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Design and Development of Smart Farming using IoT

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ABSTRACT

This paper presents an implementation of an IoT enabled irrigation for smart farming. Field parameters such as available input supply phase voltage, rain, soil water content are measured and uploaded to a cloud server for analysis. A smartphone application receives sensors data from the cloud and hosts an algorithm to control the actuators to control the water supplied to the crops. On field sensor's A-D conversion, actuators excitation, pump-set control algorithm are all implemented on commercially available SoC which allows performing these and has WiFi Stack for WiFi interface. The size, power consumption, and cost are the important aspects of implementation.

Keywords- *IoT, Embedded, Farming, WiFi, Cloud, Micro-controller, SoC.*

I. INTRODUCTION

The internet of Things (IoT) has enabled sensors which once produced data and processed locally to the information technology domain. IoT has enabled things which produce data to be globally gathered and analyzed. Thus IoT enables to build systems which are globally interactive thus providing an automatic sense and respond capability rather than delayed approaches. IoT has enabled cities to become smart cities, industries to globally monitor and control the processes . The total number of IoT connections is predicted to increase. Driven by the declining cost of sensors and governments digital initiatives through various schemes like digital India, smart cities, National Fiber Optic network, focus on improving efficiency and service, IoT is allowing to transition towards real-time data-driven management across our ecosystem. IoT enables us to become efficient including water, energy, waste, and transportation. The most basic IoT tools have been around for years, including connected street-lights, which switch off when no one is present to conserve energy or send automatic notifications when a light has gone out. Building on the basics today IoT enables us to have complex infrastructure management globally.

The IoTs potential in farming is a boon to the farmers. As we all know the farmlands are mostly remotely located and most of the farmers use irrigation pump-sets to draw water from underground or nearby water resources for irrigation. Farmers face challenges like frequent power cuts, a dry run of the pump after power restoration which left unattended causes damage to pump, sometimes the water is not available especially in dry seasons, irregular rain, timely and controlled supply of water to crops. Traditional irrigation requires farmer's presence for controlling the water and his intuitiveness to decide the amount.

IoT enabled smart farming addresses the issues faced by farmers. The penetration of mobile broadband and smartphone has made the Internet available in remote areas. IoT enabled sensors will now aid the farmer to remotely measure and monitor on field parameters. In IoT smart farming on field sensors data is gathered and made available over the Internet in real-time and a decision algorithm controls the irrigation activity by actuating the on-field actuators. The decision algorithm is implemented in a smartphone application and provides status/alert information. Alternatively, the farmer can remotely monitor and control the activity using the smartphone application.

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II. LITERATURE SURVEY:

The penetration rate for smartphones saturates, we are witnessing a fascinating new trend in the mobile device market. Users are showing an increasing interest in practically wearing a mobile device that promises to enhance the quality of life in a way that smartphones alone cannot achieve. These devices, which include health band, smart watches, wrist bands, smart glasses, smart jewelry, electronic garments, skin patches, and so on, are often simply referred to as wearables. Wearables can sense, collect, and upload physiological data in a 24x7 manner, providing opportunities to improve the quality of life in a way not easily achievable with smartphones alone. Wearables can also help users perform many other useful microtasks, such as checking incoming text messages and viewing urgent information, much more conveniently and naturally than possible with a smartphone, which is often carried in pockets or bags. Wearables are also being used to provide a range of value added services such as indoor localization and navigation, financial payments, physical and mental health monitoring, sports analytics, and medical insurance analytics. Wearables are low-cost, independent devices targeting personal use without any significant binding to medical professionals. This simplicity makes wearables more widely deployed, which in turn has led research attention at a much faster pace. Over the last few years, a wide variety of wearables have appeared in the market offering different functionalities and wearing options. At the same time, a significant volume of scientific articles has been published in the literature highlighting various research challenges related to wearables.

III. PROPOSED WORK

3.1 BLOCK DIAGRAM

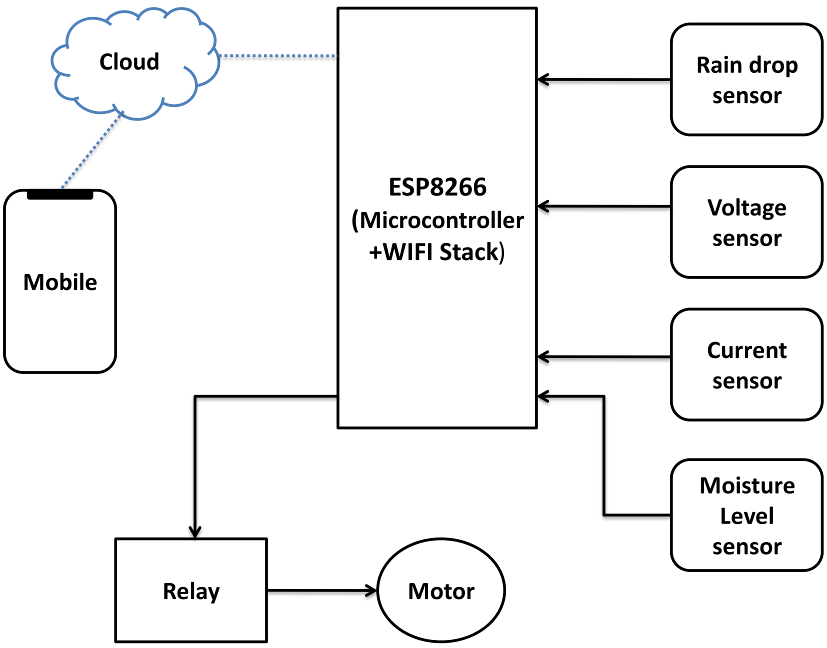

Fig. 1. Block diagram of implemented system

The system consists of a WiFi SoC, the voltage sensor, Moisture sensor, Rain sensor, Current sensor, Relay, a cloud server, and a smartphone.

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A smartphone application accesses the data from the cloud server and presents the current status to the farmer pictorially. The farmer can set the system in an auto mode wherein the watering the crops are controlled based on predefined algorithm running in the WiFi SoCs controller Alternatively the farmer can turn on Relay as he needs in manual mode. The cloud server can be paid server from various hosting companies but a free server is used in the implementation of the current system. A cloud server is used for uploading the sensor data and getting the commands for operation of the system..

3.2 HARDWARE AND SOFTWARE

The hardware is built around an ESP8266 SoC. it is highly integrated SoC and supports 802.11 b/g/n protocols. It has built-in 32-bit micro-controller which manages the WiFi activity, A-D Converter, GPIOs, UART. ESP8266 can be used as a slave to implement WiFi interface for other micro-controller using UART interface but in this mode, the internal microcontroller and its peripherals are not accessible. The internal micro-controller is utilized 20% of the time for WiFi activities and the remaining 80% of the time it is idle. The application firmware for IoT enabled farming is implemented using the internal micro-controller thereby reducing the requirement an additional micro-controller and its cost.

The rain, soil water content sensors are resistive sensors and this resistance is converted to voltages and applied to SoC. The main supply voltage is applied to a voltage step down circuit and applied to the SoC, current is measured using hall effect sensors and the hall voltage is applied to the SoC. The digitized values are uploaded to the server by using the WiFi. The application firmware in the SoC also queries the cloud server for commands, based on which it controls the motor.

The firmware of ESP8266's micro-controller gathers the sensor data, uploads to the cloud server and scans the cloud server for commands. The firmware is coded in Arduino Programming language, the coding utilizes the APIs of the SDK from the SoC manufacturer. The SDK from the manufacturer is not well documented and it required iterations and tweaking to implement the firmware. The firmware based on sensor data cuts the supply to the pump in case the motor runs dry or if voltages are not in safe operating range or the user has sent command for turning off the motor. The firmware scans the cloud server for uploading the sensor data and retrieving command from the server.

3.3 METHODOLOGY

In this Project the implementation methodology is divided into four functional modules namely

- Base Station IoT Module
- Field Module
- Cloud Server
- Mobile Application

BASE STATION IOT MODULE

The Base Station IoT module consists of Wi-Fi SoC, Voltage sensors, Current Sensors, Rain Sensor, Motor Starter interface relay, Moisture sensor

The Wi-Fi SoC is used to implement the control algorithm and provide Internet Protocol connectivity to the cloud server. The Wi-Fi is used in Station and SoC Access Point mode. In station mode, it uploads data and in AP mode it receives data from field modules. It uploads the acquired sensors data and status of the system to the cloud server via connected Wi-Fi hotspot/Wi-Fi Router. It also retrieves the user commands from the cloud server. The cloud server transactions are done cyclically with intervening time slots to conserve power. The current is measured using a hall-effect sensor, this sensor produces a voltage proportional to the current. A flow sensor provides a voltage proportional to the quantity of water pumped by the motor, a presence of voltage from

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this sensor will indicate that the motor is not running dry. If the motor is turned on and the flow sensor voltage is absent then the motor is turned off to prevent it from running dry. A rain sensor monitors the rain; a voltage proportional to the quantity of rain is generated and converted to a digital value if the motor is pumping the water and rain is sensed then the motor is turned off.

FIELD MODULE

The field module consists of a number of Wi-Fi SoCs deployed as slaves on the field. Each slave is identified by the IP address and communicates to an IoT Module using a Wi-Fi LAN. Each slave module consists of a Wi-Fi SoC, antenna, battery, and SWC Soil Water Content sensor which convert the soil water content to an analog voltage. The slave modules operate in conversion mode or comparator mode controlled by the master module control logic.

CLOUD SERVER

Cloud server provides an IoT platform that enables to collect, store, analyze, visualize, and act on data from the loT module. It serves as the data collector which collects data from IoT module and also enables the data to be pulled into the Smartphone application.

ANDROID APPLLICATON

An Android operating system based smartphone application is developed to provide the user interface. The user can view the channel data pictorially and also send commands to the IoT module

IV.RESULT

The output of this implemented system can be explained below

- The measured voltage is monitored and analyzed in the application.
- The reading is obtained from the rain sensor which is displayed on an application.
- Moisture sensor provides different levels of moisture of the soil to the application.

Based on the data in the application decision is taken to turn ON or OFF the motor.

V. CONCLUSION

Farmers require systems which are low cost, reliable, easily deployable and maintenance free. The developed system cost is less as the major components of the system namely the two SoCs are available for less than 200 rupees each. The cost of WiFi and its associated circuit is less than 600 rupees. The modules and its circuit cost is less than 400 rupees and can last for two years. The developed system is easily deployable and maintenance free are the circuit uses low power devices and small in sizes.

The sensors data can be analyzed by agriculture experts remotely and guide the farmer accordingly thereby increasing the quality and quantity of produced corps. The developed system can also be used to monitor the power consumption of the motor by the electric supply companies.

Connectivity remains the major issue in remote areas, with governments initiatives it can be minimized also emerging Wireless Wide Area Networks such as LoRaWan (Long Range Wide Area Network) which is specially developed for Low Power IoT connectivity can help to provide connectivity in remote areas.

VI. ACKNOWLEDGEMENTS

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[2] Pavithra DS, MS Srinath, "GSM based automatic irrigation control system for efficient use of resources and crop planning by using an android mobile" 2014.

[3] Kisan Raja a GSM-based controller, which allows the farmer to control the agricultural motor using his mobile or landline from the comforts of his home.

[4] Priyanka Ranade developed a smart irrigation system using FPGA based wireless sensor network. The system consisted of a field module which had a sensor interface and a control module which was a base station, both the modules used a spartan3A FPGA.