**INTERNSHIP REPORT**

**Data Communication & Control (Pvt.) Ltd.**

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**Company Overview**

Data Communication & Control (Pvt.) Ltd. was incorporated in May of 1994 and has since been a trend setter in the application of information and computer technology, and design engineering in Pakistan. The Company’s vision is to translate innovative ideas into products and services for the benefits of the common man and provide optimized solutions with indigenous resources.

With clients ranging from the armed forces to steel mills and electricity supply companies, the firm specializes in multiple engineering expertise. Moreover, the company culture is a seemless blend of fast paced technology development incorporating extensive research where the highest standard of end product is the only aim.

**Acknowledgement**

Working at DCC has been an absolute perk and has broadened our overall expertise and vision to new standards. Therefore, I want to use this platform and acknowledge Sir Samir’s intellectual guidance and motivational support throughout my time at his firm, he is a wonderful and compassionate human being and an icon for Pakistani Engineers. I would also like to commend my team; Engineers Taha , Munir, Saadan and Assad for their collaborative efforts and always making me feel part of the team and trusting in my skills and expertise. Moreover, the HR staff; Mr. Akbar and Ms. Yasmin were tremendously cooperative and friendly too. DCC has provided me an unparalleled experience during the ninety days and has layed a solid foundation for me to commence my career, for which I am greatly appreciative. Nonetheless, all glory is to God.

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# Objective

This report will provide a detailed insight into the tasks succefully carried out during our internship tenure at Data Communication & Control (Pvt.) Ltd. It will also cover the contributions made to various projects and their overview.

# Assigned Projects

* A Modular Precision Irrigation System (An ‘Internet of Things’ implementation in the Agriculture Sector).

# Exexutive Project Summary

Precision Agriculture (PA) is the use of Information Technology (IT) in agriculture. The basic purpose to use Precision Agriculture is to have more yield, sustainability and productivity from the same field using IT. Different sensors are used to monitor the crop in every aspect like nutrients in soil, moisture, humidity, temperature of the crops and surrounding. Our project deals with ‘Precision Irrigation’ which is a sub-domain of ‘Precision Agriculture’. In our project temperature, humidity and moisture of soil as well as sun exposure is being measured. But any type of sensors can be easily integrated into the project. The data gained is sent to the communication hub. Communication hub consists of two parts i.e. gateway and uplink. Gateway collects the data from all the sensors in the field at one point and uplink/upload to the database. Communication hub also dictates a water valve based on the real time soil readings which fulfil water needs of the plant whenever necessary. The Data gained in the database is then analyzed by Decision Support System (DSS) and steps are taken accordingly. Future predictions can be made based upon the historic data collected. Also If any area in the field is known to be affected based on the readings of sensors, remedial actions are taken in specified area which reduces time as well as resources.

# Introduction/Background

The use of precision agriculture is to increase the yield and efficiency of the field and save resources which are being wasted. Consequently more productivity on small area of field in order to meet the increasing demand of food.

Water is essential for the growth of field. Large acres of agricultural field requires lot of water which means wastage is also greater in this sector. PA ensures to save water by supplying water to only those areas where needed. This limits the wastage of water.

About one third of food is wasted during the production of agricultural food each year globally. It also affects the economic sector. PA can be helpful to reduce the food wasted during cultivation and harvest process.

Healthy crops give more yield. To monitor the health of crops Drones and GPS are used which provides real time images and data of the field. This lead to identify the healthy and unhealthy crops and irrigation and drainage problems.

Additionally, nutrients sensing technology can be used to identify the particular fertilizer needs of certain crops for healthy growth and thus saving the extra amount of fertilizer which is usually wasted.

# Project Objective

In our project we aim at achieving precise irrigation which means to save water. Water wastage is controlled by precise irrigation. Crops are watered when needed based on the readings from sensor installed in the field. In this way water wastage is limited and sufficient water is supplied to the crops for their healthy growth.

# Client/Stakeholder and Their Requirements

The main stakeholders in this project are the farmers, their requirements include a low cost and efficient automation system which will reduce their extra expenditures on water resources, energy resources and labor while increasing the productivity of crops. They will be able to monitor the conditions of their crops remotely and also control the watering of the plants automatically.

The state is also a major stakeholder as the energy saved by this project will benefit the energy sector of the country. More productivity will result in more exports benefitting the economy of the country.

The civil society/consumers also reap benefits of the project as the water and energy saved can be helpful in fulfiling the needs of the peoplel.

# Engineering Design and Specifications

In our project the system would be able to collect data of surrounding environment through different sensors. The data about humidity, surrounding temperature, soil temperature, light intensity and soil moisture is sent to a webiste which is hosted locally (can be hosted publically). The website shows the real time data graphically. Water valve situated in the field is electronically triggered with these sensors’ readin. If the moisture of soil falls below the set threshold value then water valve is opened automatically which basically funtions to provide water only when soil is dry and needs water.

Humidity readings are taken with the accuracy of 5% within the range of 20-80% humidity. Environmental temperature readings are accurate with the error of ±2°C. Soil temperature readings have error of ±0.5°C between the range from -10°C to +85°C.

# Benchmarking

Various projects relating to our solution are already up and working in developed countries. One example is [**“Drip - Low-Cost Precision Irrigation for Developing Nations”**.](https://www.hackster.io/wsawan/drip-low-cost-precision-irrigation-for-developing-nations-4cb957) It almost uses the same format for communication. The difference is the use of communication modules. Our radio module can be effective upto longer distances than the one used in the Drip project. Also we have created a custom database and designed a personal website which is used as the Graphical User Interface.

Another examplary project that is being implemented in Europe is called [“FIGARO”](https://cordis.europa.eu/result/rcn/151724_en.html). It is a smarter, more precise irrigation system to help promote sustainable farming. EU-funded researchers working within the FIGARO project have developed an innovative, high-tech irrigation platform capable of accurately managing the quantity of water used.

# Impact of your Solution

This project directly impacts the farmers in terms of more productivity in less resources as well as the remote monitoring of his field. It is also helpful in saving energy for the country because it precisely needs energy when required. The energy saved can be utilized to help fulfilling the energy deficit in our country.

1. **Design Concepts**

During the process of ideation of the project, different ideas about the sensors and modules to be used arose in our minds. For example, the purpose of radio communication could be fulfiled by using a stand-alone microcontroller like Arduino Uno with a separate radio transceiver module like the NRF24l01+. But the utilization of the Loraduino board results in a more compact design. The Wi-Fi module used here is called NodeMCU while others like esp8266 could be used. However, the esp8266 has stability problems that’s why the choice of a more stable developed board of esp8266 (NodeMCU) was made. Various kinds of temperature sensors like lm35,tmp35 could also be used but the use of DS18B20 was more suitable for our design of the probe. Different kinds of light sensors and moisture sensors that are more precise can also be bought but we decided to keep the project cost effective.

# Design Details

Our project design is based on two main parts:

1. Field
2. Server

**FIELD**

The probe, communication hub and water valve are the main components situated in the field.

**Probe:**

Purpose:

To collect sensor data (temperatures, humidity, soil moisture and light intensity) at a point in the field and send the data wirelessly via Radio communication.

Components:

* LORADUINO:

It is an arduino pro mini microcontroller with built in LoRa Radio transceiver (model SX1278). Arduino sketch can be uploaded via FTDI USB to Serial interface. It has low power consumption, long transmission distance and low error, board runs on 433MHZ frequency.

* DHT11:

DHT11 is a digital output based sensor which measures humidity and temperature of surrounding. It is Low cost sensor and can be operated with 3 to 5V power. It is good for 20-80% humidity readings with 5% accuracy and for 0-50°C temperature readings with ±2°C accuracy.

* DS18B20:

It is a digital temperature sensor which is used for the purpose of measuring soil temperature. It has range between -55°C to +125°C. It has ±0.5°C Accuracy from -10°C to +85°C. It requires 5v input to work.

* Photoresistor:

Photoresistor is an analog sensor. It is used to measure the light intensity. It works on 5v power.

* Soil Moisture Sensor:

Soil moisture sensor is also an analog sensor which works on 5v power. It measures the moisture of in the soil by measuring the conductivity between the plates.

* Buck Converter:

A buck converter is a DC-DC Adjustable Step Down converter which steps down input voltage to its output load. The output is adjustable from 0-12V with maximum output load current 3A.

* 12V Battery:

Battery is used to operate the system.

Working:

These sensors are attached to the LoRaduino which continuously transmit real time data. DS18B20 is fitted in the soil to measure temperature of the soil. The basic purpose of DHT11 is to measure humidity and temperature of the surrounding. Photo resistor is used to sense the sunlight falling on it. Soil Moisture sensor tells if crops need water by knowing about dryness of the soil. All this data is processed in LoRaarduino and sent to the communication hub via LoRaduino transceiver. All these sensors and the arduino are housed inside a single packaging known as the probes.

**Communication Hub:**

Purpose:

To receive the radio signals sent by the probes (one probe in our case) in the field, process the received data, take necessary decisions for watering the plants and also upload the data to the internet via Wi-Fi.

Components:

* LORADUINO:

It is an arduino pro mini microcontroller with built in LoRa Radio transceiver (model SX1278). Arduino sketch can be uploaded via FTDI USB to Serial interface. It has low power consumption, long transmission distance and low error, board runs on 433MHZ frequency.

* NODE MCU ESP8266 V1.0:

It is a development board for the esp8266 Wi-Fi Module. It is a low powered microcontroller and has an onboard esp8266 Wi-Fi chip which gives our project the Wi-Fi capability needed to upload data to the internet. It can be programmed through the Arduino IDE by downloading and installing the NodeMCU board in Arduino IDE.

* RELAY MODULE:

A 5V D.C. Relay module is used here which can also work with the 3.3V provided by the NodeMCU. It’s switching is controlled by connecting its Input to an Output Pin of NodeMCU. A 1N4007 diode (used as a snubber diode) is connected across the relay’s output because at the output a solenoid valve will be connected. The solenoid valve is an inductive load. Therefore, with the rapid change in current (when the source is disconnected), a voltage spike occurs across it which is dealt by the diode by letting the discharging current pass through it until it becomes zero thus resulting in safe closing of valve.

* Power Supply:

A 12V battery is used to power the Loraduino and NodeMCU while a 12V D.C. Adapter is connected to the relay switch and consequently powers the Water Valve.

Working:

The probes attached at various points in the field are all configured to send the sensors’ data to a central communication hub which is also situated in the field. The short distance and absence of obstacles between the probes and the hub is the reason to use radio frequency for communication as it is a faster way to communicate where distance and obstacles are not a problem. An additional Power Amplifier/Low Noise Amplifier antenna can be used with the LoRa radio transceiver module if the distance between the probe and hub is greater than 80 meters. It receives radio signals of the probes and gives it as input to the LoRaduino. This received data is then sent to NodeMCU board with wired serial communication between the LoRaduino and the NodeMCU board. It processes the received message and uploads it to a MySQL Database (on a locally hosted server in our case. However, the server can be made live by purchasing a domain) and consequently each probes’ sensor data reaches the database of our server. NodeMCU also checks the moisture value and compares it with a set threshold(a value at which soil is dry and needs water) and then decides wheter to turn the relay “ON” or “OFF”.

**Water Valve:**

Function:

To water the field according to the decisions taken by the communication hub.

Components:

* SOLENOID WATER VALVE:

A ½ inch electrically controlled solenoid water valve is used to control the water flow to the field. It takes 12V 1A D.C. Input.

Working:

The input supply to the solenoid valve is provided by the 12V D.C. Adapter (present in the hub) but the adapter’s wires pass through a relay inside the hub before reaching the water valve. Therefore making it controllable by the relay and consequently by the NodeMCU microcontroller present in the Hub.

# Prototype

Our prototype consists mainly of two separately boxed circuits which can be powered by a 12V D.C. battery or a 5V USB cable.

One of the two boxes is named “Probe”. The probe’s box is mounted on top of a PVC pipe which will be inserted in the field/plant’s soil.

The second box is named “Communication Hub”. It can also be mounted on a PVC pipe if intended to insert in the soil or can be kept un-mounted if intended to place it on a horizontal solid surface.

The second main part is the web server which is hosted locally on a computer having an internet connection. The Hub’s Wi-Fi is then connected to the same internet connection.

1. **Construction of the Probe:**

# Conclusions, Future Works

# References

# APPENDIX