-423, https://doi.org/10.1016 /B978-0-444-63696-6.00009-8

[8] Gautam N. K., Setu G., & Sarkar S. (2017), Modeling of drinking water distribution piping network corresponding to future water demand: A case study of indian state municipality, Journal of Advanced Research in Dynamical and Control Systems, 9(Special Issue 6), 410-433.

[9] Naga Babu A., Krishna Mohan G. V., Kalpana K., & Ravindhranath K. (2017), Removal of lead from water using calcium alginate beads doped with hydrazine sulphate-activated red mud as adsorbent, Journal of Analytical Methods in Chemistry, 2017, doi:10.1155/2017/4650594

[10] Vaishnavi G., Damodhar B. K., Rao S. K., & Jahan K., Underwater bearings-only tracking using particle filter, International Journal of Innovative Technology and Exploring Engineering, 2019, 8(5), 451-455.

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[11] Satish Chandra D., Asadi S. S., & Raju M. V. S., Estimation of water quality index by weighted arithmetic water quality index method: A model study, International Journal of Civil Engineering and Technology, 2017, 8(4), 1215-1222.

[12] Sujitha R., & Ravindhranath K., Extraction of phosphate from polluted waters using calcium alginate beads doped with active carbon derived from A. aspera plant as adsorbent, Journal of Analytical Methods in Chemistry, 2017, doi:10.1155/2017/3610878

[13] Aravind C., Chanakya K., & Mahindra K., Removal of heavy metals from industrial waste water using coconut coir, International Journal of Civil Engineering and Technology, 2017,8(4), 1869-1871.

[14] Asadi S. S., Rajyalakshmi K., Kumar M. S., & Kumar N. V., Evaluation of surface water characteristics using remote sensing and GIS - A model study, International Journal of Civil Engineering and Technology,2017, 8(9), 1002-1012.

[15] Asadi S. S., Ramya A., & Kowmudhi B., Evaluation of water quality role on environmental impact assessment study, International Journal of Civil Engineering and Technology,2017, 8(3), 778-784.

[16] Asadi S. S., Kumar M., Kumar N., & Rajyalakshmi, K., Estimation of runoff for agricultural utilization using geoinformatics: A model study from telangana state, International Journal of Civil Engineering and Technology, 2017, 8(10), 472-483.

[17] Narayana B. V. V. S., & Ravi K. S., IP camera based agricultural reforms, Journal of Advanced Research in Dynamical and Control Systems,2017, 9(3), 19-25.

[18] Navulur S., Sastry A. S. C. S., & Giri Prasad M. N., Agricultural management through wireless sensors and internet of things, International Journal of Electrical and Computer Engineering, 2017, 7(6), 3492-3499. doi:10.11591/ijece.v7i6.pp3492-3499

[19] Aditya B. L. V. S., & Subrahmanyam K., Embedded linux based agricultural field monitoring and automation using IoT, International Journal of Engineering and Technology(UAE),2018, 7, 774-778.