Wireless Transceiver Module HC-12 based Automatic Water-level Monitoring and Control System

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Abstract

This paper proposes a wireless approach for water-level monitoring and control-system using standard wireless transceiver module HC-12 in a legal frequency band of 433.4 MHz to 473.0 MHz supported with hundred communication channels. The monitoring and control range is up to 500 meters in open-air and about 100 meters indoor. The microcontroller Arduino ATMEGA328 is used as monitoring and controlling device. The module is set initially for the baud-rate of 9600, 20 dBm transmitting power, -112 dBm receiving sensitivity, 445 MHz transmission frequency and channel number 50. All the modules in the network are set to the same parametric values to achieve synchronized communication. The controlling program collects the information regarding water-levels in different tanks and initiates control action as to start or stop the water pumping motor. It also displays the status of the water levels in different tanks. The design is tested for the household purpose. To achieve long range communications, the LORA modules could be used but for higher cost.

Keywords:wireless, transceiver, module, HC-12, automatic, water-level, monitoring, control system

1. Introduction

Wired type and IOT-based water-level monitoring and control system are already in the market. But the major drawback of wired-type is large wiring network from overhead-tank and ground-tank to the control system. The power losses in the wiring, electromagnetic interference, aging of the wiring, wear and tear, and cost. The problem is multiplied if building is multistore. On the other hand, the IOT-based systems require internet connectivity. To counteract these drawbacks we propose a wireless approach. The advantages of wireless-approach are, the wiring network is avoided that results in lowering the cost, reducing electromagnetic interference, no wear and tear, no aging effect, no power-loss and hence almost no maintenance. Number of low-cost wireless modules have already populated the market. But

they suffer drawbacks like; networking is not possible, very less communication distance of the order of 10 to 20 meters, lesser receiving sensitivity, low transmitting power etc. We selected HC-12 wireless serial communication transceiver module on the basis of cost, networking capability, data security, large communication distance of over 100 meters, and high receiver sensitivity. HC-12 module is available at a cost of about Rs.150/- with properly matched spring antenna. The communication distance is enhanced if SMA antenna is used. Although, the datasheets of HC-12 module claim 1 KM wireless communication distance in open air but practically we observed a communication distance of about 300 meters in robust environment. The indoor communication distance of less than 100 meters is sufficient even for 10 to 15 multistore building. The basic block diagram of the wireless system is as shown in fig.1.The

message includes an alphanumeric password. The module matching the password will only respond to the control unit and share information regarding water-level in the tank. Based on water-level information from the tank-units, the control unit initiates control action to start or stop the pumping motor. The chaos of communication between modules is avoided through proper password setting which is the basis of the standalone wireless system.[1-4]
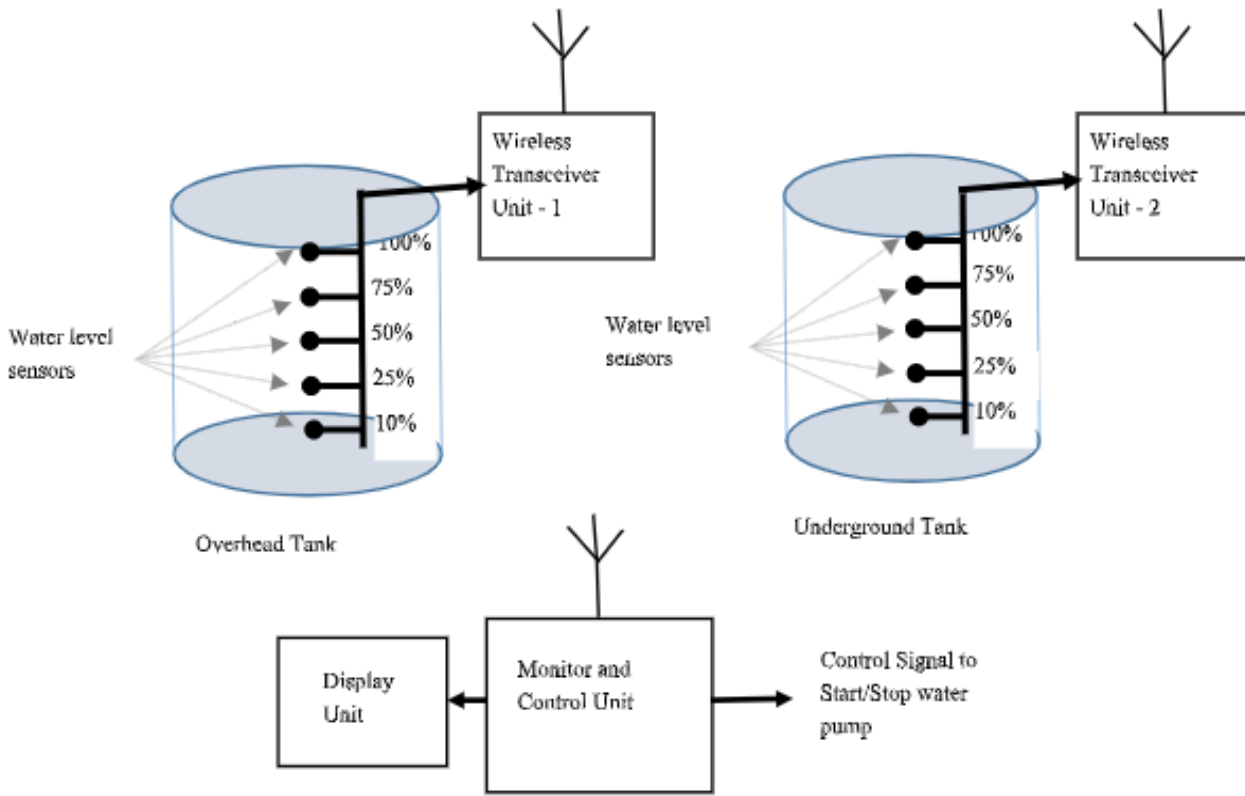

Fig.1. Block Diagram of Wireless Control System

2.Hardware

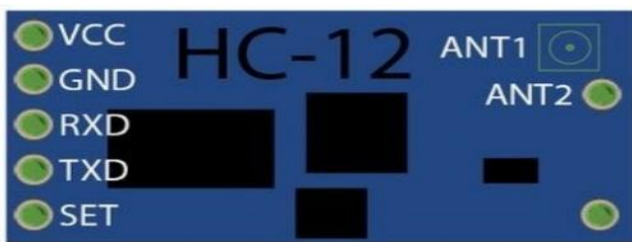### 2.1 Wireless Transceiver Module HC-12

Fig.2. show the image of wireless module HC-12.

HC-12 is a wireless serial port communication module used in variety of applications like wireless sensor, building security, wireless robot control, PC wireless networking etc.The figure shows the image of wireless module HC-12. HC-12 is a wireless serial port communication module used in variety of applications like wireless sensor, building security, wireless robot control, PC wireless networking etc. It features 1 KM open space wireless transmission at a baud-rate of 5000 bps. The maximum transmission power is 100 mW. It includes built-in MCU for serial communication with external device. [5-8].

It has totally 100 channels with a start frequency of 433.4 MHz, with a step of 400 KHz per channel, ending with 473.0 MHz for 100th channel. Other details could be obtained from the datasheets. It is a 5-pin module that includes Vcc, Gnd, TxD, RxD and SET pins and one separate pin for antenna. It operates on dc power supply of 3.2 V to 5.5 V with load current of 200 mA in transmitting mode. The module supports AT commands whenever the SET pin is held low. Sending AT to module returns OK. The list of AT commands available for HC-12 module and their meaning is available in the datasheets. Using AT commands, one can set the baud-rate, channel number (1 to 100), transparent communicationmode, transmitting power, mode

set reply, version, sleep mode, default values etc.
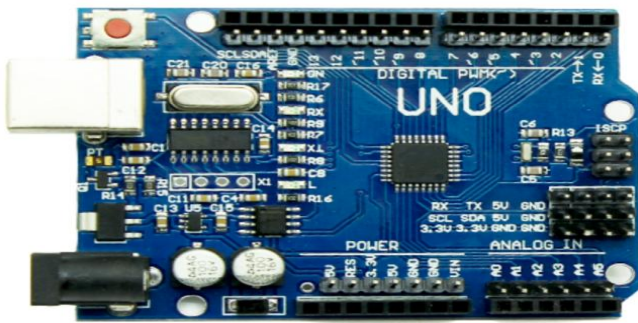
2.2 Arduino Uno (ATmega328) board

Fig.3. Arduino Uno (ATmega328) board

Circuit Serial programming. It supports 2 KB SRAM, 32 KB flash memory, 1 KB EEPROM and runs on 16 MHz clock. The software control is accomplished by the use of C functions like pinMode( ), digitalRead( ), digitalWrite( ), analogRead( ) etc. Many other technical specifications could be obtained from technical manual available from Arduino official website.

3. Connection Diagram

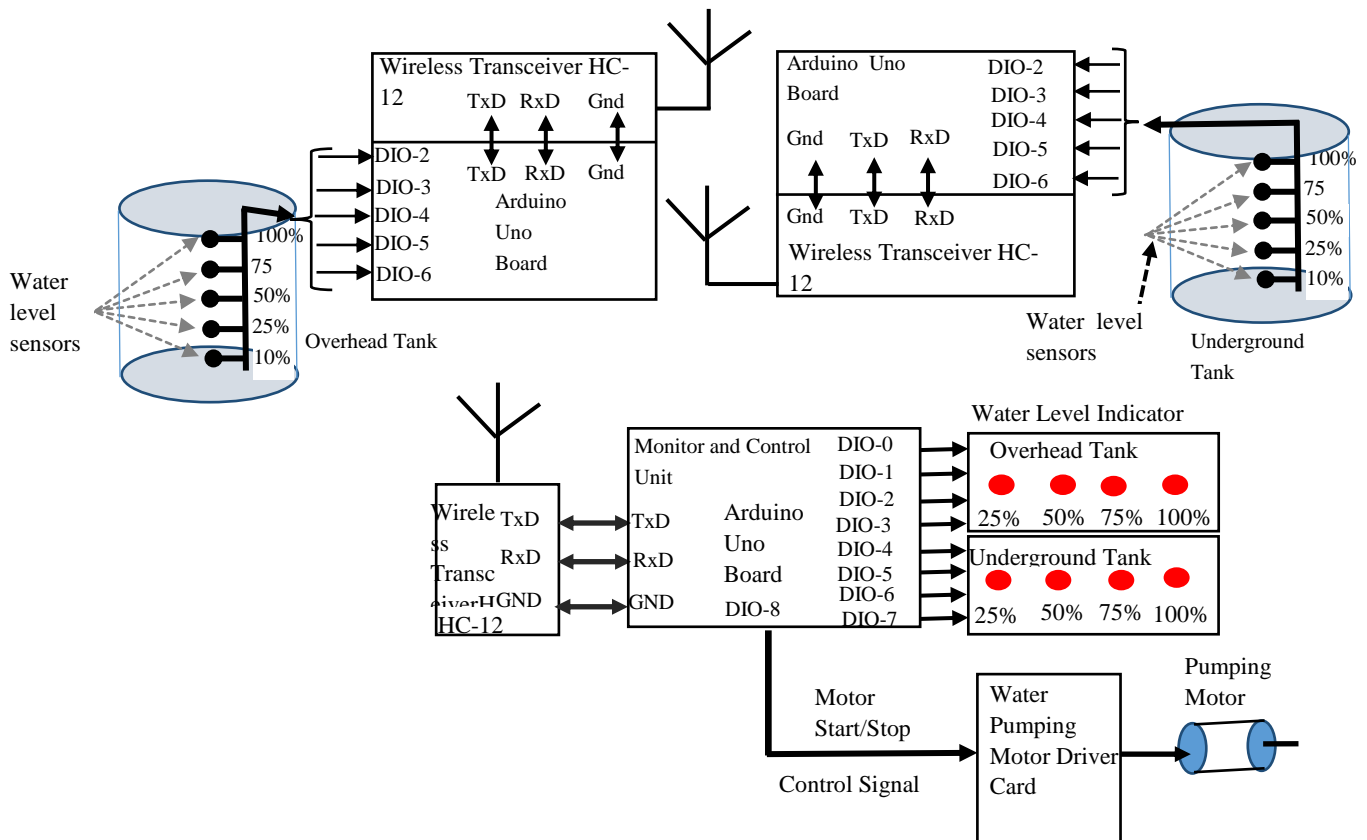The connection diagram for wireless control system is shown in fig.4. The baud-rate, power

Fig.4. Connection Diagram of Wireless Control System

Fig.3. shows image of Arduino-Uno board from Microchip Inc. It has 14-digital input-output pins (DIO-0 to DIO-13), one analog reference pin A_{ref}. Six DIO pins can also be used as PWM output. DIO-0 and DIO-1 are receive data and transmit data pins for serial communication. There are six analog input pins A_0 to A_5, with analog voltage range of 0 to +5 V. It includes a 10-bit A to D converter. A hardware RESET switch to manually RESET the microcontroller. The board support In-

output, receiver sensitivity, channel number selection, transparency settings for HC-12 are initialized by connecting HC-12 module to PC or laptop through FTDI module. All the HC-12 modules are set to same parametric values like; 9600 bps, 100 mW, -117 dBm, 50, FU3 etc. This is mandatory setting for all the wireless modules in the same network. The wireless module connected to the water tanks will supply water-level information whenever required by the control unit.

For this, the control unit sends the message to water-tank units, along with the alphanumeric password. The water-tank unit, whose password matches, will respond to the control unit, by sending the water-level information. In this manner, the half-duplex communication is achieved between control unit and water-tank units. This water-level information could be collected periodically after every half-an hour, as per requirements.

4. Software

The flowchart for the water-tank unit and control unit are shown in fig.3 and fig.4. The flowcharts of the wireless system are self-explanatory. The code is written in embedded-C, using Arduino IDE.
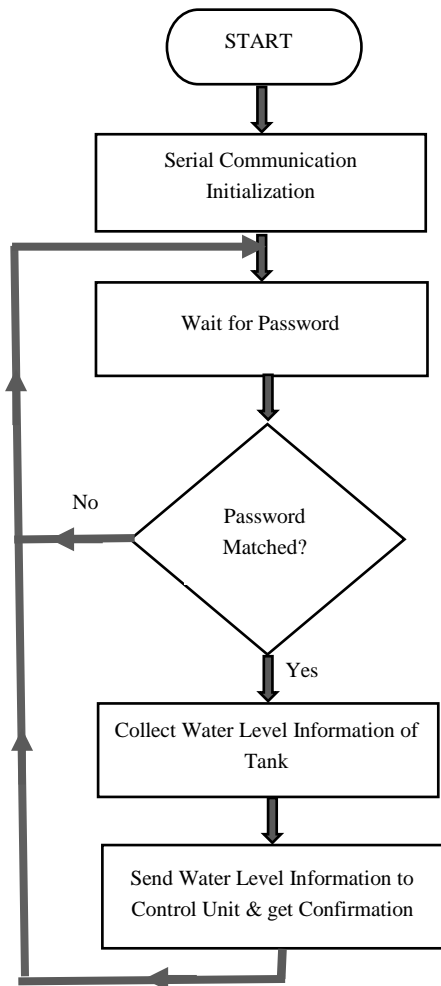
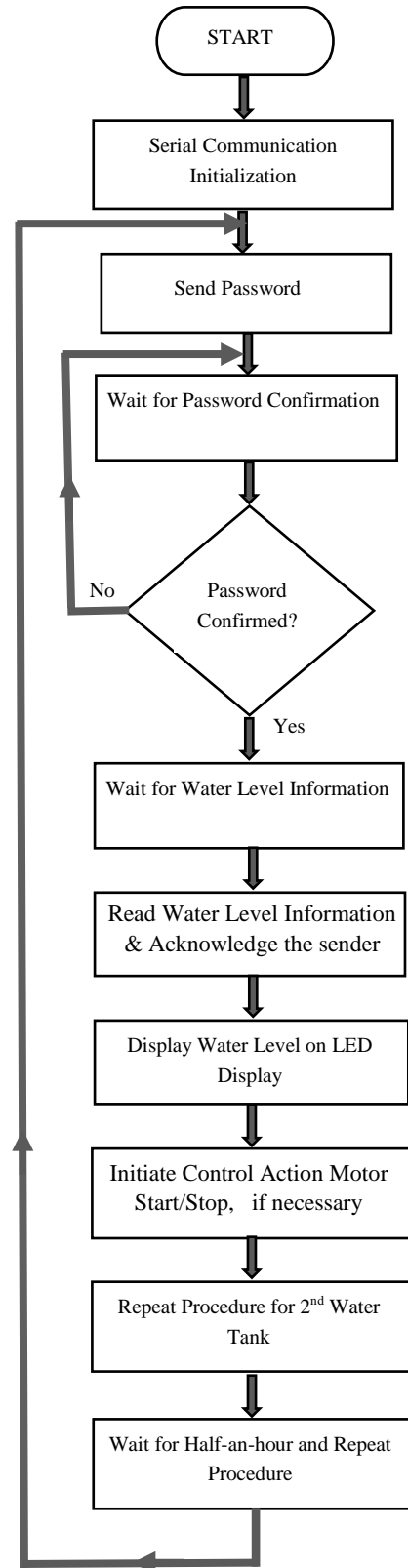**Fig.3. Flowchart of Water Tank Circuit**

Fig.4. Flowchart of Monitoring and Control System

Conclusions: -

The wireless system discussed in the paper

works in robust environment over a distance of about 100 meters for indoor application and about 300 meters in open air. It is cost-effective, rugged and reliable as compared to the wired and IOT-based systems requiring internet connectivity. Hence the wireless system is highly recommended for house-hold purpose.

Results: -

The true range of wireless communication varies with environmental conditions. The wireless system operates as per the requirements. It is a stand-alone system feasible in urban as well as rural areas equally, without the issue of connectivity or wiring network.

Acknowledgement: -

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Journals

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