



Smart Watering System

Feasibility Report

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Change Summary

The following table details changes made between versions of this document.

| Version | Date | Modifier | Description |
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| 1.0 | 15/04/2020 | General structure determined | We have started to make the overall draft of the project |
| 1.1 | 20/05/2020 | Environmental effect | The project's environmental impact and cost was investigated. |
| 1.2 | 18/06/2020 | General control of the report | All the divisions have been brought together. |
| 1.3 | 22/06/2020 | Finishing the report | All corrections have been made and finished. |

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1. INTRODUCTION

1.1. Purpose of the Feasibility Report

The purpose of this document is to present the findings of a broad feasibility study to determine whether the desired methods of achieving the objectives of the project are viable and to present the alternatives of the desired methods as well as a prescriptive conclusion.

1.2. Project Description

In the first part of the project air circulation, heating and **temperature/humidity** measurement and control will be performed. A DHT22 sensor can be used to measure **temperature and humidity**.

I2C LCD will be used to show all necessary parameters and status. The IR motion sensor triggers the LCD backlight when there's someone in the area. RTC relay clock which gives, through a digital pin, a "day/night" reference to the entire system. The inside temperature has two set points for "night" and "day" to simulate real conditions. The lights stay on during the "daytime" for about 15hrs.

Irrigation system: A rain(snow)water barrel is connected to a two-pump block through an electric valve and a filter. Water level is measured by an ultrasonic sensor. Two capacitive soil moisture sensors monitor humidity and trigger water pumps independently for their respective zone. The irrigation is blocked when water level in the barrel becomes critical and a LED is showing a "low water" warning.

IOT sensors are capable of providing information about agriculture fields. This IOT based agriculture monitoring system makes use of wireless sensor networks that collect data from different sensors deployed at various nodes and send it through the wireless protocol. This smart agriculture using IOT system will be powered by Arduino, it consists of Temperature sensor, Moisture sensor, water level sensor, DC motor and GPRS module.

When the IOT based agriculture monitoring system starts it checks the water level, humidity and moisture level. It sends SMS alert on the phone about the levels. Sensors sense the level of water if it goes down, it automatically starts the water pump. If the temperature goes above the level, fan starts. This all is displayed on the LCD display module. This all is also seen in

IOT where it shows information of Humidity, Moisture and water level with date and time, based on per minute. Temperature can be set on a particular level; it is based on the type crops cultivated. If we want to close the water forcefully on IOT there is button given from where water pump can be forcefully stopped.

13. Justification for the Proposed System

A greenhouse is a structure with walls and roof made chiefly of transparent material, such as glass, in which plants requiring regulated climatic conditions are grown. These structures range in size from small sheds to industrial-sized buildings. A miniature greenhouse is known as a cold frame. The interior of a greenhouse exposed to sunlight becomes significantly warmer than the external temperature, protecting its contents in cold weather.

Many commercial glass greenhouses or hothouses are high tech production facilities for vegetables, flowers or fruits. The glass greenhouses are filled with equipment including screening installations, heating, cooling, lighting, and may be controlled by a computer to optimize conditions for plant growth. Different techniques are then used to evaluate optimality-degrees and comfort ratio of greenhouse micro-climate (i.e., air temperature, relative humidity and vapour pressure deficit) in order to reduce production risk prior to cultivation of a specific crop. It is really significant system that is so beneficial for nature and humanity. Especially, the balance of oxygen and CO² will be protected in safe conditions by this technique.

14. Desired System Functionality

The below mentioned are the significant equipment for this project . Those not mentioned are compatible with those mentioned below. A diagram showing the interactions of the “Automatic Greenhouse Watering and Agriculture Monitoring System’s” components is available in the Appendix. Diagrams of the desired vessels are shown in Appendix: Figure 5, 6 and 7.

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

The DHT22 is a basic, low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin (no analogy input pins needed).

Ultrasonic sensor has a 3mm sensitivity and 2-400cm range. It can be used in distance measuring, radar and robot applications.

Moisture Sensor can be used to detect the moisture of soil, to judge if there is dampness around the sensor. It can be used to decide if the plants in a garden need watering. It can be used in gardens to automate watering plants. It can be used very easily by just inserting the sensor into the soil and reading the output using ADC.

WSN Dev. Kit is a board that combining Arduino and Sub1 GHz communication module with the rechargeable battery functionality. It has Atmega 328 microcontroller and cc1101 868 MHz radio module. There are also built-in humidity and temperature sensors. You can also connect Arduino compatible sensors by using the open pins and vary your project.

15. Mobile Application User Interface Description

1.5.1. Main Dashboard

In the main dashboard, the user can see daily water usage, area-based moisture levels, main water tank level, and maintained forward watering times. By pressing area boxes users can reach area based settings like watering timer manual watering options. When click on 3heorication bell users can reach the newest notifications about system like fire alert or upcoming watering event. Water usage level is shown in Figure 1.1

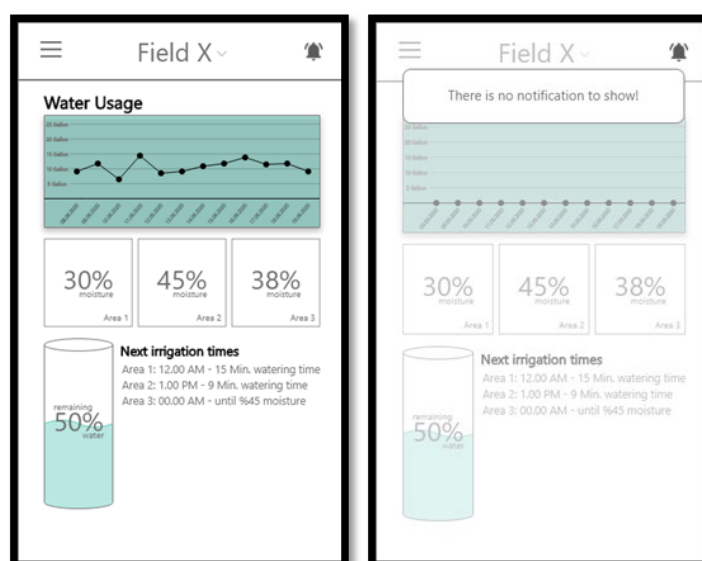


Figure 1: Water Usage Level

1.5.2. Fire Alarm

The fire alarm is activated by sending the fire signal of the device as a result of triggering the smoke detectors of the remote device. With the acceptance of the confirmation message on the screen, the fire brigade is automatically called. Also, fire extinguishing sprinklers included in the system, and they can be activated if desired. This feature takes place manually or automatically, based on the user's choice in the application settings.

1.5.3. Water Usage Statistics

The device records the amount of water used during irrigation and sends it to the phone. Based on these data, the user is more knowledgeable about the amount of water he spends and thus can save maximum water. The water usage graph is shown in the Figure 1.2.

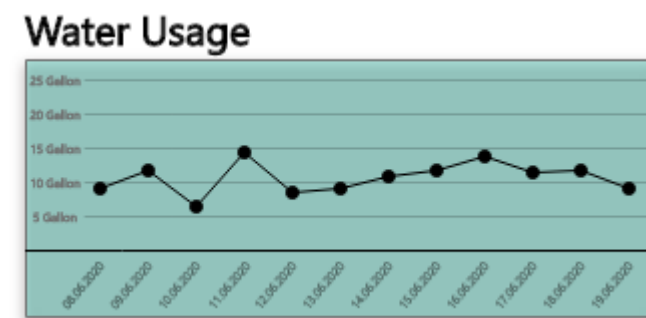


Figure 2 : Water Usage Graph

1.5.4. Water Level of Tank

If a water tank is included in the system, the water level of the tank is instantly displayed on the main screen of the application. If the water level in the tank falls below the level determined by the user, the application sends a notification to the phone of the user. The relevant image of remaining water level is shown in Figure 1.3.

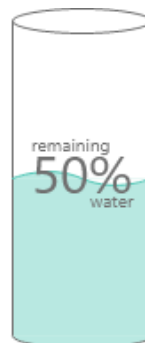


Figure 3: Remaining Water Level

1.5.5. Remote On / Off

The application's remote on/off function allows the remote device to be turned off or on with the command of the user. Thanks to this feature, the device enters standby mode. For a complete shutdown, the device must be disconnected from the power supply.

1.5.6. Moisture Levels (Area-Based)

In the main menu of the application, the user can instantly read the regional humidity levels. With this data, the user will be able to choose the irrigation time and duration depending on the user request. The moisture / area percentage is shown in Figure 1.4.

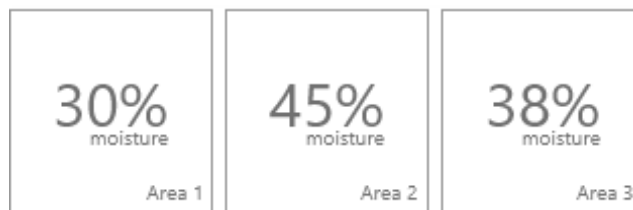


Figure 4. : Moisture/Area Percentage

1.5.7. Watering Control

The user can be select two different watering modes:

- Time-based watering
- Moisture-based watering

In time-based irrigation, the user selects when the area will be irrigated. According to different situations, the user can choose to water the soil until it reaches the targeted humidity, regardless of time.

Below, the Field X is shown in Figure 1.5.

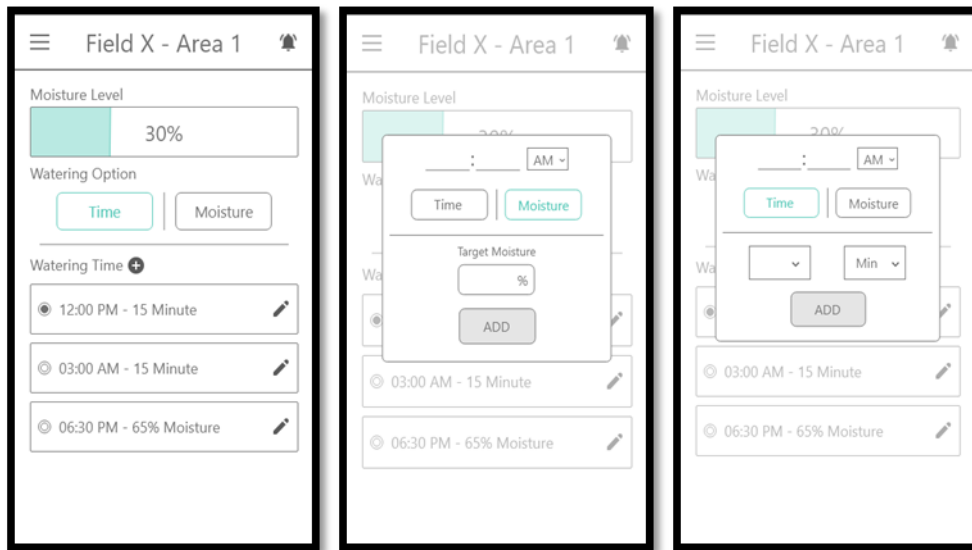


Figure 5 : Field X

According to moisture, the user assigns the base moisture rate to the area. When the moisture rate in the soil reaches the base moisture rate, the area is irrigated until it reaches the moisture rate determined by the user. The Field X II is shown in Figure 1.6.

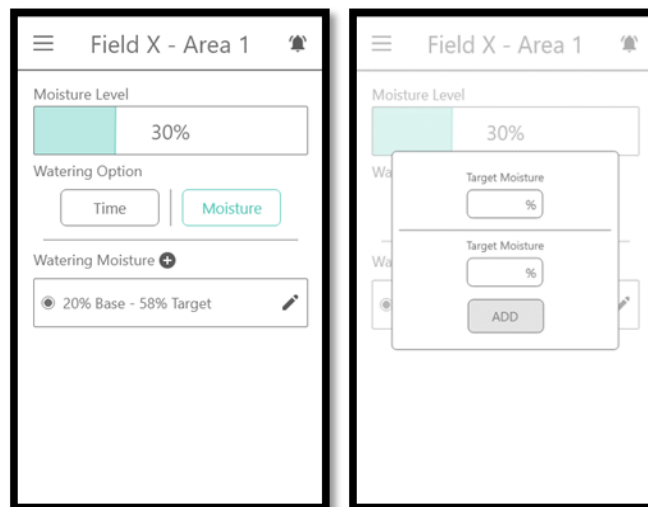


Figure 6: Field X (II)

1.5.8. Manuel Irrigation Control

Manual irrigation control allows the user to be activated or deactivated by controlling the irrigation systems of the regional or whole land manually at their command.

2. EXISTING SYSTEMS AND TECHNOLOGIES

We are developing the mobile application of our project uses React Native and Firebase, the newest and most up-to-date programs used in the world of technology. Our application holds two different blocks and one of them provide users technical support (admin).

In the traditional architecture there existed only the server and the client. In most cases the server was only a data base server that can only offer data. Therefore majority of the business logic i.e., validations etc. had to be placed on the clients system. This makes maintenance expensive. Such clients are called as ‘fat clients’. This also means that every client has to be trained as to how to use the application and even the security in the communication is also the factor to be considered.

Since the actual processing of the data takes place on the remote client the data has to be transported over the network, which requires a secured format of the transfer method. How to conduct transactions is to be controlled by the client and advanced techniques implementing the cryptographic standards in the executing the data transfer transactions. Present day transactions are considered to be “un-trusted” in terms of security, i.e. they are relatively easy to be hacked. And also we have to consider the transfer the large amount of data through the network will give errors while transferring. Nevertheless, sensitive data transfer is to be carried out even if there is lack of an alternative. Network security in the existing system is the motivation factor for a new system with higher-level security standards for the information exchange. Essentially there are two types of smart irrigation controllers: weather-based (ET) and on-site soil moisture sensors. The right solution depends on your geographic location and landscape environment.

Weather-based smart irrigation controllers

Weather-based controllers, also referred to as evapotranspiration (ET) controllers, use local weather data to adjust irrigation schedules. Evapotranspiration is the combination of evaporation from the soil surface and transpiration by plant materials. These controllers gather local

weather information and make irrigation run-time adjustments so the landscape receives the appropriate amount of water.

ET weather data uses four weather parameters: temperature, wind, solar radiation and humidity. It's the most accurate way to calculate landscape water needs.

There are three basic forms of these weather-based ET controllers:

- Signal-based controllers use meteorological data from a publicly available source and the ET value is calculated for a grass surface at the site. The ET data is then sent to the controller by a wireless connection.
- Historic ET controllers use a pre-programmed water use curve, based on historic water use in different regions. The curve can be adjusted for temperature and solar radiation.
- On-site weather measurement controllers use weather data collected on-site to calculate continuous ET measurements and water accordingly.

Soil moisture sensors used with smart irrigation controllers

Soil moisture sensor-based smart irrigation controllers use one of several well-established technologies to measure soil moisture content. When buried in the root zone of turf, trees or shrubs, the sensors accurately determine the moisture level in the soil and transmit this reading to the controller.

There are two different soil moisture sensor-based systems available:

- Suspended cycle irrigation systems, which are set like traditional timer controllers, with watering schedules, start times and duration. The difference is that the system will stop the next scheduled irrigation when there is enough moisture in the soil.
- Water on demand irrigation requires no programming of irrigation duration (only start times and days of the week to water). It has a user-set lower and upper threshold, which initiates irrigation when the soil moisture level fails to meet those levels.

2.1. Proposed System

The proposed system should have the following features. The transactions should take place in a secured format between various clients in the network. It provides flexibility to the user to transfer the data through the network very easily by compressing the large amount of file. It should also identify the user and provide the communication according to the prescribed

level of security with transfer of the file requested and run the required process at the server if necessary. In this system the data will be send through the network as a audio file. The user who received the file will do the operations like de embedding, decryption, and decompress in their level of hierarchy etc.

22. Fact Finding Techniques

In this system we are going to develop a facility to a user that he will not face any difficulty at the time of usage like data missing, one way contacts, one view contacts. As we are developing this system with an encoding technique of images the user will not be bothered on which camera support is using, as well in sound. As we are maintaining one technique of speed controlling the frame relay will not be a problem for the user like over speed display, hanged display.

2.2.1. Feasibility Study

A feasibility study is a high-level capsule version of the entire System analysis and Design Process. The study begins by classifying the problem definition. Feasibility is to determine if it's worth doing. Once an acceptance problem definition has been generated, the analyst develops a logical model of the system. A search for alternatives is analyzed carefully. There are 3 parts in feasibility study.

2.2.2. Operational Feasibility:

Question that going to be asked are:

Will the system be used if it developed and implemented.

If there was sufficient support for the project from the management and from the users.

Have the users been involved in planning and development of the project.

Will the system produce poorer result in any respect or area?

This system can be implemented in the organization because there is adequate support from management and users. Being developed in Java so that the necessary operations are carried out automatically.

2.2.3. Technical feasibility

Does the necessary technology exist to do what is been suggested

Does the proposed equipment have the technical capacity for using the new system?

Are there technical guarantees of accuracy, reliability and data security?

The project is developed on Pentium IV with 256 MB RAM.

The environment required in the development of system is any windows platform

The observer pattern along with factory pattern will update the results eventually

The language used in the development is JAVA 1.5 & Windows Environment

2.2.4. Financial and Economic Feasibility

The system developed and installed will be good benefit to the organization. The system will be developed and operated in the existing hardware and software infrastructure. So there is no need of additional hardware and software for the system.

23. System Analysis

People for long time have tried to sort out the problems faced in the general digital communication system but as these problems exist even now, a secured and easy transfer system evolved and came to be known as the Encryption and Decryption of the data and converting the file to audio format to be transferred using the cryptographic standards and Steganography. The advantages of this Audio Steganography are:

- High level Security
- Cost effective transfer

In this fast growing world where every individual free to access the information on the network and even the people are technically sound enough in hacking the information from the network for various reasons. The organizations have the process of information transfer in and out of their network at various levels, which need the process to be in a secured format for the organizational benefits.

If the organizations have the Audio Steganography System, then each employee can send the information to any other registered employee and thus can establish communication and perform the prescribed tasks in secured fashion. The audio file that the employee sends reaches the destinations within no time in an audio file format where the end user need to de embed the file, decrypt it and de compress and use for the purpose. The various branches of the organization can be connected to a single host server and then an employee of one branch can send files to the employee of another branch through the server but in a secured format.

24. System Design

The System Design includes the maintenance of the secure file transfer service with a prescribed encryption format and split at the interested level of encryption, and embed process and the receiving service at the other end with de-embed and decryption process. The design also includes the provision of facility to the user to manipulate the concerned information according to his personal use and communication process.

The design also needs to provide the communication channel to the user to communicate with other registered users through the mailing services in a reliable and secured format. Authorization and authentication services are preferred most for this purpose. The System Design includes the maintenance authorization services, File and directory services with a prescribed encryption format at the interested level of encryption and the receiving service at the other end with decryption process. The design also includes the provision of facility to the user to manipulate the concerned information according to his personal use.

The design of Audio Steganography system, basically involve the interface architecture, Security services, and communication system.

In the interface design we involve with the design of the user interface with GUI standards and a proper navigation system where the user need to enter into the flow of transactions authorization services are check and further access is provided into the system. Then the user needs to select into the operations provided through the GUI where compression, encryption, embedding, de-embedding, Decryption, Decompressing and sending of the file, General information and exit are provided.

Here the Encryption and decryption and services are provided connecting to the security services module where the encryption and decryption are carried out using the cryptographic standards implementing the Blowfish algorithm.

After the compression process is completed the user is selecting the file for encryption. After encryption of the file is completed the user is to select the file for embedding it to the audio file and sending through the network to the desired user by specifying the targeted users system IP address in the panel designed. Then the system gets connected to the targeted user and delivers the file in audio format after which the user working with the Audio Steganography software should go for the option De-Embed Files and decrypt the file by selecting the file path by which the file gets decrypted and decompress the file and is viewed on the system.

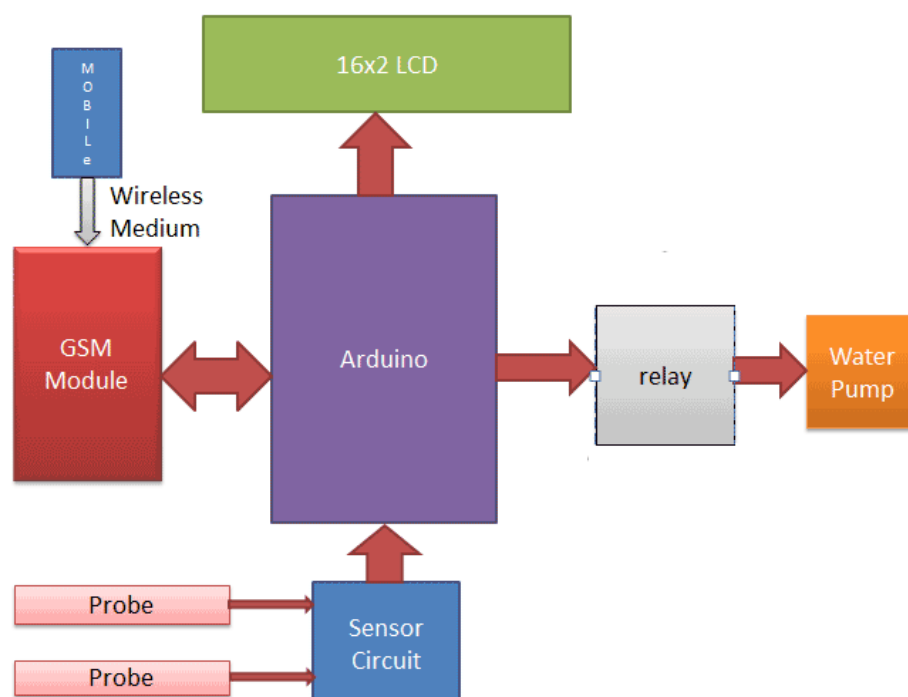


Figure 7: System Block Diagram

25. System Description

The Audio Steganography system is designed basically in four different modules they are GUI module, Compression Module, Security System module, Steganography Module, Connection Manager Module.

GUI Module basically deals with the design of the interface which include the service of providing the user with the flexibility of accessing the file system and selecting the required file for the transfer. It should also provide the system to collect the information from the user to check the authorization in providing the access to the file system. The interface is also to

consider the design, which include the services of sending and receiving of the files with encryption and decryption standards.

The Compression module basically deals with the compress and decompresses the file, which is used to send the file very easily. Which reduces the uploading time.

Security implementation module considers the implementation of the encryptions and decryption standards in transfer the files from one system to another in a distributed environment. The system design, even need to support the user to select the level of encryption he/she needs to perform depending upon the file to be transferred. The basic algorithm used in this purpose is the Blowfish where the user can enter the key depending upon level encryption he is interested.

The Connection Manager deals with the architecture, which supports the system to identify the end users for the communication and establish the communication. Connection and disconnection of the communication channel between the users for the access of file system and file transfer services. The Connection Manager receives the IP address to be connected and the file to be sent then establishes the connection and transfers the file.

2.6. Functional Requirements:

The Modules of the system are:

- 1) Blowfish Algorithm Implementation Module
- 2) Steganography Module
- 3) Compression Module
- 4) GUI Module

2.6.1. Blowfish Algorithm:

Blowfish is a block cipher that encrypts data in 8-byte blocks. The algorithm consists of two parts: a key-expansion part and a data-encryption part. Key expansion converts a variable-length key of at most 56 bytes (448 bits) into several sub key arrays totaling 4168 bytes.

Blowfish has 16 rounds. Each round consists of a key-dependent permutation, and a key- and data-dependent substitution. All operations are XOR's and additions on 32-bit words. The only additional operations are four indexed array data lookups per round.

2.6.2 Sub keys:

Blowfish uses a large number of subkeys. These keys must be precomputed before any data encryption or decryption. The P-array consists of 18 32-bit subkeys: P_1, P_2, \dots, P_{18} . There are also four 32-bit S-boxes with 256 entries each: $S_{1,0}, S_{1,1}, \dots, S_{1,255}$; $S_{2,0}, S_{2,1}, \dots, S_{2,255}$; $S_{3,0}, S_{3,1}, \dots, S_{3,255}$; $S_{4,0}, S_{4,1}, \dots, S_{4,255}$.

2.6.2. Encryption and Decryption:

Blowfish has 16 rounds. The input is a 64-bit data element, x . Divide x into two 32-bit

halves: x_L, x_R . Then, for $i = 1$ to 16:

$x_L = x_L \text{ XOR } P_i$

$x_R = F(x_L) \text{ XOR } x_R$

Swap x_L and x_R

After the sixteenth round, swap x_L and x_R again to undo the last swap. Then, $x_R = x_R \text{ XOR } P_{17}$ and $x_L = x_L \text{ XOR } P_{18}$. Finally, recombine x_L and x_R to get the cipher text.

Function F looks like this: Divide x_L into four eight-bit quarters: a, b, c , and d . Then, $F(x_L) = ((S_1, a + S_2, b \bmod 232) \text{ XOR } S_3, c) + S_4, d \bmod 232$.

Decryption is exactly the same as encryption, except that P_1, P_2, \dots, P_{18} are used in the reverse order.

2.6.3. Generating the Subkeys:

The subkeys are calculated using the Blowfish algorithm:

1. Initialize first the P-array and then the four S-boxes, in order, with a fixed string. This string consists of the hexadecimal digits of pi (less the initial 3): P1 = 0x243f6a88, P2 = 0x85a308d3, P3 = 0x13198a2e, P4 = 0x03707344, etc.
2. XOR P1 with the first 32 bits of the key, XOR P2 with the second 32-bits of the key, and so on for all bits of the key (possibly up to P14). Repeatedly cycle through the key bits until the entire P-array has been XORed with key bits. (For every short key, there is at least one equivalent longer key; for example, if A is a 64-bit key, then AA, AAA, etc., are equivalent keys.)
3. Encrypt the all-zero string with the Blowfish algorithm, using the sub keys described in steps (1) and (2).
4. Replace P1 and P2 with the output of step (3).
5. Encrypt the output of step (3) using the Blowfish algorithm with the modified sub keys.
6. Replace P3 and P4 with the output of step (5).
7. Continue the process, replacing all entries of the P array, and then all four S-boxes in order, with the output of the continuously changing Blowfish algorithm.

In total, 521 iterations are required to generate all required sub keys. Applications can store the subkeys rather than execute this derivation process multiple times.

2.6.4. Steganography:

Steganography is art of hiding information in ways that prevent the detection of hidden messages. Steganography derived from Greek, literally means “Covered Writing”. It includes a vast array of secret communications methods that conceal the message’s very existence. These methods are including invisible inks, microdots, character arrangement, digital signature, and covert channels and spread spectrum communications.

In this technology, the end user identifies an audio file, which is going to act as the carrier of data. The data file is also selected and then to achieve greater speed of transmission the data file and audio file are sent. Prior to this the data is embedded into the audio and then sent. The image if hacked or interpreted by a third party user will open up in any audio player but not displaying the data. This protects the data from being invisible and hence is secure during transmission. The user in the receiving end uses another piece of code to retrieve the data from the audio file.

The module deals with identifying the hidden data in the audio file. The module receives the audio file that is then browsed to remove the associated data. The data is then removed from the audio file.

2.6.5. Compression and Decompression:

Compression reduces the average code length used to represent the symbols of an alphabet. Symbols of the source alphabet, which occur frequently, are assigned with short length codes. The general strategy is to allow the code length to vary from character to character and to ensure that the frequently occurring character has shorter codes. We use utility package for compression.

This technique maps arbitrary input into printable character output. The form of encoding has the following relevant characteristics. The range of the function is a character set that is universally re-presentable at all sites, not a specific binary encoding of that character set. Thus, the characters themselves can be encoded into whatever form is needed by a specific system. For instance, the character ‘E’ is represented in ASCII system as a hexadecimal 45 and in EDCDIC- based system as hexadecimal- c5.

The character set consists of 65 printable characters, one of which is used for padding. With $2^6 = 64$ available characters, each character can be used to represent 6 bits of input.

No control characters are included in the set. Thus, the message encoded in Radix-64 can traverse mail-handling system. That scans the data stream for control characters. The hyphen character “-” is not included.

2.6.6. Graphical User Interface:

This project is developed using graphics in java swings. The options available are displayed in a menu format, like in an online editor. Clicking on any particular menu item through mouse or through keyboard a dropdown menu is displayed, listing all the options available under that menu item and the user can select the needed actions according to their wish.

2.6.7. React Native:

React Native is a JavaScript framework for writing real, natively rendering mobile applications for IOS and Android. It's based on React, Facebook is JavaScript library for building user interfaces, but instead of targeting the browser, it targets mobile platforms. In other words: web developers can now write mobile applications that look and feel truly “native,” all from the comfort of a JavaScript library that we already know and love. Plus, because most of the code you write can be shared between platforms, React Native makes it easy to simultaneously develop for both Android and IOS.

Similar to react for the Web, React Native applications are written using a mixture of JavaScript and XML-esque mark up, known as JSX. Then, under the hood, the React Native “bridge” invokes the native rendering APIs in Objective-C (for IOS) or Java (for Android). Thus, your application will render using real mobile UI components, not web views, and will look and feel like any other mobile application. React Native also exposes JavaScript interfaces for platform APIs, so your React Native apps can access platform features like the phone camera, or the user's location.

➤ Arduino

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board – you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

➤ **Sensors**

The following environmental data must be measured by sensors to control the Greenhouse Watering System:

- ✓ Humidity
- ✓ Temperature
- ✓ Water level

For communication several different components can be used: an IR motion sensor triggers the LCD backlight and send a notification on the phone when there's someone in the area. Agriculture monitoring system starts it checks water level, humidity and temperature and it sends another notification about the levels.

➤ **Solid Works**

Solid works is a very productive 3D CAD software tool, with its integrated analytical tools and design automation to help stimulate physical behaviour such as kinematics, dynamics, stress, deflection, vibration, temperatures or fluid flow to suit all types of design. SolidWorks is a solid modelling computer-aided design (CAD) and computer-aided engineering (CAE) computer program that runs primarily on Microsoft Windows. ...

According to the publisher, over two million engineers and designers at more than 165,000 companies were using SolidWorks as of 2013.

Enlisted are the key benefits that make SolidWorks, one of the most popular CAD platforms today: Shorter learning curve as compared to other leading CAD tools in the market.

Parametric and direct modelling capabilities are considered. Test designs; develop renderings and manufacturing documentation under common platform.

Solid works is used by designers, engineers and manufacturer's to produce realistic 3d models for documentation, visualization and production. Solid works models quickly become un- manageable if they aren't created with care and a good understanding of the principles of the software.

Below, CAD drawing example and dimensions drawing are shown in Figures 2.1 and 2.2.

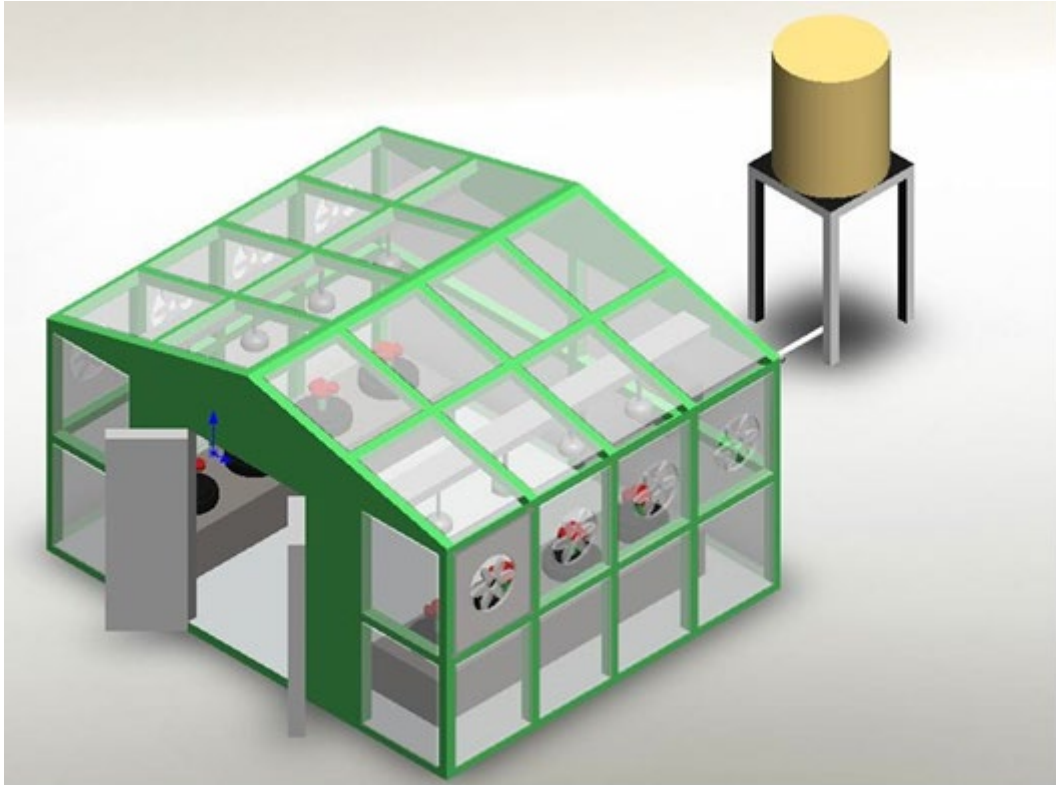


Figure 8 : CAD Drawing Example

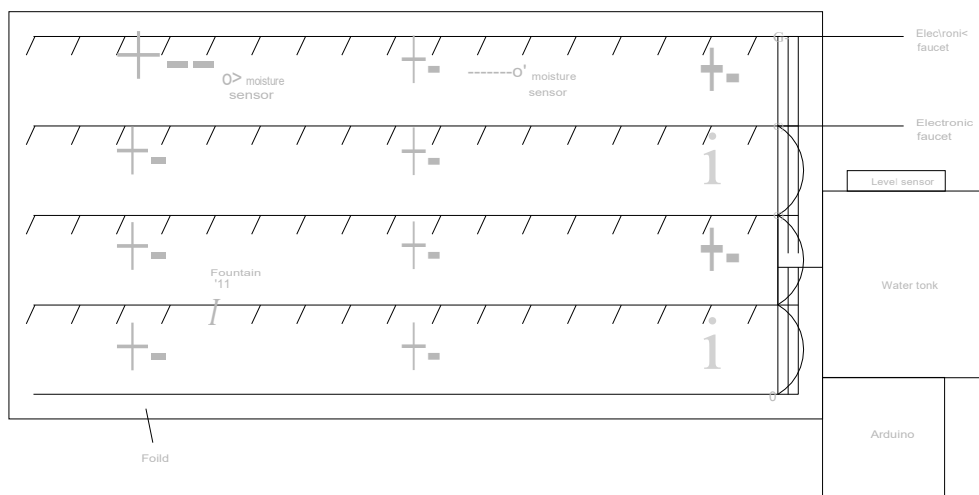


Figure 9: 1 Dimension Drawing on CAD

3. CONSIDERATION

➤ Cost

The project is not accompanied by a solid business plan (a return on capital injection is besides the goal, absence of a committed donor or sponsor); therefore particular attention must be paid to the overall costs of the endeavour ensuring minimum incurrence of costs.

➤ Skillset & Experience

Our team comprises of first time automatic greenhouse watering and agriculture monitoring system developers without much hands-on experience in production of goods, therefore whichever solution is proposed must align or complement the team member's skillset.

➤ Time

The project should be completed before the end of the year; therefore it is imperative that all Activities (development, production and testing) are not complex or beyond the team's reasoning. Licence Finishing Working Status Table is shown in Figure 3.1.

| LICENSE FINISHING WORKING STATUS | 22 April | 29April–06 May | 13 – 16 May | 17 – 24 May | 29May |
|--|-----------------|-----------------------|--------------------|--------------------|--------------|
| Determining a License Subject | x | | | | |
| Identification of Project Management Team | x | | | | |
| Determination of Time Management | | x | | | |
| Information About Greenhouse and Monitoring System | | x | | | |

| | | | | | |
|---------------------------------------|--|--|---|---|---|
| Information About Sensors and Arduino | | | x | | |
| Drafting the Project | | | x | | |
| Determination of Material List | | | | x | |
| Presentation of Project | | | | | x |
| Submit Date of the Report | | | | | x |

Figure 10 : Licence Finishing Working Status Table

4. ANALYSIS

Analysis is the process of breaking a complex topic or substance into smaller parts in order to gain a better understanding of it. The technique has been applied in the study of mathematics and logic since before Aristotle, though analysis as a formal concept is a relatively recent development.

- Market Analysis
- Technical Analysis
- Financial Analysis
- Calculations

Market Analysis

A detailed market analysis is unnecessary because the planned development of the automatic greenhouse watering and agriculture monitoring system is mainly for an agricultural sector. The digital systems which will be developed, and the greenhouse's structure and finishing cannot be considered to be of competent value on today's sophisticated digital marketplace where automatic greenhouse watering and agriculture monitoring systems are expected to be on the market. The United States User Forecast is shown below in Figure 4.1.

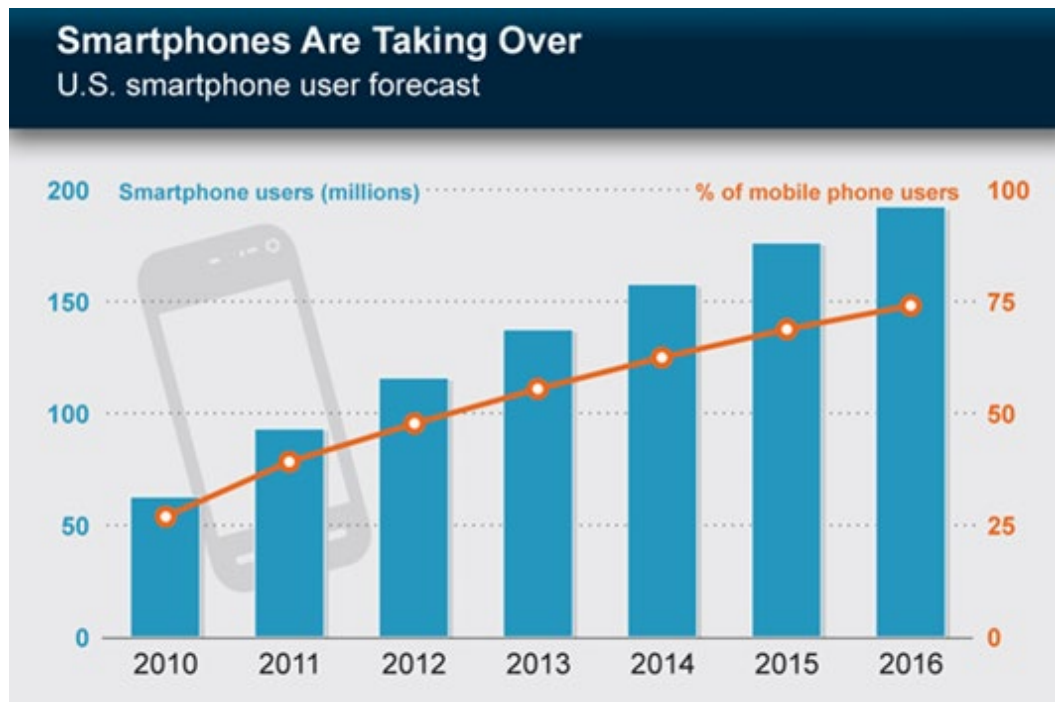


Figure 11: The United States User Forecast

Besides of the necessity of our system, the use of system also could be adapted by the clients easily. As we can see from the usage of smart phones are increasing dramatically over the years. We don't think clients will have any problem with using our system. Yet demand will likely to be increased in the coming years according to the charts above.

Technical Analysis

Considering the point stressed above, a technical analysis cannot be performed because the project deliverable is not going to be put up for sale or used as a prototype for market research, because of insufficient data (historical), and because a business case is non-existent. It shows how profitable the greenhouse project is and how to increase productivity levels with the use of the greenhouse application.

Below, Project Team Management is shown in Figure 4.2.

| Project | Research | Design | Documents |
|-----------------|----------|--------|-----------|
| Management Team | | | |
| Barış Karapelit | ✓ | ✓ | ✓ |
| Can Doğa Uçak | ✓ | ✓ | ✓ |
| Moment Zuaite | ✓ | ✓ | ✓ |
| YaşarAygün | ✓ | | ✓ |

Figure 12: Project Team Management

Financial Analysis

Again, considering that the project involves development of a single unit which will not be put on the market, conducting a financial analysis will not be necessary. Instead, a solution (or means) of developing and producing within the stated criterion (constraints) must be selected.

After a detailed research we come up with these products to be used in our system. These are the high tech, most reliable and cost-effective products we could find to use. Product Details List is shown in figure 4.3.

| Depo Kodu | Ürün Kodu | Açıklama | KDV | Adet | B.Fiyat | Tutar |
|------------|-----------|--|--------|--------|-------------|----------|
| A7A3 | 13134 | Toprak Nemi Algılama Sensörü | %18,00 | 3 Adet | 6,96611 TL | 20,90 TL |
| A2C1 | 11918 | 9V Pil Başlığı | %18,00 | 1 Adet | 0,84438 TL | 0,84 TL |
| G1C2 | 12899 | Orta Boy Breadboard | %18,00 | 1 Adet | 10,90653 TL | 10,91 TL |
| L2C12+F5A1 | 12445 | 10K Potansiyometre - WH148 | %18,00 | 1 Adet | 1,11176 TL | 1,11 TL |
| F2B7 | 13070 | Su Seviye Anahtarı - Su Seviyesi Sensörü - Water L | %18,00 | 1 Adet | 17,31675 TL | 17,32 TL |
| P1D1 | 11958 | 40 Pin Ayrılabilen Erkek-Erkek M-M Jumper Kablo-20 | %18,00 | 1 Adet | 4,22188 TL | 4,22 TL |
| P1D2 | 11959 | 40 Pin Ayrılabilen Dişi-Erkek M-F Jumper Kablo-200 | %18,00 | 1 Adet | 4,01079 TL | 4,01 TL |
| KS133 | 16193 | Arduino Eğitim Kitabı - Gökhan Dökmetaş | %0,00 | 1 Adet | 44,4444 TL | 44,44 TL |
| B5C3 | 12019 | HC06 Bluetooth-Serial Modül Kartı | %18,00 | 1 Adet | 23,57217 TL | 23,57 TL |
| A1B7+USB1 | 11605 | Arduino UNO R3 (Klon) | %18,00 | 1 Adet | 40,81153 TL | 40,81 TL |
| E3F11 | 14651 | 4X4 Membran Tuş Takımı - Keypad | %18,00 | 1 Adet | 6,33282 TL | 6,33 TL |
| D4A3 | 11702 | Ses Kartı - Buzzer Kartı | %18,00 | 1 Adet | 4,29225 TL | 4,29 TL |
| J4A9 | 17881 | ESP-12E ESP8266 Wifi Serial Port | %18,00 | 1 Adet | 18,43555 TL | 18,44 TL |
| A2A3 | 11725 | 1 Way 5V Relay Module - Tekli 5V Röle Kartı | %18,00 | 1 Adet | 4,61241 TL | 4,61 TL |
| B3B2 | 16575 | Sıvı Pompası - 750GPH (24v) - SFBP2-G750-01 | %18,00 | 1 Adet | 98,51058 TL | 98,51 TL |
| B3C6 | 12365 | 2x16 LCD Ekran - Yeşil Üzerine Siyah - TC1602A | %18,00 | 1 Adet | 28,84953 TL | 28,85 TL |

| Depo Kodu | Ürün Kodu | Açıklama | KDV | Adet | B.Fiyat | Tutar |
|-----------|-----------|--|--------|--------|-------------|----------|
| M4B9 | 12242 | 1/4W 330R Direnç Paketi - 10 Adet | %18,00 | 1 Adet | 0,34704 TL | 0,35 TL |
| E3B6 | 14368 | BC547 - TO92 Transistör | %18,00 | 1 Adet | 0,27763 TL | 0,28 TL |
| R2A2 | 16828 | GePro UM-75, 12V 500mA Adaptör | %18,00 | 1 Adet | 8,6759 TL | 8,68 TL |
| M4B6 | 12244 | 1/4W 220R Direnç Paketi - 10 Adet | %18,00 | 1 Adet | 0,34704 TL | 0,35 TL |
| M4B3 | 12248 | 1/4W 100R Direnç Paketi - 10 Adet | %18,00 | 1 Adet | 0,34704 TL | 0,35 TL |
| R1A2 | 11515 | ZD-10A Havya Standı | %18,00 | 1 Adet | 14,05496 TL | 14,05 TL |
| M4C5 | 12238 | 1/4W 1K Direnç Paketi - 10 Adet | %18,00 | 1 Adet | 0,34704 TL | 0,35 TL |
| M4D5 | 12227 | 1/4W 10K Direnç Paketi - 10 Adet | %18,00 | 1 Adet | 0,34704 TL | 0,35 TL |
| M4C8 | 12234 | 1/4W 2K2 Direnç Paketi - 10 Adet | %18,00 | 1 Adet | 0,34704 TL | 0,35 TL |
| M4E5 | 12217 | 1/4W 100K Direnç Paketi - 10 Adet | %18,00 | 1 Adet | 0,34704 TL | 0,35 TL |
| M4D3 | 12230 | 1/4W 4K7 Direnç Paketi - 10 Adet | %18,00 | 1 Adet | 0,34704 TL | 0,35 TL |
| P4B1 | 15184 | Marlow ZD-30B 40W Havya | %18,00 | 1 Adet | 27,76288 TL | 27,76 TL |
| C5G9 | 17106 | Montaj Kablosu Rulosu - 22AWG, 15mt, Tek Damar, Kı | %18,00 | 1 Adet | 5,5300 TL | 5,53 TL |
| A4D10 | 11947 | GP Greencell 9V Pil | %18,00 | 1 Adet | 2,9151 TL | 2,92 TL |
| A5C6 | 11512 | Soldex 0.75 mm 200 gr Lehim Teli (%60 SN / %40 Pb) | %18,00 | 1 Adet | 39,79115 TL | 39,79 TL |
| L3B12 | 16026 | Proskit 8PK-031B Lehim Sökme Fitiği | %18,00 | 1 Adet | 5,3971 TL | 5,40 TL |

Figure 13 : Product Details List

Calculations

V = Speed

✓ Formulas:

F = Force

$$1. F = V^2 \cdot A \cdot Q$$

P = Pressure

$$2. A = \frac{\pi \cdot r^2}{4}$$

A = Area

$$3. Q = V \cdot A$$

Q = Density

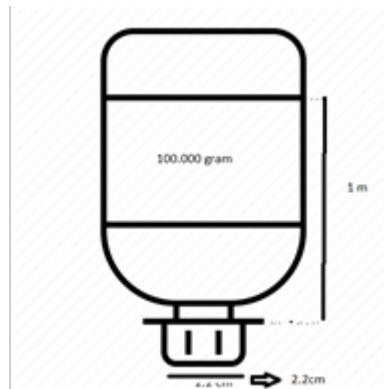
$$4. T = \frac{Q_t}{Q_{time}}$$

Use Formula One :

$$P \cdot A = V^2 \cdot A \cdot Q$$

$$P = V^2 \cdot Q$$

$$100.000 P_a = 10 \text{ ml} = 1 \text{ bar}$$



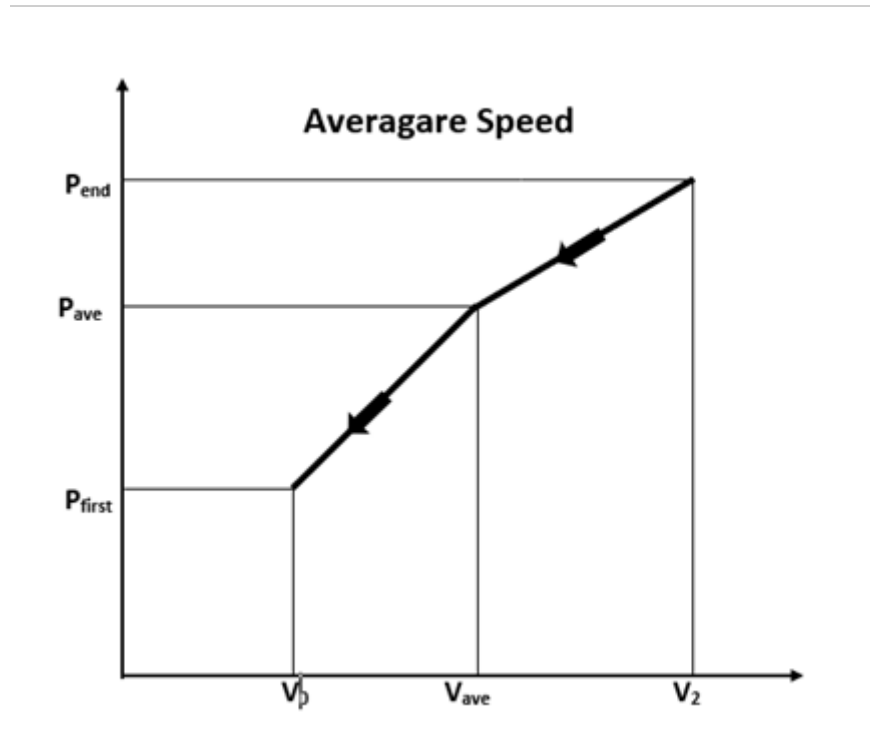
Here, 1 m = 10.000 Pa

$$10.000 = V^2 \cdot 1000 \quad V^2 = 10$$

$$V = 3,16 \text{ m/s}$$

$$\text{Spout Area} = A = \frac{\pi \cdot r^2}{4}$$

$$A = \frac{3.14 \times 0,022^2}{4} = 0.00032 \text{ m}^2$$



$$P_{ave} = \frac{P_{end} + P_0}{2} = \frac{10.000}{2} = 5000 \text{ Pa}$$

$$P_{ave} = V_{ave}^2 \cdot 1000$$

$$V_{ave}^2 = \frac{P_{ave}}{1000} = \frac{5000}{1000} = 5$$

$$V_{ave} = \sqrt{5} = 2,236 \text{ m/s}$$

$$Q_{debi} = 2,236 \times 0,00033 \times 1000^2 = 737 \text{ gram}$$

$$t = \frac{Q_t}{Q_{debi}} = \frac{100.000}{737} = 135.6$$

5. COMPARISON OF SOLUTIONS

In this section, we are comparing the solutions to other problems and in the development phase of the project.

- **Developing from Scratch**
- **Reuse**
- **Skip to Assembly Stage**

5.1. Comparison of Solutions:

5.1.1. Developing from Scratch

With exceptions, this solution requires a larger sum of starting capital in order to purchase raw materials for greenhouse, the electricals and the computer devices. A well-equipped and well-designed ergonomic workshop (with an inventory) for the development, production and testing of the product will also be required and the cost thereof will be additionally incurred. The skillset and experience of the team members poses the risk of exceeding time limitations for completion of the project. However the expected end-product would be a of high quality (total quality conforming).

5.1.2. Reuse

Reusing scrap, some refuse and 2nd hand parts, components or products seems to be the best cost effective option. This is so because all of the reusable items gathered would have been rendered free of charge and only the knowledge of the exact time it would take to find and assemble the freely available material would be a cause for concern, especially if reusable material cannot be sourced easily.

5.1.3. Skip to Assembly Stage

Purchasing of semi-finished and/or finished parts, components, systems, etc. is a solution which fits in almost perfectly with the skillset and time constraints of the team. Assembling (with simple to use and operate equipment and tools in a conducive room) is the only process which will be required and the time of development and design is shortened giving allowance for more time for testing and preparation (for the competition). The costs are favorable compared to the costs of developing from scratch.

6. REALISTIC CONSTRAINTS

6.1. Environmental Issues

The greenhouse effect is a natural phenomenon and is beneficial for us. Certain gases in the atmosphere retain part of the thermal radiation emitted by the Earth's surface after being heated by the sun, this maintains the planet's temperature at a level suitable for the development of life.

6.1.1. Impacts of the Smart Irrigation System on the environment

Environment destruction caused by humans is a global, ongoing problem. By the year 2050, the global human population is expected to grow by 2 billion people, thereby reaching a level of 9.6 billion people. The human effects on Earth can be seen in many different ways. Negative environmental impacts could have a serious effect on the investments in the irrigation sector. The impacts stem from the altered hydrological conditions caused by the installation and operation of the irrigation scheme. Unfortunately, Salinization is a worldwide problem that affects the physical and chemical properties of soil, leading to the loss of crop productivity.

Smart Irrigation systems powered by renewable energy sources (RES) have been proven to substantially improve crop yield and the profitability of agriculture. Irrigation is the process of applying controlled amounts of water to plants at needed intervals. Irrigation helps to grow agricultural crops, maintain landscapes, and revegetate disturbed soils in dry areas and during periods of less than average rainfall. Much effort in water resource management is directed at optimizing the use of water and in minimizing the environmental impact of water use on the natural environment. Water and food are two of the most important commodities in the world, which makes agriculture crucial to mankind as it utilizes water (irrigation) to provide

us with food. Climate change and a rapid increase in population have put a lot of pressure on agriculture which has a snowball effect on the earth's water resource, which has been proven to be crucial for sustainable development. The need to do away with fossil fuel in powering irrigation systems cannot be over emphasized due to climate change. Therefore, we have built this system based on the renewable energy sources.

6.1.2. Hydrological conditions

Hydrology is the scientific study of the movement, distribution, and management of water on Earth and other planets, including the water cycle, water resources and environmental watershed sustainability. A practitioner of hydrology is called a hydrologist. Hydrologists are scientists studying earth or environmental science, civil or environmental engineering and physical geography. Using various analytical methods and scientific techniques, they collect and analyse data to help solve water related problems such as environmental preservation, natural disasters, and water management. Therefore, we studied some hydrological conditions within the water management on our project then we came up with the sensors that detect the soil's dryness to manage the water levels in the field, which keeps the soil under good controlled circumstances. Controlling the irrigation levels prevent the field's soil from salinization or root and turf diseases. A type of irrigation is the surface irrigation that includes potential overwatering and wasteful runoff. If soil lacks proper sloping or doesn't absorb readily, water can't move through the field. Standing water damages plants and reduces yields for edible crops.

6.1.3. Salinization

Salt in soils decreases the osmotic potential of the soil so that plants can't take up water from it. Salinization is a prevalent environmental hazard, posing serious socio-economic and environmental implications. Current estimations of the proportion of salt-affected soils in irrigated lands for several countries are 20% for Australia, 27% for India, 28% for Pakistan, 50% for Iraq, and 30% for Egypt. Soils can become sodic, sodic soils present particular challenges because they tend to have very poor structure which limits or prevents water infiltration and drainage, this could occur when the salt (Na^+) levels increase in the soil's characteristics. Salinity from irrigation can occur over time wherever irrigation occurs, since almost all water (even natural rainfall) contains some dissolved salts. When the plants use the water, the salts are left behind in the soil and eventually begin to accumulate. Therefore, managing a smart irrigation system can solve the salinization's impact on the soil.

Leaching with irrigation water of dissolved substances, notably salt, in the soil is described depending on the hydrological regime and the soil's properties, which can be handled by a hydrological model (leaching model). The leaching process in a salty soil to be reclaimed is illustrated in the leaching curves derived from a particular data.

6.1.4. Climate changes

Climate change can affect soil functions both directly and indirectly. Direct effects include temperature, precipitation, and moisture regime changes. Indirect effects include those that are induced by adaptations such as irrigation, crop rotation changes, and tillage practices. The impact of climate change on soil moisture could push the land past a tipping point turning it from a net carbon sink to a source of CO₂. Levels of soil moisture, which are impacted by rising temperatures and extreme events such as droughts, can have a large negative influence on the land's ability to store carbon. Usually, increased CO₂ levels in the atmosphere bolsters the growth and, therefore, carbon uptake of plants. Plants lose water when they perform photosynthesis. Because of that many species stop when water supplies are depleted, meaning they are not taking in carbon anymore. The loss of water during photosynthesis is called "transpiration" and it has a cooling effect on the surrounding environment. As a result, when it is dry and transpiration stops, it can result in warming temperatures. Warming temperatures increase rates of respiration the loss of carbon from soil and vegetation.

6.1.5. Groundwater mining with wells, land subsidence

When more groundwater is pumped from wells than replenished, storage of water in the aquifer is being mined and the use of that water is no longer sustainable. As levels fail, it becomes more difficult to extract water and pumps will struggle to maintain the design flow rate and consume more energy per unit of water. Eventually it may become so difficult to extract groundwater that farmers may be forced to abandon irrigated agriculture. As the groundwater is pumped out, the effective stress changes, precipitating consolidation, which is often non-reversible. The subsidence (or the sinking) of land resulting from groundwater extraction. It is a growing problem in the developing world as cities increase in population and water use, without adequate pumping regulation and enforcement. Our project helps the environment by giving the soil its exact need of water neither less nor more amount. More water consuming is determined more water saved to use in other proper place without the need of

more wells to be built for more groundwater mining or extracting groundwater which cause the land subsidence.

6.1.6. Lost land use opportunities

Irrigation projects may reduce the fishing opportunities of the original population and the grazing opportunities for cattle. The livestock pressure on the remaining lands may increase considerably because the ousted traditional pastoralist tribes will have to find their subsistence and existence elsewhere, overgrazing may increase, followed by serious soil erosion and the loss of natural resources. Downstream water users often have no legal water rights and may fall victim of the development of irrigation. Pastoralists and nomadic tribes may find their land and water resources blocked by new irrigation developments without having a legal recourse. Flood-recession cropping may be seriously affected by the upstream interception of river water for irrigation purposes. For example, After the closure of the Kainji dam, Nigeria, 50 to 70 per cent of the downstream area of flood-recession cropping was lost, which was hurting the water resource in the area caused by the Pastoralists and nomadic tribes.

6.1.7. Water-borne and water-related diseases

Water-borne or water-related diseases are commonly associated with the introduction of irrigation. The diseases most directly linked with irrigation are malaria, bilharzia (schistosomiasis) and river blindness (onchocerciasis), whose vectors proliferate in the irrigation waters. They occur if soil drainage is poor, drainage canals are either absent, badly designed and/or maintained, also when canals are unlined and have unchecked vegetation growth more diseases can come up. Other irrigation-related health risks include those associated with increased use of agrochemicals, deterioration of water quality, and increased population pressure in the area. The reuse of wastewater for irrigation has the potential, depending on the extent of treatment, of transmitting communicable diseases. The population groups at risk include agricultural workers, consumers of crops and meat from the wastewater-irrigated fields, and people living nearby. Our smart irrigation system can protect humanity from these diseases because of the sensors that detect the soil needs by itself to save work for humans like checking the soil if it is in good conditions or needs fertilizing.

6.1.8. Dams and Reservoir

The benefits of a dam project are flood control and the provision of a more reliable and higher quality water supply for irrigation, domestic and industrial use. Intensification of agriculture locally through irrigation can reduce pressure on uncleared forest lands, intact wildlife habitat and marginal agricultural land. While though there are direct environmental impacts associated with the construction of the dam or the reservoir (for example dust, erosion, borrow and disposal problems), the greatest impacts result from the impoundment of water, flooding of land to form the reservoir and alteration of water flow downstream. These effects have direct impacts on soils, vegetation, wildlife and wildlands, fisheries, climate and especially the human populations in the area. Increased pressure on upland areas above the dam is a common phenomenon caused by the resettlement of people from the inundated areas and by the uncontrolled influx of newcomers into the basin catchment. On-site environmental deterioration as well as a decrease in water quality and increase in sedimentation rates in the reservoir result from clearing of forest land for agriculture, grazing pressures, use of agricultural chemicals, and tree cutting for timber or fuelwood.

6.2. Sustainability

Greenhouse systems improve growing conditions of vegetable, fruit and ornamental crops. Greenhouse coverage protects plants from adverse atmospheric agents and, together with suitable equipment, influences and ultimately modifies the crop microclimate, thus lengthening the market availability of the products, improving their quality and allowing higher yields.

Greenhouse production has a higher return per unit area than crops grown in the open field, but it requires the use of large amounts of energy to operate the equipment on one hand and generates huge quantities of wastes to be disposed of on the other hand. Protected cultivation can be environmentally unfriendly, especially in areas with a large concentration of greenhouses. Therefore, the steady worldwide increase in the area covered by greenhouses has generated the need for developing sustainable protected horticulture. Sustainable greenhouse horticulture can be achieved by means of different cultivation techniques, adequate equipment management and innovative materials aimed to reduce agro-chemicals and energy use, water consumption and waste generation.

6.3. Ethics Issues

The 17th Conference of the Parties to the United Nations Convention on Climate Change (COP17) concluded in December 2011, in Durban, South Africa, two days late, after two

weeks of negotiations. What ultimately emerged was a further voluntary commitment period for the Kyoto Protocol international instrument that sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emissions, and expires in 2012—and more significantly, the Durban Platform for Enhanced Action. This is an agreement that commits governments to developing a protocol, legal instrument, or an agreed outcome to cut greenhouse gas (GHG) emissions with legal force applicable to all countries by no later than 2015, under the United Nations Framework Convention on Climate Change (UNFCCC), to be implemented from 2020.

6.4. Health and Safety Issues

Greenhouse gases have far-ranging environmental and health effects. They cause climate change by trapping heat, and they also contribute to respiratory disease from smog and air pollution. Extreme weather, food supply disruptions, and increased wildfires are other effects of climate change caused by greenhouse gases. The typical weather patterns we've grown to expect will change; some species will disappear; others will migrate or grow.

6.5. Social and Political Issues

Cap and trade and its close cousin a carbon tax are the approaches that most economists favour for reducing greenhouse gas emissions. These market-based approaches work by creating incentives for businesses and households to conserve energy, improve energy efficiency, and adopt clean-energy technologies — without prescribing the precise actions they should take. A market-based approach that “puts a price on carbon” is likely to be more cost-effective (i.e., achieve a given emissions target at a lower cost) than the traditional “command-and-control” approach of government regulation.

Social costs of greenhouse gases; scientific studies show that climate change will have, and in some cases has already had, severe consequences for society, like the spread of disease, increased food insecurity, and coastal destruction.

6.5.1 Socio-economic impacts irrigation schemes

Increase agricultural production and consequently to improve the economic and social well-being of the rural population is the objective of irrigation projects. However, changing land use patterns may have other impacts on social and economic structure of the project area. Small plots, communal land use rights, and conflicting traditional and legal land rights all

create difficulties when land is converted to irrigate agriculture. Irrigation projects tend to encourage population densities to increase, either because of the increased production of the area or because they are part of a resettlement project. The most significant issue arising from large dam construction is resettlement of people displaced by the flooding of land and homes. This can be particularly disruptive to communities and insensitive project development would cause unnecessary problems by lack of inadequate compensation of the affected population. Groups living around the construction that use common land to make their living or fulfill their household duties, for example for charcoal making, hunting, grazing, collecting fuel wood, growing vegetables, etc. may be disadvantaged if that same land is taken over for irrigated agriculture or for building irrigation infrastructure.

6.6. Legal Consequences

This article presents the empirical facts, reasoned predictions, and potential forms of reaction concerning the greenhouse effect. The authors trace how the considerations regarding solutions to the greenhouse effect evolved from a scientific to the political form. The article then examines how the probable response to the greenhouse effect will require an unparalleled commitment of resources by the United States government and how the greenhouse effect will have global ramifications requiring a global approach to the problem.

- **Alternatives exist to mitigate adverse effects of irrigation development. Some of them are listed below:**
 - ✓ Locating the irrigation project on the site where negative impacts are minimized.
 - ✓ Improving the efficiency of existing projects and restoring degraded croplands to use rather than establishing a new irrigation project.
 - ✓ Developing small-scale, individually-owned irrigation systems as an alternative to large-scale, publicly-owned and managed schemes.
 - ✓ Using sprinkler irrigation and micro-irrigation systems to decrease the risk of water-logging, erosion and inefficient water use.
 - ✓ Maintaining flood flows downstream of the dams to ensure that an adequate area is flooded each year, among other reasons, for fishery activities.

7. CONCLUSION

- It has not achieved its modern identity.
- Greenhouses with advanced systems and modern systems are very few in our country.
- A large number is available. In particular, the indoor air temperature and humidity of the sera uncontrollable causes bad results. To increase plant productivity
- The important criterion is to capture the optimum growing temperature and humidity.
- This environment prototype is suitable for indoor climate conditions against the effects of external environment in a greenhouse.
- Availability of simple devices and remote-control irrigation system was investigated by using. Apparatus used in the study with appropriate use nothing about small arrangements in greenhouses without automation.
- It is a system that can be used easily in greenhouses which can be used newly.

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9. APPENDICES

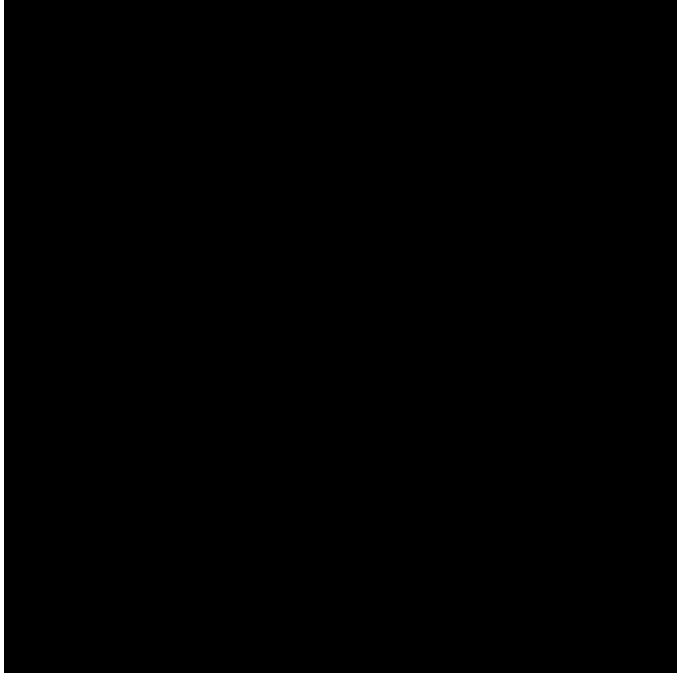
Appendix 1: Table of Cost Analysis

3 = MOST FAVORABLE, 2 = NO MOST & NOT LEAST, 1 =LEAST FAVORABLE

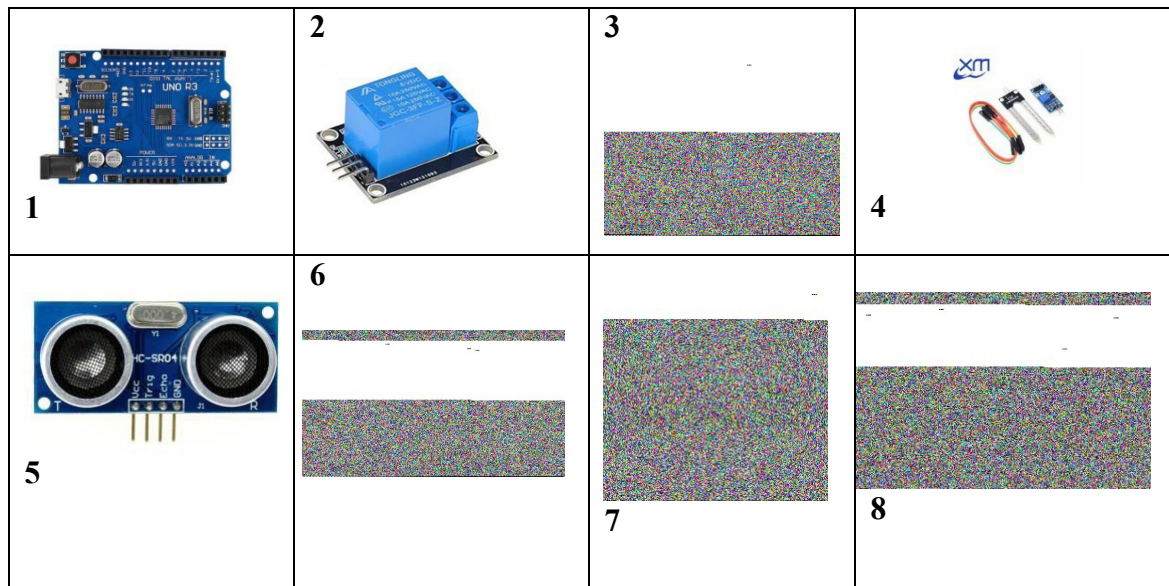
| | DEVELOP FROM SCRATCH | REUSE (SCRAP, REFUSE, 2 ND HAND) | SKIP TO ASSEM- BLY STAGE |
|-----------------|-------------------------|---|-----------------------------|
| COST (estimate) | 1 | 3 | 2 |
| SKILLSET | 1 | 2 | 3 |
| TIME | 1 | 2 | 3 |
| TOTAL | 3 | 7 | 8 |

| | DEVELOP FROM SCRATCH | REUSE (SCRAP, REFUSE, 2 ND HAND) | SKIP TO ASSEM- BLY STAGE |
|-----------------------|-------------------------|---|-----------------------------|
| MARKET ANALY- SIS | 1 | 3 | 2 |
| TECHNICAL ANALYSIS | 1 | 3 | 2 |
| FINANCIAL ANALYSIS | 1 | 3 | 2 |
| TOTAL | 3 | 9 | 6 |

Appendix 2: Ardunio Controls Table



Appendix 3: Figure of Ardunio Control Images



Appendix 4: Functions of The System

