HAYWARD®

Wireless Pool-Side Multi-Sensor System

hayward-pool.com

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PROJECT MOTIVATION:

In many facets of life, consumers are expecting more and more tasks to be automated. Thermostats, indoor and outdoor lights, and even garage doors are now easily and instantly automated through the use of mobile applications and timed schedules. Current pool automation technologies also offer remote control and schedules but require either wired sensing of remote parameters or require the pool filtration system to be turned on. They also sense only a subset of what is needed to automate lighting and water levels. Existing aftermarket solutions are insufficiently featured or are too costly to install, resulting in an unmet market need for a comprehensive solution.

A new wireless sensing system would provide a low cost upgrade to existing automation systems. This system would upgrade existing systems and provide an extended range of highly desirable features such as precise air and water temperature measurement, water level detection, automated landscape lighting control, and pool cover detection.

ANTICIPATED BEST OUTCOME:

An alpha level prototype of a two-unit system consisting of a poolside sensor hub unit and receiver unit which communicate via radio. The sensor unit should be battery operated and collect environmental data including air temperature, water temperature, pool cover position, water level, and ambient light level. This environmental data should be communicated to the receiver unit where it will be processed and sent to the existing automation units, which will control various pool features.

IMPLICATIONS FOR COMPANY AND INDUSTRY:

This new system will bring pool automation closer to current technology and fill a currently existing gap in the pool automation market for a comprehensive system. The poolside sensor system will give consumers the control expected of many home automation products today in a low cost package which will interface with existing Hayward pool automation products.

PROJECT OUTCOME:

The Anticipated Best Outcome was achieved.

KEY ACCOMPLISHMENTS:

Sensor Selection: Possible sensors were researched. The majority of the sensors needed to measure environmental factors were selected. These include ambient light and range detection for the pool cover, air and water temperature detection, and capacitive water level sensing

Radio and Microcontroller Selection: An integrated radio-microcontroller package (SAMR30G) was selected after substantial research.

Initial Sensor Testing: Sensor communication was achieved using an Arduino to explore I2C connection with project specific sensors. Testing was also completed using the ambient light sensor near sunset to establish a baseline level at which outdoor lighting should be turned on.

Radio Communication: Initial radio communication has been achieved using two MCU development boards. A private MiWi Star network is set up between the two devices, where one is the determined transmitter (poolside sensor unit) and the other the dedicated receiver (OmniLogic Receiver), or PAN coordinator.

I2C Protocol Communication: I2C Protocol was selected in order to reduce the amount of GPIO pins used by our multiple sensors, as it only requires two pins to create a data bus. Communication is accomplished via device addressing, which means that each I2C device is assigned an address that the MCU must use to communicate with it.

Thermistor Value Detection: Successfully capturing ADC value from thermistors in order to accurately determine temperature value, important for OmniLogic interfacing

Capacitive Sensing Layout Determined: Worked alongside contacts at Microchip to determine the ideal sensing layout and PCB layout for our water level sensing application. The large ground-coupling of the pool water allows the system to employ a small, thin measuring strip paired with a rectangular, floating reference pad of the same area in order to accurately measure the water level.

Pool Cover Detection Method and Sensor Determination: After researching pool coping measurements, pool cover reflectivity, and ideal water levels, an IR ranging / ambient light combination sensor was chosen in order to measure both the distance detection and light level.

Initial Schematic and PCB Design: Significant progress on the poolside sensor unit schematic and board layout has been completed. The MCU, external crystal oscillators, sensing devices, and battery holders have be chosen, laid out in the schematic, and placed on the PCB layout. Finalizations for the antenna must be completed before final traces and ground planes can be completed. All designs have been done using Pulsonix. See Figure 1

Initial Low Power Considerations Implemented: Our poolside sensor unit's processor has been programmed to go into a sleep mode between sensor reads which has significantly lowered the power consumption of the device. See Figure 3

Initial Enclosure Design: A basic prototype of the enclosure for the poolside sensor unit has been drawn up and is currently being designed. See Figure 4

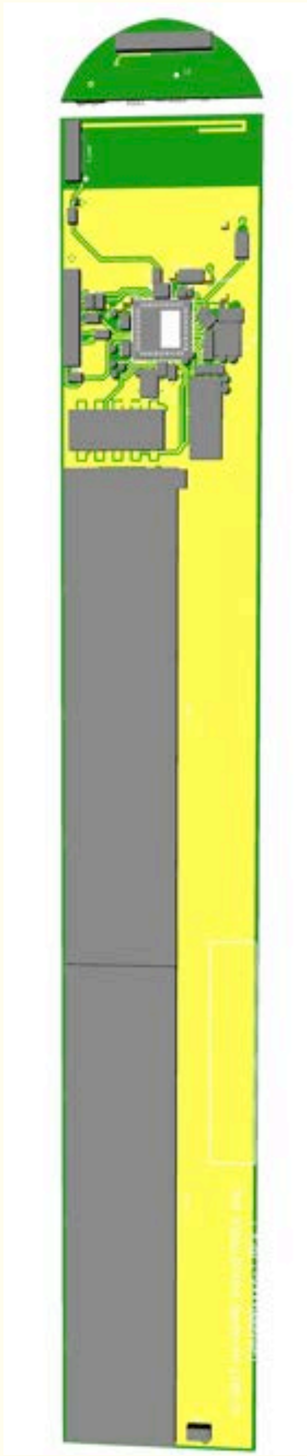

Fig 1: Printed Circuit Board Model of the Poolside Sensor Unit

Fig 4: SolidWorks Casing Prototype of the Poolside Sensor Unit's enclosure

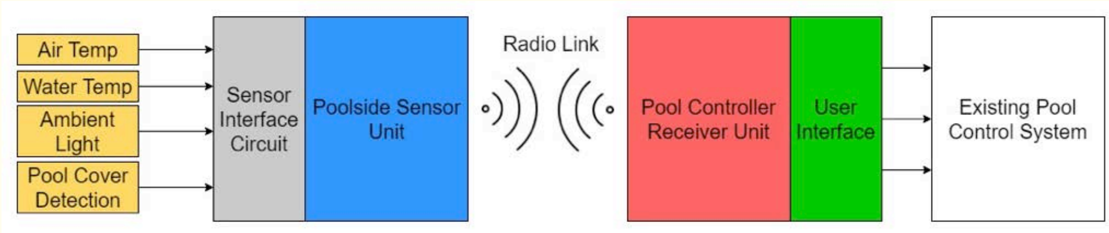

Fig 2: System Level Block Diagram showing the devices connected via wireless radio link.

Fig 3: Power Consumption Graphs of Poolside Sensor Unit in Awake Mode vs. Sleep Mode