Journal
of the
Oriental Institute
M.S. University of Baroda
ISSN: 0030-5324

E-AGRICULTURE USING RASPBERRY PI

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Target Files

Abstract-

***T**he Present final project offers sensors-different types of industries. Figure (2) illustrates that there is a general tendency to create connected based solutions according to the cheapening of minicomputers and in line with the recent spreading of IOT (internet of things) technologies. The main application field covered is smart agriculture, where sophisticated system that sense environmental conditions and trigger output devices, usually with object on industrial control purpose, are being studied and even implanted nowadays. For this reason, consequently, a prototype has been designed.

CHAPTER 1:

INTRODUCTION

According to tendency information found at statista.com [1], is also clear an exponential increase in the number of devices related to IOT, as figure [1] shows, which obviously means there is a new global market generated over this idea.

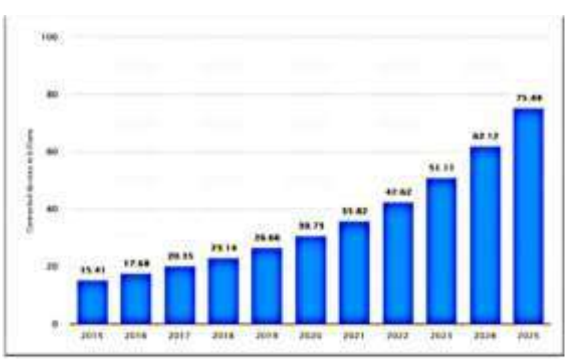


Figure 1. IOT increasing tendency

IOT may even now cover many of the every- day issues and it is also increasing its presence insystems, where information is shared among devices and their states arechanges continuously. It is also possible that a register stores activity data in a local or cloud database

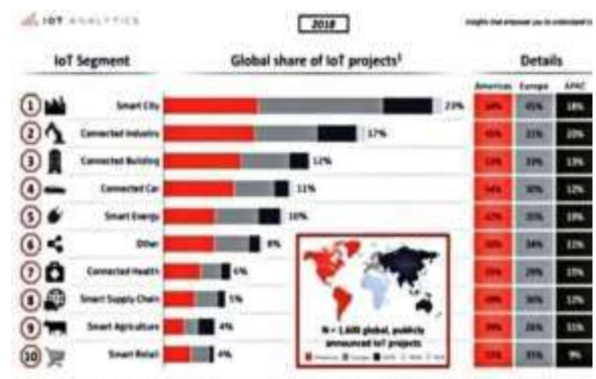
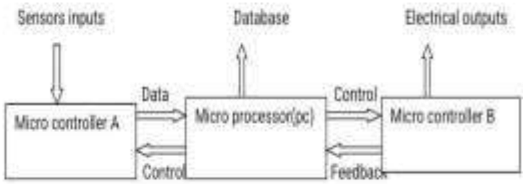


Figure 2. IOT Global Dispersion

In general view, there is an evident dominance of this kind of industries on more-developed areas. Where APC (Asia- Pacific), followed by MEA (middle east and Africa), contributions much less to global statistics. It is also remarkable the unbalanced distribution of sectors over the global, especially on focus over the differences between America and Europe.

motivation and requirements of the prototype

In short, Smart Agriculture refers to several procedures and techniques that check the plants' state



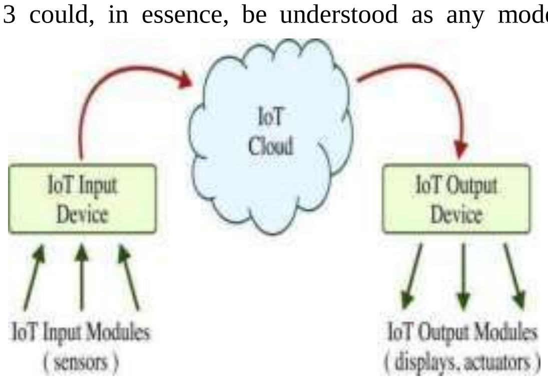
and environmental characteristics, in order to ensure they grow and are kept in the best possible conditions -usually, also in the fewer time-, by means of sensors and automated processes. The present work is, therefore, inspired under the conviction that industrial processes could get benefit of using more refined control systems and, particularly, that there is an upward tendency of growing plants under an enclosed climate where organic matter, chemical products and electrical resources needs to be optimized, all which requires a specific tracing based on indicators throughout the whole life of a plant. Although detailed information about those indicators may be offered later, for now it could be assumed that soil, climate and water pH conditions will be considered. in order to ensure they grow and are kept in the best possible conditions -usually, also in the fewer time-, by means of sensors and automated processes. The present work

CHAPTER 2:

STATE OF ART

IOT Technologies and Applications in Autonomous Systems

The simplified diagram of an IOT system shown in Figure
3 could, in essence, be understood as any modern



telecommunication system:

Figure 3. IOT Typical Flow

There are input elements; a processing unit that receives information; and output devices to be triggered. However, the IOT approach focuses much more on achieving the previous configuration by means of network connectivity, whose data processing is usually coordinated under a master control and/or a big data processor.

Figure 4. Block Diagram

Analysis to the State of Art

After the previous information, it should be clear that IOT technologies may in essence share the main purpose of control systems' technologies, but change drastically on the user experience, offering new command ways such as remote or voice control and also an elegant information presentation. Therefore, providing an easy user interaction and clear output results are indispensable requirements for IOT future systems. Therefore, information processing should be carefully designed. It is necessary to state the difference between autonomous and smart devices and the scope of the prototype.

CHAPTER 3:

SELECTION OF COMPONENTS AND SENSORS

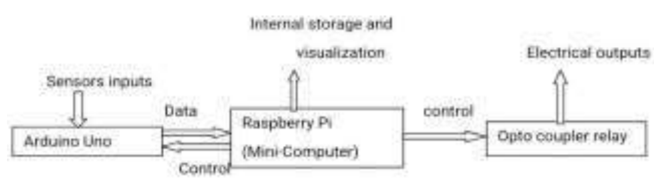


Figure 5: block diagram

This project uses both digital and analog sensors, which will be connected to the Raspberry Pi mini-computer and to the Arduino Uno microcontroller, respectively. It is also remarkable to understand that in the present design Arduino transmits its analog sensors' information via serial communication to the Raspberry Pi, so that it processes all the data and switches the output devices consequently.

On another perspective, Raspberry Pi also runs the following network services:

1. MQTT server(broker), to forward data to wireless devices

2. Surveillance camera server, as a security functionality

3. Remote connection, to control raspberry pi over the internet

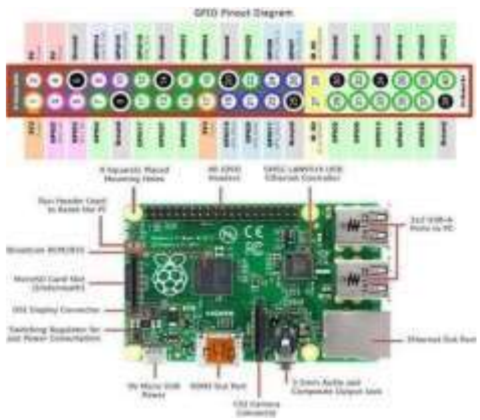


Figure 6. Raspberry Pi 3 B+ - Pinout

Main System Electrical Characteristics:

This section tries to sum up the considerations that have influenced design decisions as well as give a very brief understanding of Raspberry Pi GPIO structure. The main target is to define how to prevent over voltages and keep the working under nominal values. It could be summarizedas

• If a GPIO is configurated as output, it will never demand
>16mA. The reason for this is that the current is drawn from the 3.3V supply, whose limitation is 50mA, shared for all 3.3 connections. In other words, it may draw no more(>50mA) from the +3.3 V supply

• Pins 3 and 5 use pull-ups (1.8k ohm). These affect thesystem, as

• they drive 12C. communication that will be used in thepressure sensor sndand in the LCD

SOIL SENSING

The importance of soil sensors in Smart Agriculture is such that, even though there is just one type ofsensor of this type, which may work under the two different physical principles exposed afterwards, it needed a specific section for its consideration. Soil sensors suppose one of the first sensing in the humanity history. Although new technology in this field proposes more elaborated techniques, the most simple and effective solution for a low cost system consists still on a simple sensor that needs to be put into the water, fluid or soil to be measured and a sample of its voltage change. Soil Moisture During the design period an analog soil sensor based on resistance principle was used (see Figure11 [6]).

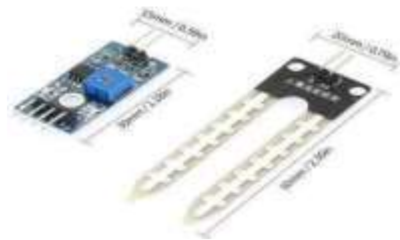


Figure 3.3 Resistance Soil Moisture Sensor

This device is usually sold with a probe (right element in theFigure
11), which is the sensor itself, and a small circuit (left element in Figure 11) that feeds the probe with current and provides an analog output as well as a digital one, whose value is compared to a threshold controlled by the blue potentiometer

CLIMATE SENSING:

The next category includes all the sensors that may be used in order to register environmental conditions. They could perfectly be used in an industrial control system. Environmental Humidity and Temperature These two parameters are obtained thanks to a small sensor named DHT22 it needed a place in this exposition. Contrary to the previous types, gas sensors usually perceive not only the main element, but also, in a smaller proportion, other compounds. For simplicity, it could be assumed there is only one main component to be detected by these devices. Initially some gas sensors, all of the MQ family in order to satisfy the low- price requirement, were studied.

Figure 3.4 DHT22 Sensor (left) Figure 16. DHT11 Sensor (right)

Gas:

Although this sensor has no implementation in the present prototype, it neededa place in this exposition. Contrary to the previous types, gas sensors usually perceive not only the main element, but also, in a smaller proportion, other compounds. For simplicity, it could be assumed there is only one main component to be detected by these devices. Initially some gas sensors, all of the MQ family [23] in order to satisfy the low-price requirement, were studied. For instance, MQ2 was sensitive to LP gas and propane, while MQ3 responds to alcohol and MQ7 to carbon dioxide.

Figure 3.5 Gas Sensor MQ135

Light:

An analog candidate was proposed for the aluminic sensor. The option proposed was selected for two main reasons: its behaviour is simple, as it uses mainly a photoresistor component and it responds

Figure 3.6 Light Sensor

In this measurement, there were no other sensors considered, both because they all were based on this same photoreaction, under a similar range of price, and also due

CHAPTER 4:ELECTRICAL CONNECTIONS AND OUTPUTS

electrical connections:

The present chapter includes all the information that refers to the activation of output devices in the prototype. It also required a dedicated place according to its place in the flow. According to a general abstraction, it represents all the terminal devices to be.

Electrical Diagram

According to the previous information, it is clear that the element that triggers the outputs in this system is the optocoupler relay, but it also needs power feed and GPIO signal from Raspberry Pi or ESP32. As it can be understood, this example prefers 5V as VCC and uses only one GPIO, set as output. As it was explained Criticism to the State of Art, this project uses the Alexa voice-assistant. Currently there are manyfunctionalities and compatible devices to Alexa, which also justifies its inclusion in the project. The model selected is the Amazon Echo Dot (2nd generation) [32], because it is able to process English instructions. On the contrary, 3rd generation, at least in Spain, only respond to commands in Spanish.signals.

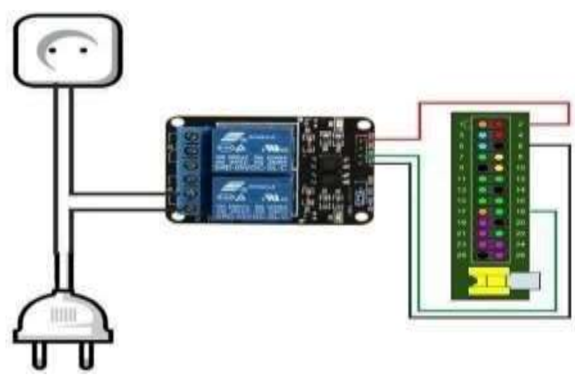


Figure 4.2 Optocoupler Relay Basic Circuit

CHAPTER 5: SYSTEM DESIGN

5.1 Arduino Sensing:

The context of this section is that the prototype required both analog and digital sensors whose data is processed by the Raspberry Pi. According to the information provided in previous chapters, the digital sensors could directly be linked to the mini-computer. However, Raspberry Pi’s GPIO do not support analog signals.

CHAPTER 6:

ANDROID APP AND MQTT PROTOCOL SERVER

MQTT General Idea:

Message Queuing Telemetry Transport is a protocol that allows to send mostly short messages inside a network. Four main concepts play an important role, summarised here: MQTT broker: It is the MQTT server that distributes the messages. Topic: Each of the categories whose

Mosquito:

Mqtt server configuration Eclipse Mosquito implements the MQTT protocol in a lightweight way. For this reason and due to its simple installation it is used in this proposal. In order to have an idea of how light a MQTT message could be, it could be considered the following composition: 2-bytes obligatory header, 4-bits optative header and, under usual conditions, 2-4kB of payload. It is clear, therefore, that MQTT could be able to communicate under low bandwidth scenarios and be compatible to devices with limited computational resources. As for the configuration, it is absolutely recommended to use a password to protect the topics.

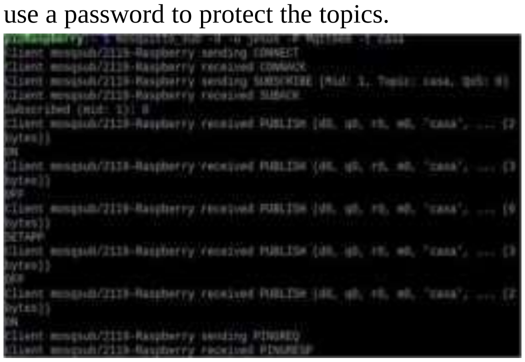


Figure 6.2 Mosquito Subscribe Example

CHAPTER 7:

PLANNING AND TESTS

Design Stages and Results:

The design of this whole Final Project has not been linear, reason for which the present exposition tries to

be as understandable as possible. It is clear that many sections interconnect and that alternative options are explained as well as those that belong to the Smart Agriculture Prototype. The following lines summarize the whole process. The original idea was to create a simple irrigation system, which is by itself not a new concept. Initially it was thought that a periodical activation of a water pump would be enough.

Modular Integration Idea:

This Final Project offers a new model of product based on independent modules that required a progressive integration and continuous testing. For this reason, each of the sensors that compose the Smart Agriculture Prototype, as well as those that have been

Planning:

According to this Degree program, the Final Project should represent at least 360 hours of work. This project extends further than that due to constant research that was hardly affordable to be done all at once at the very beginning. Moreover, the modular integration implies that a certain sensor’s functions may be implemented to the main code while some other sensor may be studied on its theoretical terms. Nevertheless, with purpose on a global understanding. At this point, an important decision was taken in this project: Raspberry Pi will receive digital sensors (ie. DHT22) and, via serial communication, it will ask Arduino for its analog readings (ie. soil sensors). Therefore, IOT technologies apply here. They play an important role in the project on, first, connecting wireless devices and providing an alternative method to turn on actuators by means of ESP32; and, second, on allowing a user-control by means of an Android app that simplifies the ON/OFF messages in the MQTT network

CHAPTER 8:
BUDGET FOR IOT SOLUTIONS AND LAW

Services according to Requirements

According to the information provided in the present paper, it is clear that many options are offered and each one have required a certain amount of time, technological resources and, if used under commercial uses, needs a different money retribution.

Base products:

Purely Wired: It is the most studied solution.

Hybrid: Sensors or actuators may communicate wireless. It requires MQTT server configuration.

Wireless Sensors and actuators communicate wireless. It requires MQTT server configuration. Moreover, there are extra services that

increase the total cost of particular option: Large number of sensors required: If code needs modification there should be a cost increase. It is

currently able to work for 10 different sensors. Historical record, via Thingspeak Private security camera, via Motion Remote connectivity option, via No-Ip. Total product: Base product + Extra Service(s) As an example, a Purely Wired option for sensors' control increases its cost if also it needs to be remotelycontrolled. IOT Technologies:

MQTT server configuration: Needed for every wireless solutionand included in Hybrid and Wireless options

1-point IOT demotic system: ESP32. May or not be compatible with Alexa

N-point IOT demotic system: ESP32. May or not be compatible with Alexa iv. Stapp Android App: Outputs are controlled via anAndroid device

Socio-economic Summary The next information is stated in order to abstract the whole socio-economic environment studied along the different sections of this project.

Regulatory Framework and Law

The Smart Agriculture Prototype and any IOT based solutions need to follow several commercialization rules.

Figure 8.3 Raspberry Pi Visual Identity

CHAPTER 9:

CONCLUSIONS

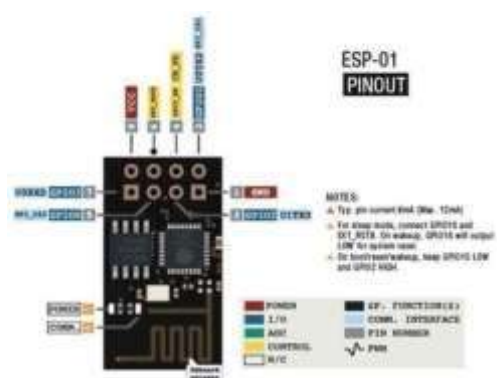
Adversities during the Project:

The project was initially conceived for a smaller system, for which a 16 GB SD was thought to be enough However, Raspbian installation and the described modules finally required a migration to a 32 GB card in order to continue working with no compromise on the fluency of the Raspberry Pi. It is also remarkable the discarded option of the ESP01-S. This device belongs to the ESP8266 family, as well as the ESP32 does, and was the first wireless option to be It only offers 2 GPIO (extensible to 4) but it appeared to have many drawbacks

Figure 9.1.1 ESP 01 Pinout

Future As a prototype:

The Smart Agriculture project may propose only a coarse approximation to the actual industry methods



and considers little interconnection between the different sensors'

data, which could provide very useful information. For this reason, the first line of future improvements is using big data analysis in order to understand better how sensors interact. It is also possible to use this approach to find

9.2 Future As a prototype:

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