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# PRACTICAL ASPECTS OF SMART GARDENING SYSTEM BASED ON PRIORITY DRIVEN SCHEDULING TO UTILIZE RESOURCES AT OPTIMUM LEVEL

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Abstract. *Agriculture in India plays an important role in GDP (Gross Domestic Product) too. We have proposed a novel system based on the priority-driven approach to irrigating the plants. Our focus is on utilizing the resources, especially water in the agriculture sector at an optimum level. Providing good quality water to the crops is also one of the modules of the proposed system. The advantage of the proposed system is to immediately provide water to the plant where moisture level is decreased. Smart gardening is proposed as most demanded sustainable technology. In the agriculture sector, in future due to the irregularity of monsoon water scarcity will increase. Though sufficient water is available, still we have to preserve it for the future because day to day monsoon is irregular and ground-water is decreasing. We have used sensors and devices to sense the temperature, humidity, moisture, pH of the water and soil. Providing water to the plant where moisture level is very less, calculating pH of the water and soil are the important aspects of our proposed system. If the farmer is using pesticides which is harmful to the soil and which is affecting the pH of the soil, it will be immediately noticed by the system.*
**Keywords:** Priority driven scheduling, WSN, Moisture sensors, Smart irrigation, Volumetric water contents

1. **Introduction.** We are living in the technology era so we are recommending the use of technology for the sake of society. We have to develop applications with the future perspective. We have developed a novel system for gardening. In this proposed system, our objective is to utilize the water at optimum level and we have achieved this goal with priority-driven scheduling [1,6,14]. We have used the sensors to sense real-time values of temperature, humidity, moisture and pH. Based on sensed moisture values from ‘n’ plants system will decide where the irrigation is to be applied. Therefore we say, such systems will be the future need and handier. Handling gardens, as well as agriculture, will be possible remotely with added advantages. With single GUI, the end user will get the detailed analysis of the field. In the proposed system, based on moisture values the plant with less moisture will be irrigated which results in saving the water. If we are giving water to the plants in manual approach, many times unnecessarily water is being given which is also harmful to the plants and due to excess water useful minerals, fertilizers may be lost. Section 2 emphasizes current problems in the field and found solutions for them. Section 3 elaborates literature review conducted. In Section 4, we have presented our proposed system and Section 5 consists of results and discussions. Finally, Section 6 gives some concluding remarks.

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2. **Problem Statement.** "Water" is an important natural resource and it is our duty to utilize it in an effective way. The proposed system focuses on optimum utilization of water, which is the present challenge for us. In present days, it is required that novel system must handle gardening and agriculture challenges. Hence, in gardening and agriculture, it is required to develop such systems, which will not only save the water but also there should be some additional advantages. We have presented a system, which checks pH of the soil and water to maintain the quality. We are also checking TDS and conductivity of the water. Daily temperature, humidity & moisture values are recorded which is very useful for crop yield prediction.

3. **Literature Review.** Whenever we think about sustainability, a longer-term vision must be considered. Hence, sustainable development requires immediate actions to be taken. As discussed in the abstract water which is an important natural resource must be utilized in an effective way. The irregularity of monsoon and decreasing groundwater level requires we should prepare ourselves for future. Irrigation and gardening is the major component of Gross Domestic Product (GDP) of Indian economy [7-10,18]. Through this proposed system, we wish to pass a message to the society that water must be treated as the valuable asset and its proper utilization is everybody's responsibility. The seasonal reversal of the wind direction occurring in May and June brings copious moisture from the warm waters of the tropical ocean to the Indian continent through southwester lies, but sometimes it can be delayed up to July, too [9,10]. Since last few years, we are observing irregularity in its monsoon. A patent, multi-zone landscape irrigation and lighting system, which have a computer equipped with a detachable wireless remote, and a multi-station controller operating a plurality of irrigation valves and lighting circuits in accordance with schedules is the new era in agriculture, which specifies remote access is possible for the large field [22]. In irrigation scheduling is important and can be executed using a unique Graphical User Interface (GUI) remotely operating is becoming feasible [23]. A control system is developed for low-volume irrigation to control the valves like opening and closing valves. An irrigation system controller for controlling the valve controllers in accordance with irrigation scheduled plan [24].

4. **Proposed System Design.** Proposed system can be described as follows where 'n' modules are mentioned. LCD is used to display values of temperature, humidity, moisture and pH of the soil. X-bee controller is used to coordinate the operations, i.e., fetching values from nodes and passing instruction, too, and pH sensor is used to sense the value of pH of the soil. Already we have mentioned in the abstract that, if due to fertilizer and pesticides soil quality is decreasing with the help of this technique we can immediately intimate the farmer. Similarly, DHT 11 temperature and humidity sensor is used to sense the daily temperature and humidity. The intention of noticing this temperature and humidity values is, we will correlate these values with the moisture. Therefore, we can decide the moisture holding capacity of the soil and along with this one more advantage, it helps farmers to decide choice between crops by checking soil parameters.

All the nodes will fetch and transmit all the sensed values to the system in a periodic manner and system passes ACK in terms of instructions [4,5]. It is necessary that soil should hold moisture, i.e., volumetric water contents. Moisture holding capacity is nothing but the water availability at the root zone of the plants. Soil moisture plays an important role in irrigation and we have used moisture as a key parameter to implement this system [3,11-13,16,20]. In our demonstration, we have used 3 types of soil – red soil, brownish soil and black soil. We have also tested these soils in terms of pH, conductivity, etc. before use. Using such systems by analyzing the saved values in database one can decide the best soil to be used for gardening. In our proposed system, important aspect is moisture-sensing subsystem, which senses moisture from the plants and passé to the system [19].

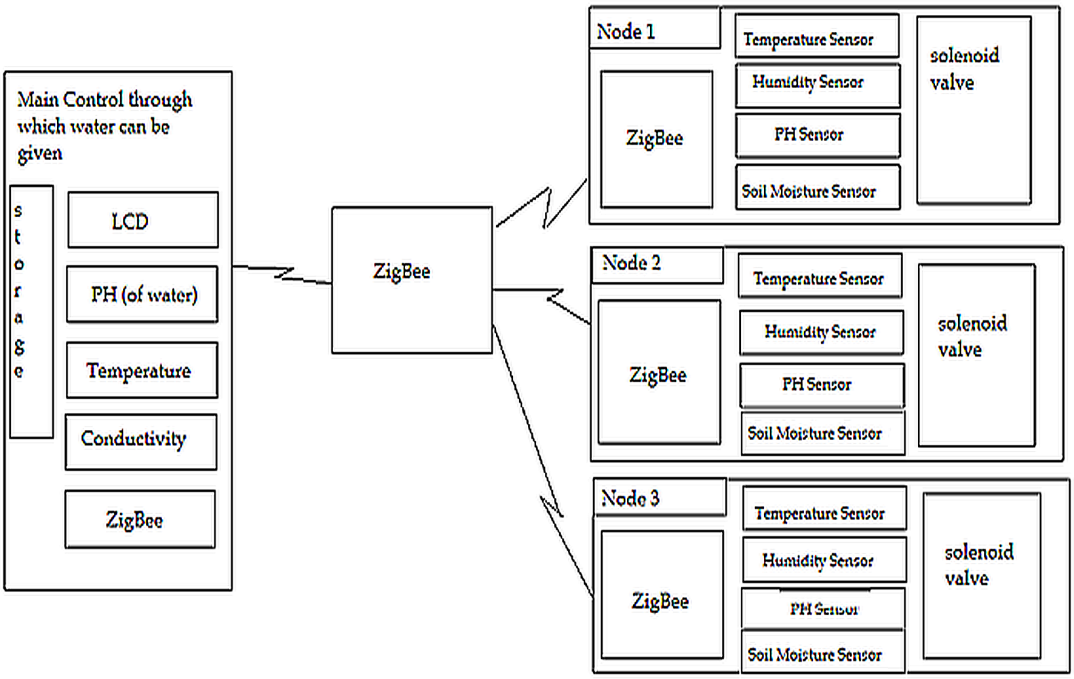


Figure 1. Proposed system

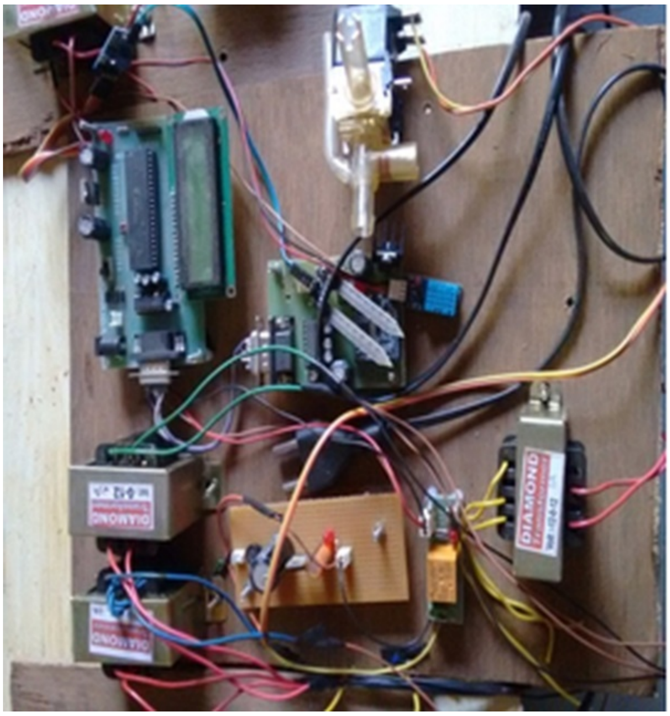

Figure 2. Node in the proposed system

The system upon receiving all the values compares and finds out the node where moisture is very less. With the help of relay-operated solenoid valve irrigation starts to increase the moisture level.

Above Figure 2 describes the node in the proposed system. Wireless sensor network technology has been used in this proposed system. Using 'n' sensors and devices temperature, humidity, moisture, pH values will be stored in the database for future use. System passes the instructions to the X-bee [17]. Then controller operates the relay and solenoid valve to start irrigation where moisture level is low.

5. **Results and Discussions.** Once a system is executed, results are obtained as follows.

TABLE 1. Sample values

| Node | Temp | Humidity | Moisture | Date | Time |
|---|---|---|---|---|---|
| *NODE1* | *22* | *22* | *0* | *04/01/2018* | *16:03:00* |
| *NODE2* | *23* | *35* | *0* | *04/01/2018* | *16:03:22* |
| *NODE3* | *22* | *35* | *0* | *04/01/2018* | *16:03:44* |
| *NODE2* | *23* | *35* | *0* | *04/01/2018* | *16:04:50* |
| *NODE3* | *22* | *35* | *0* | *04/01/2018* | *16:05:11* |
| *NODE1* | *22* | *22* | *81* | *04/01/2018* | *16:05:54* |
| *NODE2* | *23* | *35* | *0* | *04/01/2018* | *16:06:15* |
| *NODE3* | *22* | *35* | *0* | *04/01/2018* | *16:06:38* |
| *NODE1* | *22* | *22* | *80* | *04/01/2018* | *16:07:25* |
| *NODE3* | *22* | *35* | *0* | *04/01/2018* | *16:08:09* |
| *NODE1* | *22* | *22* | *81* | *04/01/2018* | *16:08:50* |
| *NODE2* | *23* | *35* | *79* | *04/01/2018* | *16:09:14* |
| *NODE3* | *22* | *35* | *0* | *04/01/2018* | *16:09:36* |
| *NODE1* | *22* | *22* | *81* | *04/01/2018* | *16:10:22* |
| *NODE2* | *23* | *35* | *79* | *04/01/2018* | *16:10:45* |
| *NODE1* | *22* | *22* | *81* | *04/01/2018* | *16:11:50* |
| *NODE2* | *23* | *35* | *79* | *04/01/2018* | *16:12:10* |
| *NODE1* | *23* | *23* | *81* | *04/01/2018* | *16:26:22* |
| *NODE2* | *23* | *35* | *78* | *04/01/2018* | *16:26:44* |
| *NODE3* | *22* | *35* | *68* | *04/01/2018* | *16:27:06* |
| *NODE1* | *23* | *23* | *81* | *04/01/2018* | *16:27:53* |
| *NODE2* | *23* | *35* | *78* | *04/01/2018* | *16:28:12* |
| *NODE3* | *22* | *35* | *54* | *04/01/2018* | *16:28:33* |
| *NODE1* | *23* | *23* | *81* | *04/01/2018* | *16:29:21* |
| *NODE2* | *23* | *35* | *78* | *04/01/2018* | *16:29:43* |
| *NODE3* | *22* | *35* | *4* | *04/01/2018* | *16:30:07* |
| *NODE1* | *23* | *23* | *81* | *04/01/2018* | *16:30:52* |
| *NODE2* | *23* | *35* | *78* | *04/01/2018* | *16:31:15* |
| *NODE1* | *23* | *23* | *81* | *04/01/2018* | *16:32:17* |
| *NODE2* | *23* | *35* | *78* | *04/01/2018* | *16:32:39* |
| *NODE3* | *22* | *35* | *75* | *04/01/2018* | *16:33:03* |
| *NODE1* | *23* | *23* | *81* | *04/01/2018* | *16:33:48* |

In the above data analysis, we can observe that in initial phase all the node's moisture values are null. Hence, in the first cycle, node 1 will be served and again in the 2nd cycle, all the values once again will be fetched and at this time node 2 will be served and similarly, node 3 will be served in next cycle. In above Table 1, we can observe the changes in moisture values recorded by the system. This approach is very useful to the end user if the farm or garden consists of variable soil structure. For variable soil structure, one can easily conclude the moisture holding capacity. Moisture holding capacity is nothing but water availability in the soil for a long period. Therefore, end user can decide which soil is helpful for which crop. Data in the above Table 1 can easily calculate the period within soil dries out and to which soil structure repeated irrigation is required. It also helps the end user to select crops according to soil structure. We have performed "Regression analysis" which is a statistical technique that helps estimate the relationship between two or more variables. It also shows whether the relationship among those variables is valid. Regression analysis can be used to identify the causal relationship between the independent and dependent variables. In our case, the dependent variable is "Moisture" values and independent variables are "Temperature" and "Humidity". During early in the morning, humidity is high which keeps moisture level high but as soon day passes, increased in temperature decreases the moisture level.

Regression Analysis for Table 1

Table 2. Regression summary output

| SUMMARY OUTPUT | |
|---|---|
| ***Regression Statistics*** | |
| **Multiple R** | **0.575418** |
| **R Square** | **0.331106** |
| Adjusted R Square | 0.284976 |
| Standard Error | 31.16124 |
| Observations | 32 |

In Table 2, we have performed regression analysis in which 'moisture' values are the dependent variables and 'independent variables' are temperature and humidity. We are checking how temperature and humidity affects the moisture. It can be used in the forecast of moisture based on the temperature and humidity, which is good for crop yield.

Table 3. ANOVA analysis

| **ANOVA** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *df* | *SS* | *MS* | *F* | ***Significance F*** | | | |
| Regression | 2 | 13939.2 | 6969.602323 | 7.177586 | **0.00293547** | | | |
| Residual | 29 | 28159.67 | 971.0231157 | | | | | |
| Total | 31 | 42098.88 | | | | | | |
| | *Coefficients* | *Standard Error* | *t Stat* | ***P-value*** | *Lower* 95% | *Upper* 95% | *Lower* 95.0% | *Upper* 95.0% |
| Intercept | −489.001 | 248.9006 | −1.964643535 | **0.059102** | −998.0599892 | 20.05793 | −998.06 | 20.05793 |
| Temp | 27.80144 | 11.07375 | 2.510571228 | **0.017883** | 5.153076547 | 50.4498 | 5.153077 | 50.4498 |
| Humidity | −2.76165 | 0.911998 | −3.02813554 | **0.005126** | −4.626900098 | −0.89641 | −4.6269 | −0.89641 |

To check if our results are statistically significant or acceptable, we have to check **significance F (0.00293547)**. If this value is less than 0.05, we are OK. If significance F is greater than 0.05, it is probably better to stop using this set of independent variables.

It is a graphical approach to assess whether the data set is distributed. After plotting the data, it should form an approximate straight line. If we are not getting straight line,

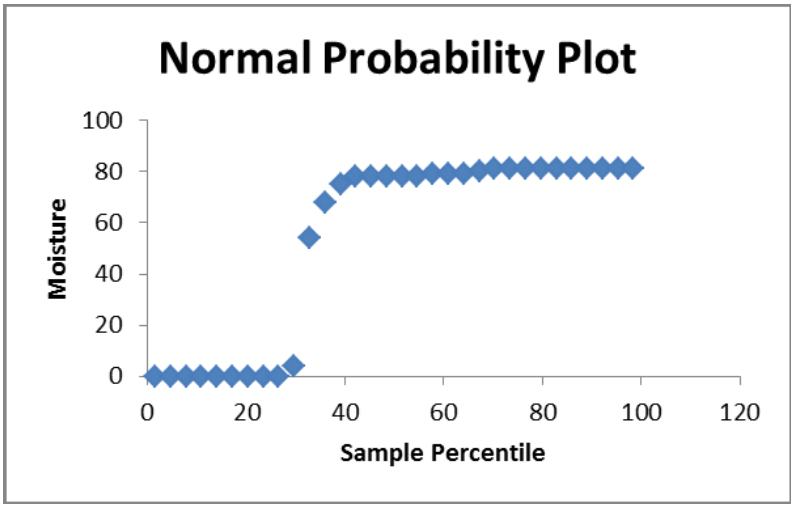


Figure 3. Normal probability plot

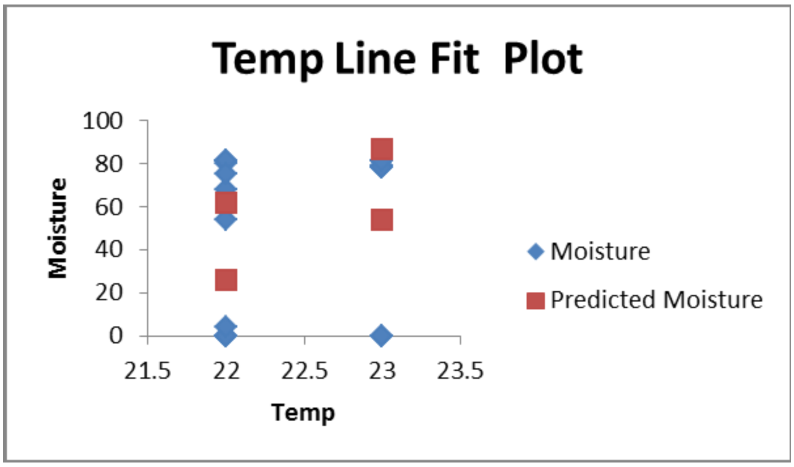


FIGURE 4. Temperature line fit plot

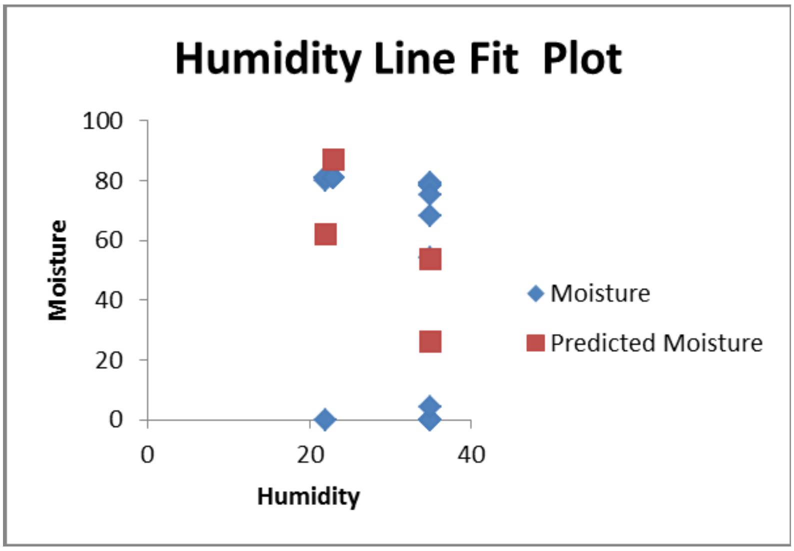


FIGURE 5. Humidity line fit plot

it means there is variation in the data. It is clear that temperature and humidity both affect the moisture and hence moisture values are varied.

Line fit plots in Figure 4 indicate the relationship among moisture and temperature based on the data collected in Table 1. We have presented temperature line fit plot with moisture in Figure 4.

Similarly, in Figure 5, line fit plot is presented by showing the relationship among humidity and moisture. Actually, we have proposed a system to help farmers and gardeners to predict the crop growth and their yield. Moisture values will be immediately passed to the coordinator and irrigate the plant with the help of solenoid valve.

6. **Conclusions.** Our intention is to show how priority driven approach will save the unnecessary wastage of the water and how the moisture of soil can be maintained. The system will fetch and then compare all the moisture values with the help of relay-operated solenoid valve irrigation starts. If we are irrigating the garden twice in a day then there will be a huge wastage of water. To avoid this wastage of water we have suggested a system where automated irrigation is the best solution. With this automated irrigation, we can control the unnecessary usage of natural resource as compared to the manual approach.

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