AUTOMATED DOMESTIC WATER PUMP CONTROL SYSTEM WITH ENHANCED USABILITY AND LOW MAINTENANCE

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INTRODUCTION

Water is the most essential commodity for human life. Even though two third of the earth's surface is covered by water, less than 1% of that can be utilized for our day to day needs which comes from a variety of sources (Postel, 1996); the wells, lakes, rivers, rain water collections as well as purified sea water are these sources. In any of these forms, the water is very precious and should be used very carefully.

In Sri Lanka, for domestic use, the water is usually pumped to an overhead tank either from a well or from a sump which collects water from the National Water Supply and Drainage Board (NWS&DB) water supplies. The water is pumped from the well to the overhead tank using a domestic water pump which may run just under 1kW. From the tank, the water flows to the tap openings due to the force of gravity. The water pumps are usually manually switched on and off which requires a considerable human involvement in this process. Human errors such as forgetting to switch off will result in overfilling the tank. This in turn results in wasting both the electricity utilized to operate the pump and water itself. On the other hand, the water in the tank may be gradually utilized and it can lead to a situation that the tank runs out of water without being noticed.

To address these issues, many automatic water pump control systems have been proposed and implemented. The operation of these systems relies on a mechanism to detect the water level crossing the predefined thresholds. In order to detect the threshold some systems deploy a pair of electrodes at the lower and upper water levels (Rajapakshe, 2011). On the other hand some systems use float switches or vacuumed balls to detect the lower and upper level crossings (REUK, 2008 and Siben, 2005). However in all these systems, two clear drawbacks are visible. With time, the electrodes or the float switches which are in touch with water will get corroded or clogged with minerals in the water. Eventually they start malfunctioning and need maintenance. On the other hand, the deployment of the existing systems requires considerable technical expertise. Especially, deploying a sensor at the bottom of the well to detect the well's low threshold water level needs considerable effort.

In order to overcome these drawbacks in the existing water pump control systems, in this paper, a novel automatic water pump control system is proposed. In this system the innovative design step is to use an ultrasonic water level sensor (Robot Electronics, 2012) which does not need to be in contact with water and also can be installed away from the water surface at an easily accessible location at the top of the tank/well. Further, the proposed system is in a modular form. The latter feature makes sure that even a user without any technical background would be able to install this system. Furthermore, the installation can be completed in a very short time.

METHODOLOGY

The proposed system consists of two sub units namely a wireless sensor node and a pump control unit (Figure 1). Sensor node is equipped with an ultrasonic module which emits an

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ultrasonic beam and collects the reflected beam from the water surface. Then it calculates the distance to the water surface. Furthermore, the sensor node consists of a Zigbee transceiver module (Safaric, 2006) to transfer the water level information to a separate control unit. This same sensor node is powered by a 9V battery, hence at the sensor, power is a scarce resource. In order to save power, the node is normally in sleep mode. In a practical implementation,

The sensor node is mounted to a wall near the top of the tank/well and there are two such sensor node units employed to monitor the water levels in the tank and the well. The current water levels in the tank and the well are represented by S1 and S2 respectively.

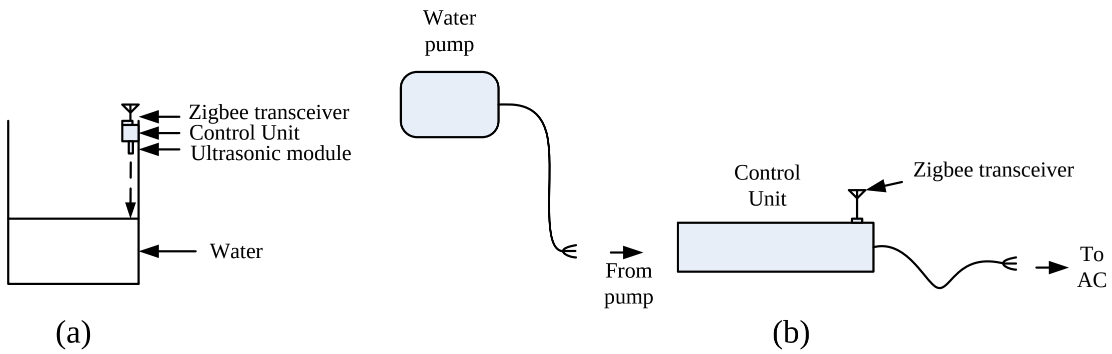

Figure 1: (a) Sensor node deployment (b) Pump control unit deployment

There are two important water threshold levels namely the low (L) and high (H) levels, crossing of which will initiate a notification message generation. Upon the generation of the notification, the transceiver sub unit wakes up and transmit the information to the remote control unit. At the sensor node, all these processes are controlled by a PIC 16F877 microcontroller based sensor control circuit. The control unit too consists of a Zigbee transceiver which receives the water level information transmitted from the two sensor nodes and act according to the water control algorithm shown in Figure 2.

Note that in order to improve the user friendliness in the system, this pump control unit has a socket to which the water pump's power plug can be plugged and a plug which is to be connected to the AC 230V power supply. Eventually the pump is powered through the control unit (Figure 1 (b)). The control unit is equipped with a silicon control rectifier (SCR) based electronic switch (Bogart, 2004) which can on/off the power supplied to the pump. Another important feature of this control unit is that an inbuilt transformer-rectifier-regulator circuit to provide a 5V direct current supply for the internal circuits including a PIC 16F877 microcontroller and for the Zigbee module.

TEST RESULTS AND DISCUSSION

In order to verify the proposed pump control system's operation, a test setup was installed in a commercial plastic water tank of 1m height and with a well. The water inlet in the well was so placed so that the water level in the well does not fall below the minimum during the water filling process. Further, the lower level and the upper level in the tank were selected to be 10cm and 90cm respectively. The system was run for 10 tests and the results are shown in Figure 3 which clearly demonstrates the accuracy of filling. The use of a novel technique, the ultrasonic based water level measuring, provides usability and robustness, the system has a very good accuracy in starting/stopping the pump. The minor variations are the results of ripples in the water surface which are not captured by a ripple rejection feature in our control algorithm.

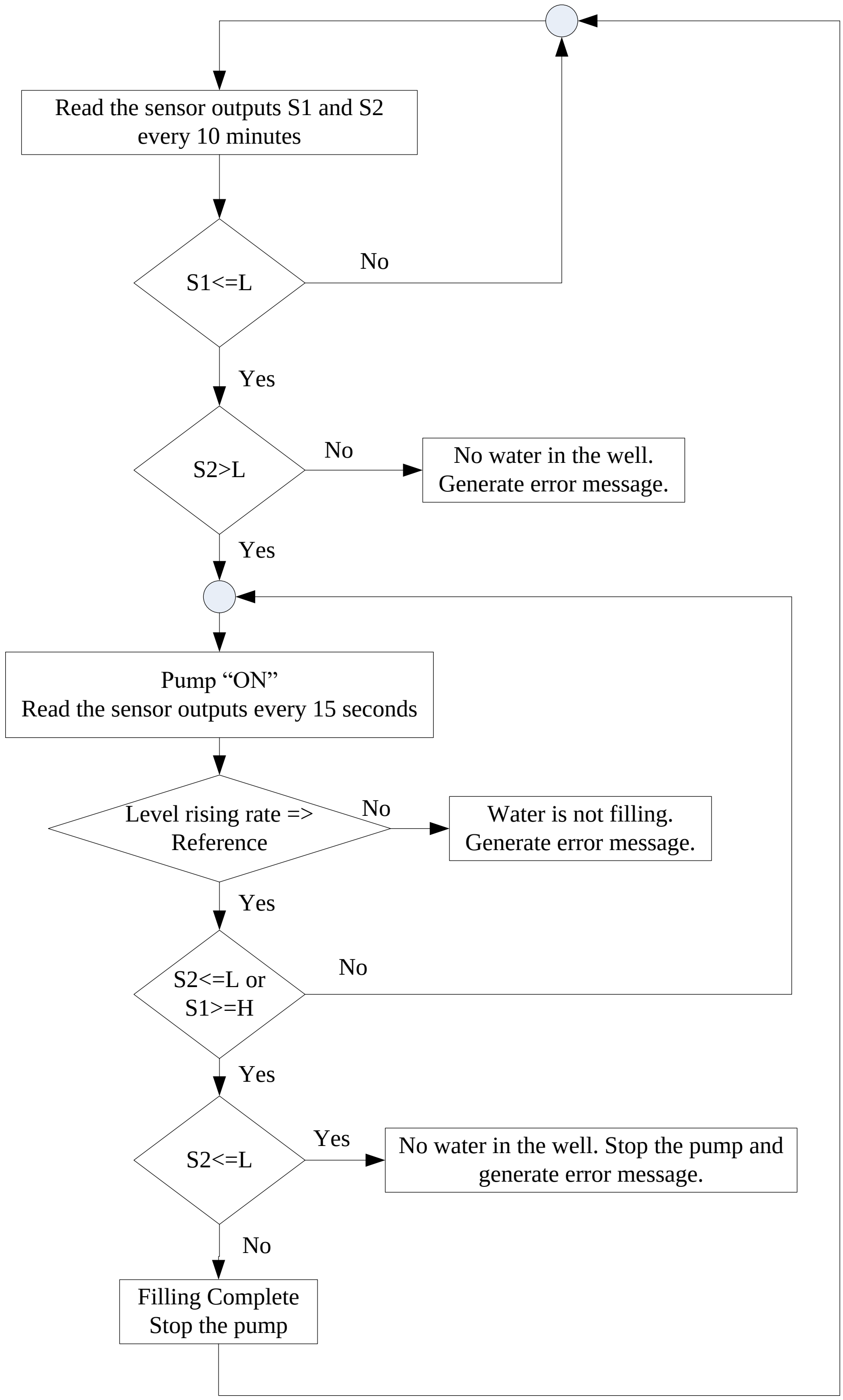

Figure 2: Water management algorithm

CONCLUSIONS AND FUTURE WORK

This paper discusses the design of a control system for a domestic water pump. The system is designed and developed in a modular form such that the installation is very simple and can be carried out even by a non-professional. Further with the use of ultrasonic water level sensors, the malfunctioning of sensors with time is minimized.

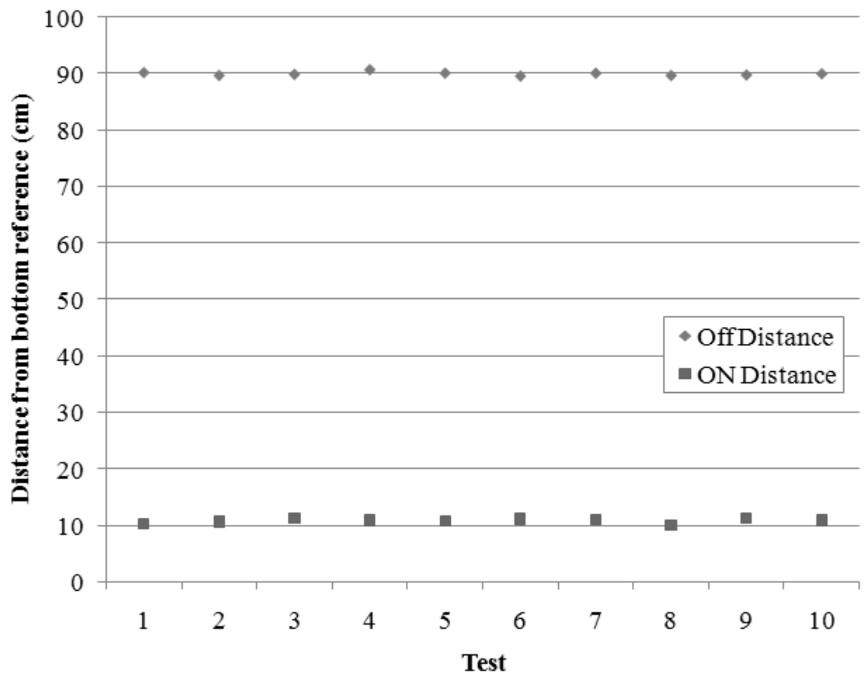

Figure 3: Accuracy of water filling

This system can be further improved by accompanying a SMS notification feature which will inform the owner in case of an error. On the other hand the sensors are strictly power limited; hence improving the sensor's power utilization with a better sleep-wake up mechanism would be very handy.

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