IoT Based Smart Crop Protection System for Agriculture

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that the project report for **"IoT Based Smart Crop Protection System for Agriculture"** is the bonafide work of "**Nivedha M S, Adalin V, Dafni Leenel N L, Jina J S, Divya V"** who carried out the project work under my supervision.

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1. INTRODUCTION

1.a. PROJECT OVERVIEW

Crop damage caused by animal attacks is one of the major threats in reducing the crop yield. Due to the expansion of cultivated land into previous wildlife habitat, crop raiding is becoming one of the most conflicts antagonizing human- wildlife relationships [1]. With a population of more than200,000 wild boars (Sus scrofa) and 300,000 deer in the region of Tuscany alone in Italy, being estimated to be four times more than any other region in Italy, there is an increasing damage of vineyards and farm lands that has resulted in a huge drop in wine production. According to annual production loss in the wine industry is estimated at 130,000bottles of wine, which amounts to the range of 8,962,250-13,036,000 euros, with an annual cost to the government estimated around 2.5million euro per year. In addition to crop damages, up to 1000 road accidents are also caused by these wild animals annually.

Wildlife tracking involves acquiring information about the behavior of animals in their natural habitat. This information is used both for scientific and conservation purposes. The primary form of information that needs to be
obtained is the location of the animal at certain points in time and this is generally referred to as tracking or radio-tracking. However, due to the
similarities in obtaining the information, the terms are frequently used
interchangeably. There are remote methods that can be used to track and
identify animals visually and through acoustic signals.

The current methods used to counter this problem include the use of electrified welded mesh fences (usually 30cm in the ground), chemicals or organic subtances and gas cannons. Other traditional methods applied by farmers include the use of Hellikites, Balloons, Shot/Gas guns, String & stone, etc. These solutions are often cruel and ineffective. They also require a vast amount of installation and maintenance cost and some of the methods have environmental pollution etlect on both humans and animals. On the other hand, the chemical products used to prevent these animal attacks have an application cost per hectare and their effectiveness is dependent on weather conditon, as rain may cause a dilution effect. Technology assistance at various stages of agricultural processes can significantly enhance the crop yield. Sensor networks express a substantial improvement over traditional invasive methods of monitoring. Our proposed method is bascd on an animal

friendly ultrasounds generator, which does not produce physical or biological harm to the animals nor sounds audible to humans.

Moreover, in agriculture and especially in wine production, very small changes. In the micro climate can impact the quality of the product. It is vital for agronomists to have a clear view of the meteorological conditions in a very small area of the entire territory usually characterized by very different soil characteristics. Diseases such as Bunch-rot" Botrytis cinerea" and Peronospora in vineyards can be prevented by an hourly monitoring of the plant and by providing timely based required treatment to the plant. Based on the above problems, a complete system that will both protect and monitor a vineyard is of significant importance.

1.a.1. Agriculture

Agriculture is the art and science of cultivating the soil, growing crops
and raising livestock. It includes the preparation of plant and animal products for people to use and their distribution to markets. Agriculture provides most of the world's food and fabrics. Cotton, wool, and leather are all agricultural products. Agriculture also provides wood for construction and paper products. These products, as well as the agricultural methods used may vary from one part of the world to another.

1.a.2 Start of Agricuture

Over centuries, the growth of agriculture contributed to the rise of civilzations. Before agriculture became widespread, people spent most of their lives searchng for food-hunting wild animals and gathering wild plants. About 11,500 years ago, People gradually learned how to grow cereal and root crops,and settled down to a life based on farming. By 2,000 years ago, much of Earth's population had become dependent on agriculture. Scholars are not sure why this shift to farming took place, but it may have occurred because of climate change. When people began growing crops, they also began herding and breeding wild animals. Adapting wild plants and animals for people to use is called domestication.

The first domesticated plant was probably rice or corn. Chinese farmers were cultivating rice as early as 7500 BCE. The first domesticated animais were dogs, which were used for hunting. Sheep and goats were probably domesticated next. People also domesticated cattle and pigs. Most of these animals had once been hunted for hides and meat. Now many of them are also sources of milk, Cheese, and butter. Eventually, people used domesticated animals such as Oxen for plowing. pulling, and transportation.

Agriculture enabled people to produce surplus food. They could use this extra food when crops failed or trade it for Other goods. Food surpluses allowed people to work at other tasks unrelated to farming. Agriculture kept formerly nomadic people near their fields and led to the development of permanent villages. These because linked through trade. New economies were so successful in some areas that cities grew and civilizations developed.

The earliest civilizalions based on intensive agriculture arose near the Tigris and Euphrates Rivers in Mesopotamia (now Iraq and Iran) and along the Nile River in Egypt.

1.a.3 Agricultural Significance

Agriculture has always been accorded an important position in the Indian society. Agiculture in lndia was incomparable with other countries. But due to education system and modernization our traditional agriculture system has decayed. Due to this the economy of our country has got declined with increase in poverty and malnutrition. Thus, lndian agriculture requires Sophistication in farming and maintaining the field so that people with other business and dwelling in other place also can control and maintain the field with the help of internet. In our proposed system it is made possible with the heip of sensors such as humidity sensor which checks the humidity ol soil which gathers data,

according to the threshold value i.e. if value is low, water is sprinkled if value is high, irrigation is not required at present. Same way temperature sensor, water level indicator sensor and animal detection sensor is used. The reading that is gathered is stored continuously and then an alert is sent to the owner of the field when required. Precision farming clinches swift time responses to dreadful environmental and Weather forecasting issues with efficient controlling capacity for production and reduced labor machination. This arrangement of highly self directing agricultural system requires Vigorous sensing at the field and fleeting communication in the air for the information transmission is necessary. The prominent and advanced features of computational gathering of data, self decision making ability and the controlling of the vivacious factors of the farm is highly required for increasing the production value of our country and for the development and enormous magnification of our motherland. The variegated sections of smart agricultural field are as follows,

- Observing agricultural circumstances
- Recognition of sensing whereabouts and data assembling
- Fetching data from crop field and directing it to the control station
- Message alert and steering action based on the sensed data values

The pesticide dosage reduction is addressed by means of an innovative combination of the wireless sensor system. The proposed solution introduces the estimation of the spatial distribution of the optimal dosage. The attention to the environmental sustainability of agriculture and to the reduction of pesticide use for organic cultivation is rapidly increasing. However, the efficieney constraints of the mass production require the minimization of yield losses due to infections. New disease control strategies are required to find the best tradeoff between economic and environmental aspects.

1. b. Purpose of Smart Agriculture

In smart villages, access to sustainable energy services acts as a catalyst
for development. Enabling facility of internet connection for the new possibilities of increasing agricultural cultivation with proper information and guidance, access to clean water, sanitation and nutrition, of a country depends on the village's development. Most of the agriculture productivity suffer greatly with unforeseen change in climate. Therefore, farmers need to get appropriate o formation's if any sudden climate disruption occur, it should notify on time to avoid any major damage in agricultural field. As part of the smart village concept, an intelligent system is designed that may help a farmer to get basic facilities/ infrastructure by agricultural development. Here an intelligent system is proposed on the fact of farmers getting all relevant details about the improvement in feriilization of soil and agriculture by delivering climate change information's through an IoT (lnternet of Things) devices. These information's could be handled through website and mobile phones. To ease for farmer understandings all the facts and information related to soil fertilization and climatic alerts are delivered as per their native language / language of their interest. This system may help its members to collaborate and take it to another level of requirement in improving their production capacity. These IoT devices are operated either through solar panel or electric supply appropriately to balance the power requirement across the field. Agriculture is the essential wellspring of work of individuals in our country. In past decade, it is watched there isn't much product improvement in agribusiness part. Nourishment costs are

ceaselessly expanding in light of the fact that harvest rate is declined pushed more than 40 million individuals into destitution since 2010. There are number of variables which are in charge of this, it might be because of water squander, low soil richness, compost manhandle, environmental change of infections, and so forth. It is extremely fundamental to make successful mediation in agribusiness and the arrangement is IoT in incorporation with Wireless sensor systems.

Internet of Things

In general, there is no accepted definition about the Internet of Things. Actually, there are many different groups of people that have defined the term, although its initial use has been attributed to an expert on digital innovation. A common idea in all the definitions that the first version of the Internet was about data created by human, while the next version is about data created by things, that's why it called Internet of things. There are many definitions for the Internet of Things. Below comes some of the definitions: loT was generally defined as "dynamic global network infrastructure with self-configuring capabilities based on standards and interoperable communication protocols; physical and virtual "things" in an loT have identities and attributes and are capable of using intelligent interfaces and being integrated as an information network.

The purpose of loT is to increase the functions of the first version of Internet and make it more useful. With loT, users can share both information provided by humans that contained in databases and also information provided by things in physical world. Describe the IoT as the connection of physical things to the Internet and to each other for various useful purposes through different intelligent technologies, creating smart ecosystem of pervasive computing. It can also be described as including embedded intelligence in individual objects that can notice changes in their physical state. The common definition of loT is that computers, sensors, and objects interact with each other and process data, therefore we can state that IoT is a new technology system combined of a number of information technologies. The Internet of Things combined different technologies into a semi-autonomous network. It connects individual devices to the network and to each other. There are also controller systems in the network (sofiware and services) that act as brains of the system for processing data by analyzing and using the data collected by the connected devices to make decisions and initiate actions from the same or other devices.

The central objective of IoT is to enable us to uniquely identify, signify, access and control things at anytime and anywhere by using internet. The interconnected device networks can result in a large number of intelligent and autonomous applications and services bringing significant personal,
professional, and economic benefits.

Smart environments are aimed to exploit rich combinations of small computational nodes to identily and deliver personalized services to the user while they interact and exchange information with the environment. loTs technology can be applicd to create smart homes in order to provide
intelligence, comfort and to improve the quality of our Iives. A "Smart home"
can be defined as a home which is automated through the application of the

Internet of Things technologies and capable of reacting to requirements of the inhabitants, providing they comfort, Security, safety and entertainment.

In the future, the I0T will anticipate to have significant home and business applications, improving the quality of life and the world's economy. With loT, it is possible to access and control the electrical devices installed in your house remotely anywhere and anytime in the world. For example, smart homes will enable their inhabitants to automatically open their garage when reaching home, prepare their coffee, control air conditioning system, smart TVs and other appliances inside the home. Smart devices and automation sytems make up Smart Homes. Everything connected with the help of Internet. Simple home automation uses timers and clocks to enable desired operations, but smart home technology can handle more complex operations and trigger devices based on input from other devices.

Wireless Technologies

Wireless technologies are very important for Internet of Things. For home automation solutions it is obvious that making wired connections to all devices is much more complex and harder to install. In this wireless technologies Wi-Fi, ZigBee and Bluetooth are used. Wireless technology is rapidly evolving, and is playing an increasing role in the lives of people throughout the world. In addition, ever-larger numbers of people are relying on the technology directly or indirectly.

Wireless Communication

Radio frequency as a technology is electromagnetic phenomena in spectrum between 3Hz and 300 GHz. With oversimplifying there are two physical components: transmitter and receiver. Between those radio waves is carrying information. The transmitter's main tasks are adding error correction code, i.e. encoding, and then input to a modulator, which maps the data to output waveforms. The receiver collects the signal and demodulates it and a channel decoder eliminates the errors. The receiver is left with a bit stream, which in this case stays in digital format. Wireless communication is the transfer of information or power between two or more points that are not connected by an electrical conductor. The most common wireless technologies use radio. With radio waves distances can be short, such as a few meters for television or as far as thousands or even millions of kilometers for deep-space radio communications. It encompasses various types of fixed, mobile, and portable applications, including two-way radios, cellular telephones, personal digital assistants (PDAs), and wireless networking. Other examples of applications of radio wireless technology include GPS units, garage door openers, wireless computer mice, keyboards and headsets, headphones, radio receivers, satellite television, broadcast television and cordless telephones. Wireless communication is among technology's biggest contributions to mankind. Wireless communication involves the transmission of information over a distance without help of wires, cables or any other forms of electrical conductors. The transmitted distance can be anywhere between a few meters and thousands of kilometers.

Objective

- The device will detect the animals and birds using the Clarifai service
- If any animal or bird is detected the image will be captured and stored in the IBM Cloud object storage.
- It also generates an alarm and avoid animals from destroying the crop
- The image URL will be stored in the IBM Cloudant DB service
- The device will also monitor the soil moisture levels, temperature, and humidity values and send them to the IBM IoT Platform
- The image will be retrieved from Object storage and displayed in the web application.
- A web application is developed to visualize the soil moisture, temperature, and humidity values
- Users can also control the motors through web applications.

To accomplish this, we have to complete all the activities and tasks listed below:

- Create and configure IBM Cloud Services
    - Create IBM Watson IoT Platform
    - Create a device & configure the IBM IoT Platform
    - Create Node-RED service
    - Create a database in Cloudant DB to store location data
    - Create a cloud object storage service and create a bucket to store the images
- Develop a python script to publish the sensor parameters like Temperature, Humidity, and Soil Moisture to the IBM IoT platform and detect the animals and birds in video streaming using Clarifai.
- Develop a web Application using Node-RED Service.
    - Display the image in the Node-RED web UI and also display the temperature, humidity, and soil moisture levels. Integrate the buttons in the UI to control the Motors and Lights.

2. LITERATURE SURVEY

Review on IoT in Agricultural Crop Protection and Power Generation:

Agriculture is that the science and artwork of cultivating plants. Agriculture performs most important position inside the economic development of our us of a and this can be the first occupation from a few years. so as to extend the productivity of the crops and to attenuate the expenses of agricultural practices we adopt smart agriculture techniques using IOT. The sensors are placed at different locations within the farm, by which the parameters is controlled using remote or through internet services and by interfacing the sensors operations are performed with microcontrollers. India is that the second most populated country. Power generation and supply is typically an unlimited problem. This paper mainly addresses power generation and rainwater harvesting as an influence generation method using energy together with crop protection.

IOT based smart crop monitoring in farm land:

As new technologies have been introduced and utilized in modern world, there is a need to bring advancement in the sector of agriculture also. Various Researches have been undergone to enhance crop cultivation and are widely used. So as to enhance the crop productivity efficiently, it is necessary to monitor the environmental conditions in and around the field. The parameters that have to be exact monitored to enhance the yield are soil characteristics, weather conditions, moisture, temperature, etc., Internet of Things (IOT) is being utilized in a number of real time applications. The introduction of Internet of thing (IOT) along with the sensor network in farming nourishes the traditional way of farming. Online crop monitoring the use of IOT helps the farmers to stay related to his subject from somewhere and anytime. Various sensors are used to screen and collect records about the area conditions. Collectively the about the farm circumstance is disbursed to the farmer thru GSM technology.

Development of IOT based Smart Security and Monitoring Devices for Agriculture:

Agriculture area being the backbone of the Indian economy deserves security. Security no longer in phrases of sources solely however additionally agricultural products wishes protection and safety at very preliminary stage, like protection from attacks of rodents or insects, in fields or grain stores. Such challenges should even be taken into consideration. Security systems which are getting used now a days don't seem to be smart enough to produce real time notification after sensing the matter. The mixture of typical methodology with present day technologies as Internet of Things and Wireless Sensor Networks can cause agricultural modernization. Keeping this scenario in our mind we've got designed tested and analysed an 'Internet of Things' based device which is capable of analysing the sensed information then transmitting it to the user. This gadget will be controlled and monitored from far off region and it is carried out in agricultural fields, grain shops and bloodless stores for protection purpose. This paper is oriented to

intensify the methods to unravel such problems like identification of rodents, threats to crops and turning in actual time notification spported records evaluation and processing besides human intervention.During this device, referred to sensors and digital units are built-in using Python scripts. Supported attempted take a look at cases, we had been capable to obtain success in 84.8% check cases.

2.a.Existing Problems:

Access to clean, reliable energy enables farmers and argibusinesses to increase food production and engage in value-added processing. It also allows farmers living I off-grid areas to replace expensive diesel generators with new and cleaner technologies, such as solar food dryers and solar water irrigation. The solar agricultural market is still in the early stages of development and barriers include the relatively high technology costs, limited awarness of the benefits, lack of appropriate policy incentives and limited access to finance for farmers and suppliers to make solar technologies more affordable.

We support enterprises that adopt, develop and market sustainable, cost-effective solutions for agricultural production, post-harvest and storage processing, including solar pumping, cooling, chilling and drying. These technologies result in saved costs, increased yields and local value capture for farmers.

2.b. References:

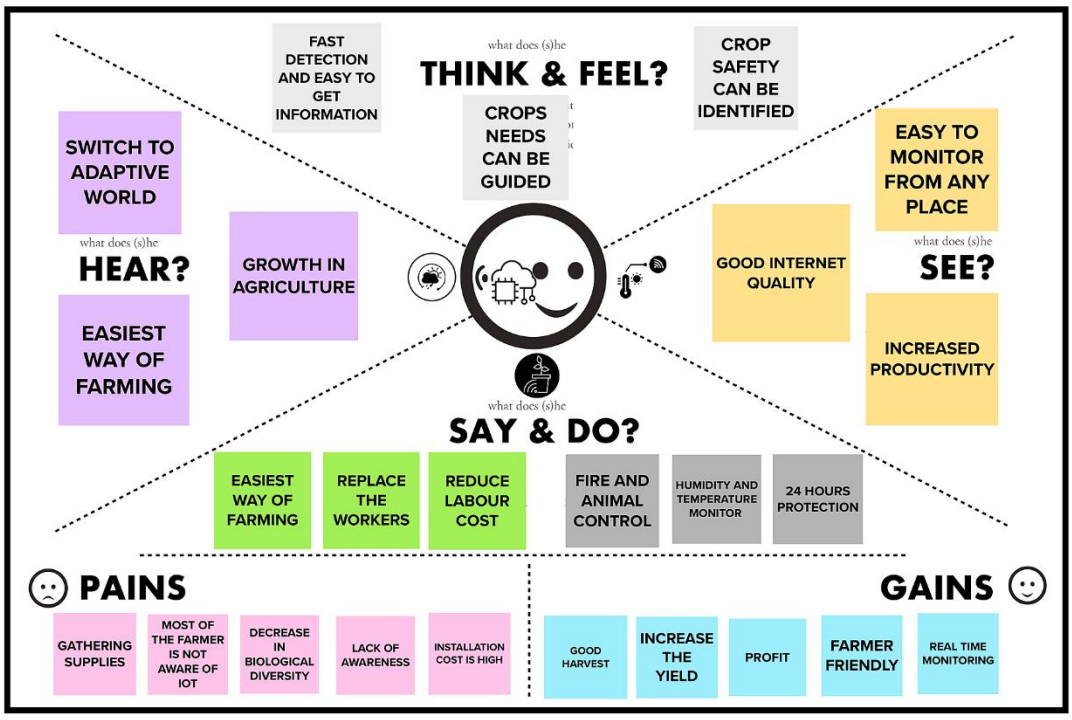
- https://www.researchgate.net/publication/352399626_IoT_Based_Smart_Agriculture_System
- https://easternpeak.com/blog/iot-in-agriculture-technology-use-cases-for-smart-farming-and-challenges-to-consider/
- https://www.wikipedia.org/
- https://www.ibm.com/blogs/research/2018/09/smarter-farms-agriculture/
- https://newsroom.ibm.com/2019-05-22-IBM-AI-and-Cloud-Technology-Helps-Agriculture-Industry-Improve-the-Worlds-Food-and-Crop-Supply
- https://www.clarifai.com/products/armada-ml-prediction

2.c. Problem Statment Definition:

In Early days before smart crop protection system has emerged, Farmers need to stay in the fields or need to fence the field to protect the crops from animals or any others which leads to increase in the cost and waste of time for the farmer.
In this smart crop protection system, Farmers can monitor the field from any place, any where, any time through mobile applications, so that he/she can view the field real time. Thus, the system help help to monitor the temperature, moisture, humidity, etc. ,pump water to the field by on/off the motor when it is required and notify him/her when the animal/bird is detected in the field.

3.IDEATION AND PROPOSED SOLUTION

3.a. Empathy Map Canvas:



EVENT DESIGN USING THE EVENT CANVAS™ METHODOLOGY
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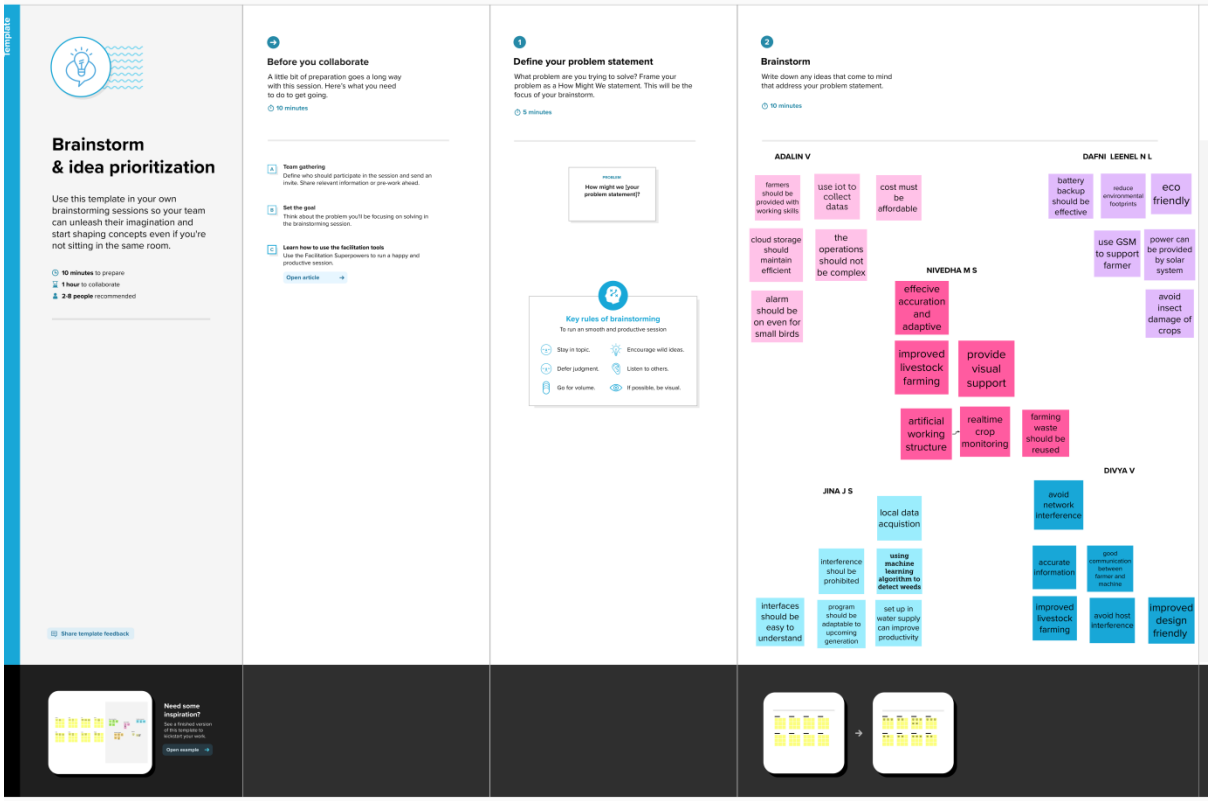
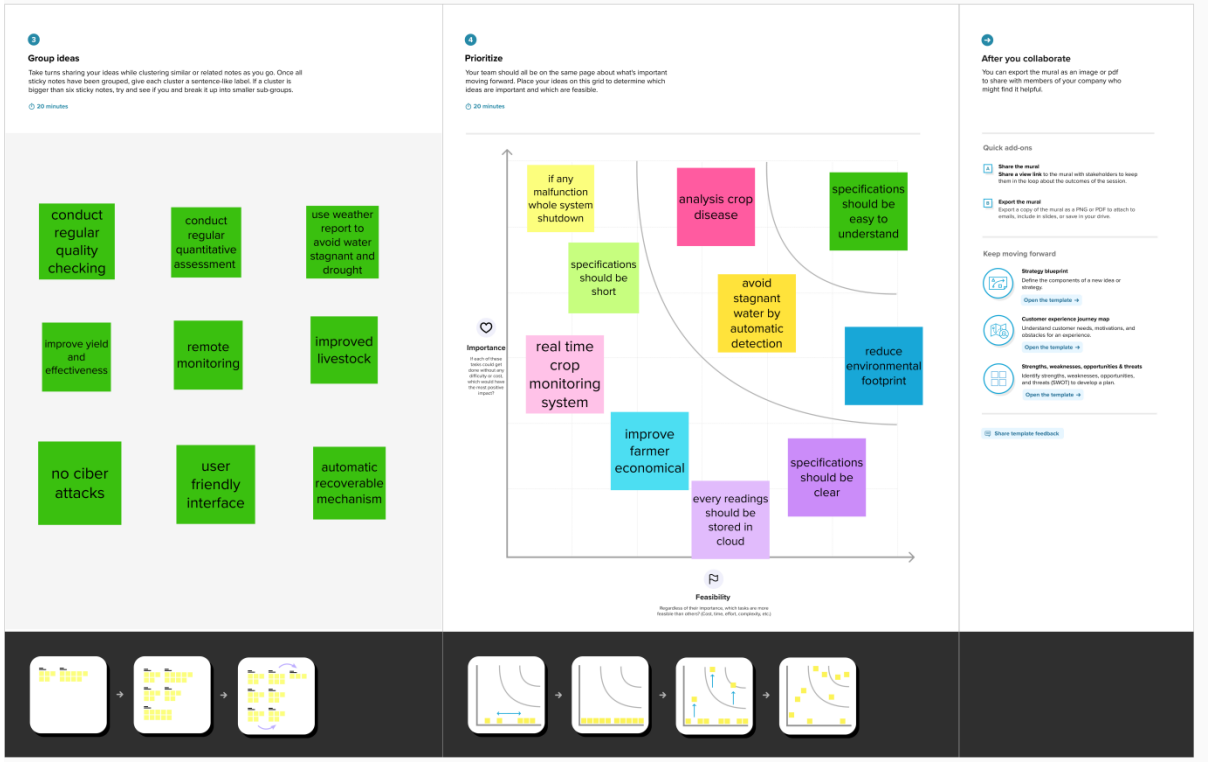
version 20180621
Source: adapted from XPLANE

3.b. Ideation and Brainstorming:

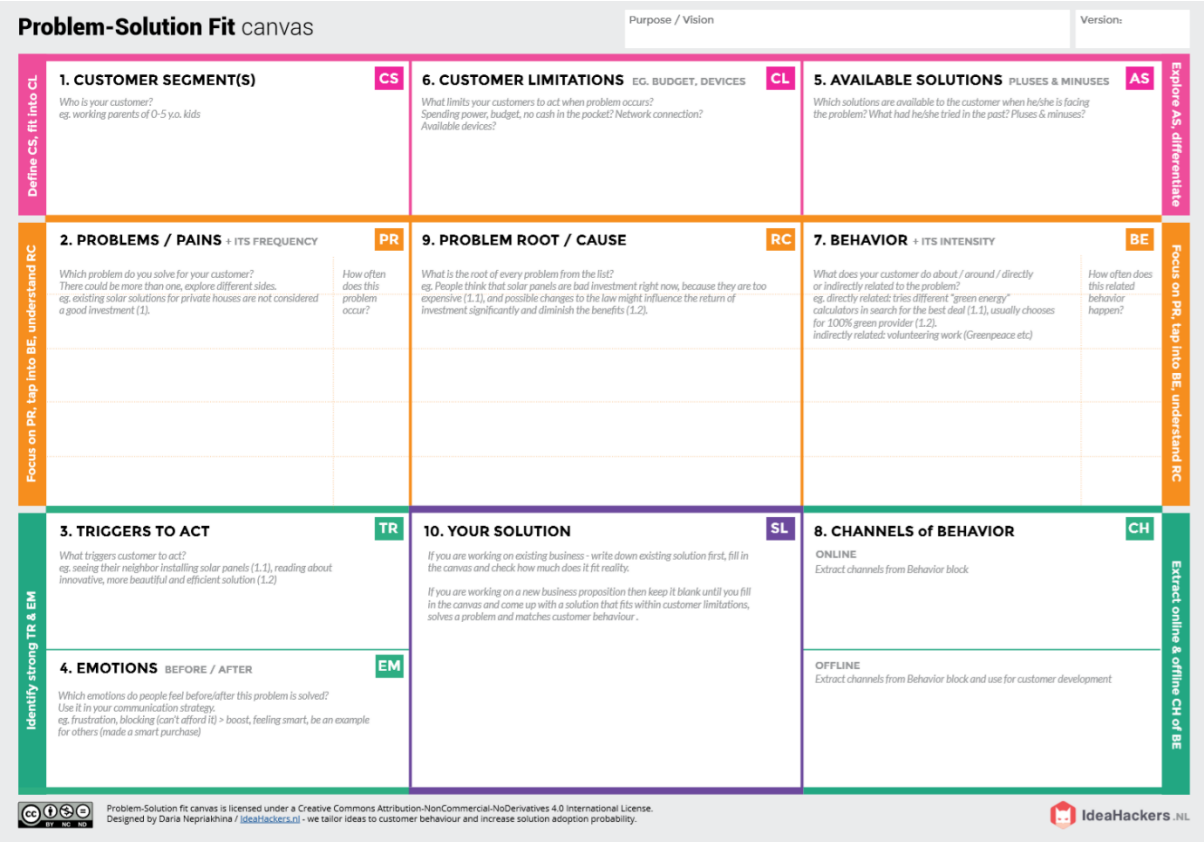




3.c. Proposed Solution:

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Agriculture plays a major role in the development of rise of human civilization, the livelihood of many farming communities in the country has come under threat from the attacks of wild animals on crops and villages ,to solve these problems Smart farming is adopted . Smart Farming is focused on providing agricultural industry with the infrastructure to leverage advanced technology .
2.	Idea / Solution description	Smart farming is one of the best approach to increase production for competing with the increasing population of our country. Smart farming helps to increase the production of different crops by transforming agricultural systems.
3.	Novelty / Uniqueness	This project will be more helpful for farmers . It can be monitored and controlled from anywhere by using smart phones . System can be done even in urban areas.
4.	Social Impact / Customer Satisfaction	The data can be transmitted through a longer distance , they can monitor the crops being where ever in the world.
5.	Business Model (Revenue Model)	The devices and sensors employed need a regular maintenance and the manufacturing will improve the economy.
6.	Scalability of the Solution	To extend or reduce the database management for crops and to provide efficient product in terms of both hardware and software components.

3.d. Problem Solution Fit:



4.REQUIREMENT ANALYSIS

4.a.Functional Requirements:

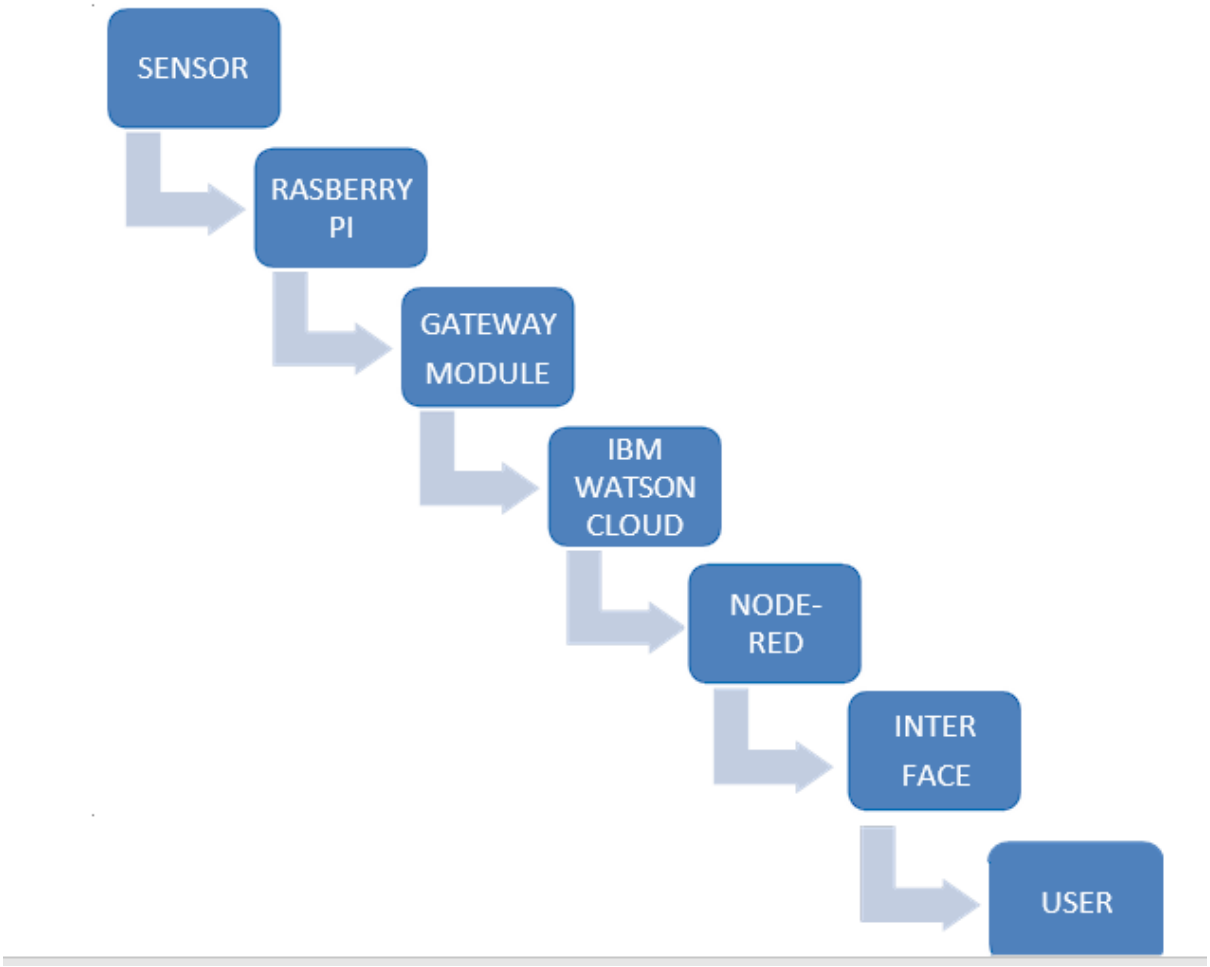
FR No.	Functional Requirement (Epic)	Sub Requirement (Story/ Sub-Task)
FR-1	Motion Detection	Detection of animal movement in the agriculture field.
FR-2	Temperature	Monitoring the temperature and givingthe alert signal to the farmer.
FR-3	Humidity	Monitoring the humidity and givingthe alert signal to the farmer.
FR-4	Controlling the Electrical Appliances	Switch the Light ON and OFF in the field. Switch the Motor ON and OFF in the field.
FR-5	SMS	Alert the user aboutthe above instances.

4.b. Non-Functional Requirements:

NFR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The Project is easy to use and implement. It is more user friendly.
NFR-2	**Security**	Itis based on IBM cloud hence the security willbe high by default.
NFR-3	**Reliability**	Aswe use computer visionthe reliability is very high.
NFR-4	**Performance**	It can withstand any kindof environment as it is based on crop protection.
NFR-5	**Availability**	Itis always available since the sensors willsense the data and transmit to cloud frequently forprocessing.
NFR-6	**Scalability**	It is scalable to a great extentsince it used IBM cloud and NodeRed.

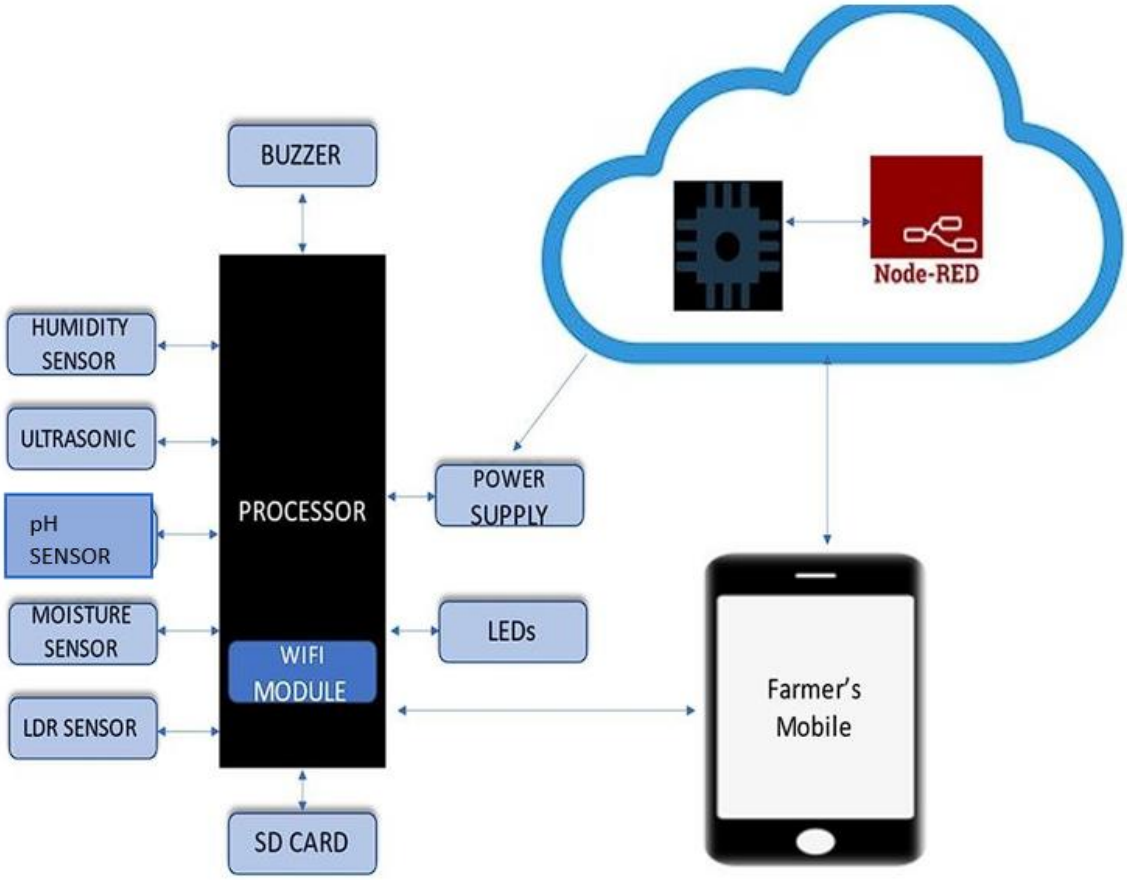
5.PROJECT DESIGN

5.a.Data Flow Diagram:

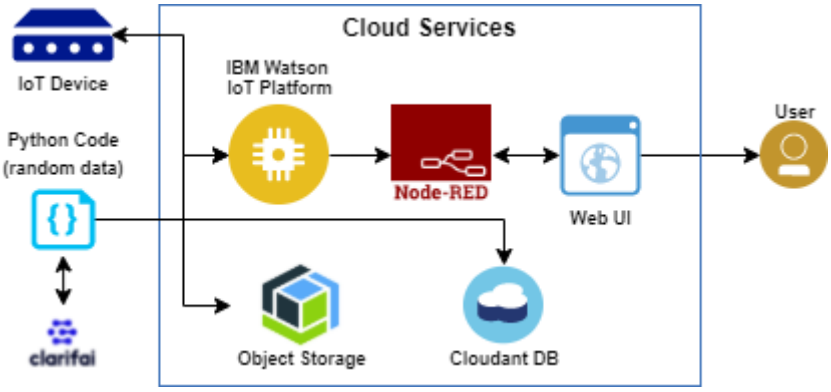


5.b .Solution and Technical Architecture:

5.b.1. Solution Architecture:



5.b.2.Technical Architecture:



5.c.User Stories:

User Type	Functional Requirement(Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer(Farmer)	MaintainingFields	USN-1	As a user, I can monitort he growth of crops and protect the crops againstanimals	I can maintain the fieldswith lesslabor	High	Sprint-1
	AnalyzingProblems	USN-2	As a user, I collectthe required information about the problems onagriculture fields	I can ask my field ownerdirectly.	Low	Sprint-2
		USN-3	As a user, I can monitor the moisture level in soil and solve the problems by usingSmartIOT System	I can take remedialaction immediately	High	Sprint-1
Project Designers	Identifying the problem and provide solutions	USN-4	As a user, I can sense the water leveland flame in the field usingsensor and monitor using IOT	I can performthis actions via IoT.	Medium	Sprint-1
		USN-5	As a user, I can make services for Irrigation, pesticides, Fertilization, and Soilpreparation	I can solve this problemusing IOT	High	Sprint-1

			As a user, I can monitor the field againstanimal attacksusing a camera interface module and appropriate actions can betaken	I can monitor the fieldcontinuously.	Medium	Sprint-2
Customer (Field Maintainer)	Problemsolutions	USN-6	As a user, areas can be monitored from aremote place	Checking Process	Medium	Sprint-3
	Application	USN-7	[illegible]	[illegible]	Medium	Sprint-3
	Final Process	USN-8	This proposed smart IOT-based cropprotection device is found to be cost-effective and efficient	I can take necessaryaction if required.	Medium	Sprint-4

6.PROJECT PLANNING AND SCHEDULING

6.a.Sprint Planning and Estimation:

Sprint	Functional Requirement(Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	User can register for the application by entering email,password, and confirming password in mobile app.	8	High	Nivedha M.S, Dafni LeenelD.L
Sprint 1		USN-2	User will receive confirmationemail once registered for the application.	13	Medium	Adalin V, Jina J.S
Sprint-2	Login	USN-3	[illegible]	10	High	Divya V, Nivedha

						M. S.
Sprint -2	Technical support team	USN-4		2	Medium	Dafni Leenel N.L, Adalin V

Sprint -2	Technical support team	USN-4	User can contact and get the supportfrom technical assistantteam whenever there is issue in IOT system.	2	Medium	Dafni Leenel N.L ,Adalin V
Sprint -2	Security	USN-5	User data is secured and end-to-endencrypted with password-based system.	13	High	Jina J.S, Divy

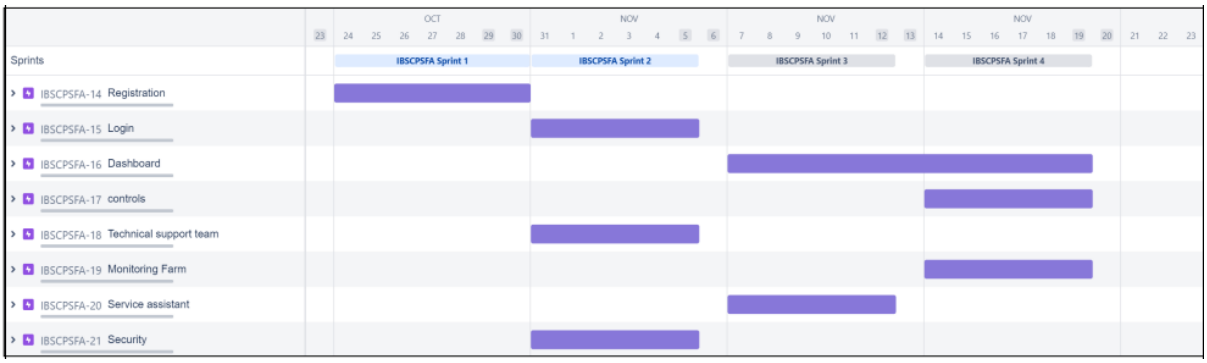
						a V
Sprint -3	Service assistant	USN-6	User canget service availability for the entiresmart syst emperiodically.	5	Medium	Nivedha M. S, Adalin V
Sprint -3	Service assistant	USN-7	User can get immediate response from the service assistant about functionality of the system.	5	Low	Dafni Leenel D.L ,Jina J.S
Sprint-3	Dashboard	USN-8	User can detect whetherany animal is in the fieldor not.	5	Medium	Adalin V, Divya V.

Sprint-3		USN-9	[illegible]	5	High	[illegible]
Sprint-4		USN-10	User can able to control and monitor thefield manually depending upon the [illegible]	5	Medium	Divya V, Dafni LeenelD.L
Sprint-4	Controls	USN-11	[illegible]	5	Low	Nivedha M.S, DafniLeenel N.L
Sprint-4	Controls	USN-12	User can able to turn on the motor pump / buzzer /Light system to overcome threat s infield.	5	High	

6.b.Sprint Delivery Schedule:

Sprint	Total Story Points	Duration	Sprint StartDate	Sprint End Date(Planned)	Story Points Completed (as on PlannedEnd Date)	Sprint ReleaseDate (Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	1Nov 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	7 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	13 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

6.c.Reports From JIRA:



7.CODING AND SOLUTIONING

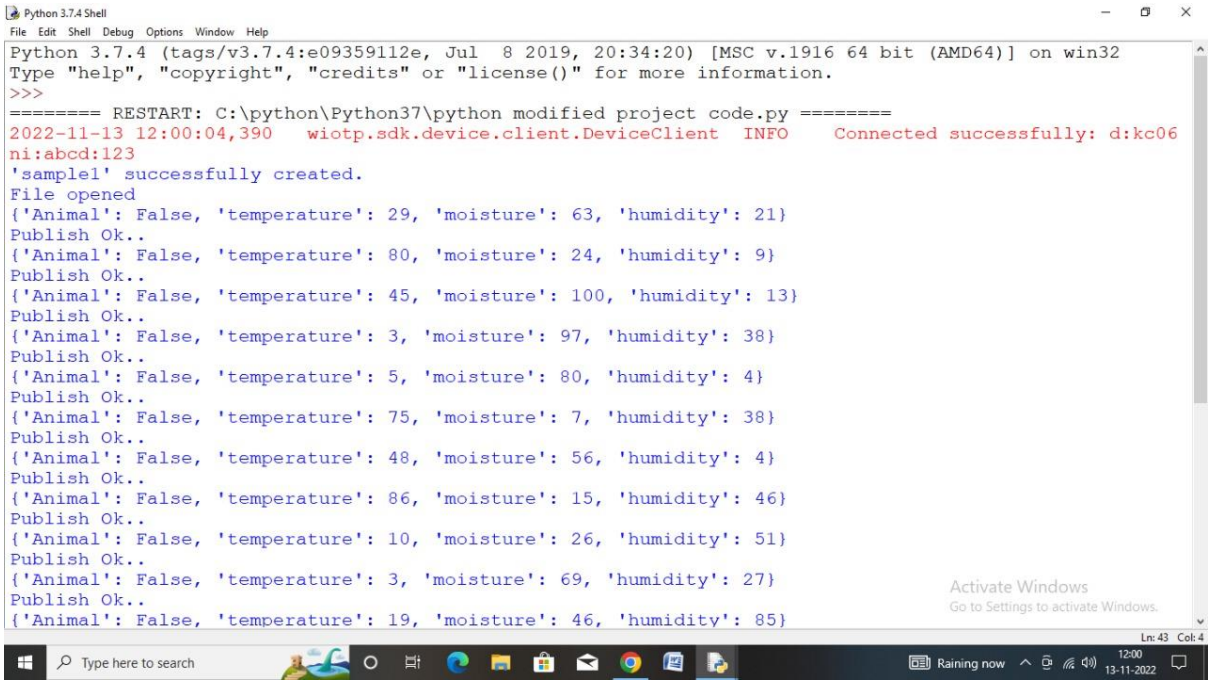
7.a.feature 1 (Coding and Result):

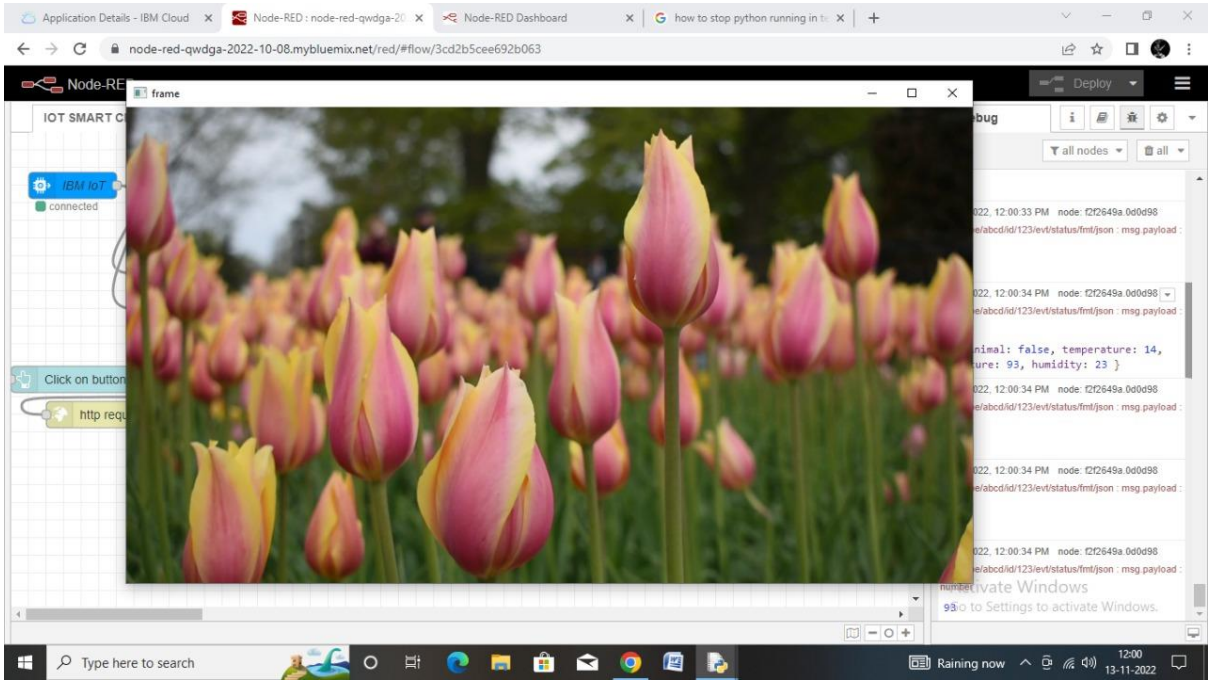
```
import cv2
import numpy as np
import wiotp.sdk.device
import playsound
import random
import time
import datetime
import ibm_boto3
from ibm_botocore.client  import Config,ClientError
#Cloudant DB
from cloudant.client import Cloudant
from cloudant.error import CloudantException
from cloudant.result import Result, ResultByKey
from clarifai_grpc.channel.clarifai_channel  import ClarifaiChannel
from clarifai_grpc.grpc.api import service_pb2_grpc
stub=service_pb2_grpc.V2Stub(ClarifaiChannel.get_grpc_channel())
from clarifai_grpc.grpc.api import service_pb2, resources_pb2
from clarifai_grpc.grpc.api.status import status_code_pb2
metadata =(('authorization','Key 2248806a90084c6a8ee5dce662a0542b'),)#clarifi
service credential
COS_ENDPOINT ="https://adalin.s3.jp-tok.cloud-object-storage.appdomain.cloud"
COS_API_KEY_ID ="uK89t2Ead9kwv4PKtIvpo7UdN5TZSzF095U2_JsMGtTv"
COS_AUTH_ENDPOINT ="https://iam.cloud.ibm.com/identity/token"
COS_RESOURCE_CRN ="crn:v1:bluemix:public:cloud-object-
storage:global:a/c3c1d2d11b42464d9c706f832c28b807:380fafe0-66e6-44f2-9abb-
e989ae484b63::"
clientdb=Cloudant("apikey-v2-
17ohzcgg9s8gag385pikw8c0rvg66om8u9rdhnbdj4pb","d2c0c50d290716c4f3a6c1637
54fd4d2",url= "https://apikey-v2-
17ohzcgg9s8gag385pikw8c0rvg66om8u9rdhnbdj4pb:d2c0c50d290716c4f3a6c163754
fd4d2@fc0b7457-1856-4d19-a6d4-985e0054e85f-
bluemix.cloudantnosqldb.appdomain.cloud")
clientdb.connect()
#create resource
cos = ibm_boto3.resource("s3",
   ibm_api_key_id=COS_API_KEY_ID,
   ibm_service_instance_id=COS_RESOURCE_CRN,
   ibm_auth_endpoint=COS_AUTH_ENDPOINT,
   config=Config(signature_version="oauth"),
   endpoint_url=COS_ENDPOINT
)
def multi_part_upload(bucket_name, item_name, file_path):
   try:
      print("Starting file transfer for {0} to bucket:{1}\n".format (item_name,
bucket_name))
```

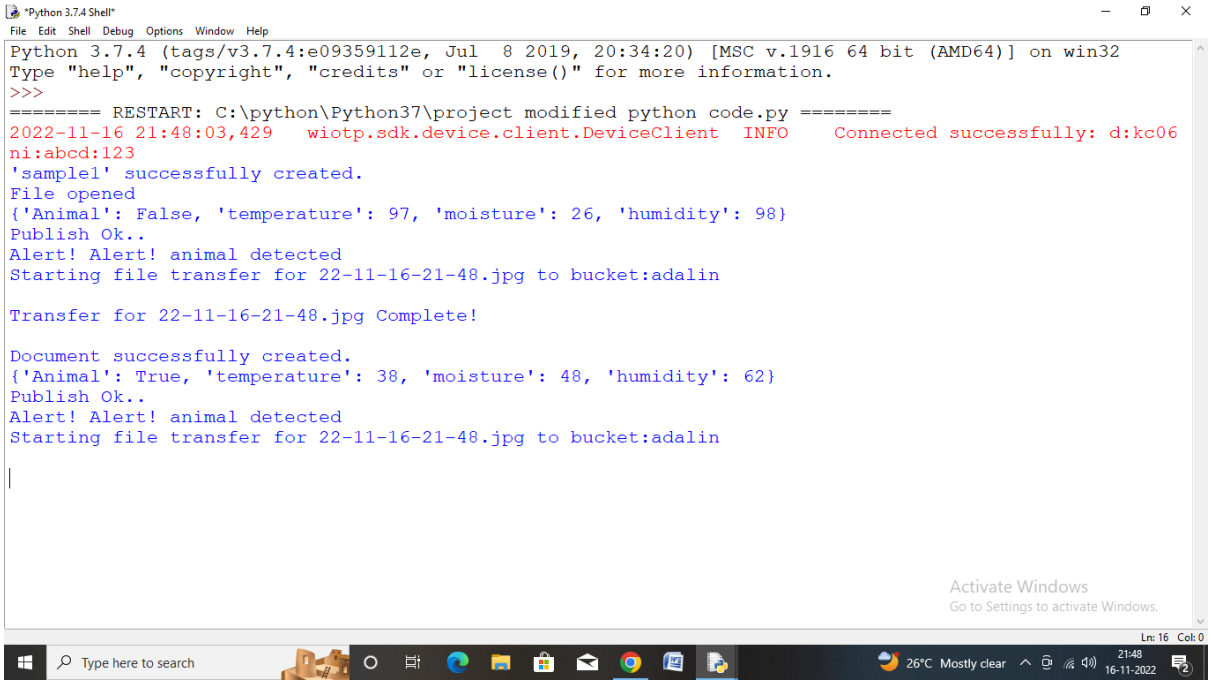
```
        part_size = 1024 * 1024 * 5
        file_threshold = 1024* 1024 * 15
        transfer_config=ibm_boto3.s3.transfer.TransferConfig(
          multipart_threshold=file_threshold,
          multipart_chunksize=part_size
        )
        with open(file_path, "rb") as file_data:
          cos.Object(bucket_name, item_name).upload_fileobj(
            Fileobj=file_data,
            Config=transfer_config
          )
        print ("Transfer for {0} Complete!\n".format(item_name))
    except ClientError as be:
        print ("CLIENT ERROR: {0}\n".format(be))
    except Exception as e:
        print("Unable to complete multi-part upload: {0}".format(e))

def  myCommandCallback(cmd):
    print("Command received: %s" % cmd.data)
    command=cmd.data['command']
    print(command)
    if(command=='lighton'):
        print('lighton')
    elif(command=='lightoff'):
        print('lightoff')
    elif(command=='motoron'):
        print('motoron')
    elif(command=='motoroff'):
        print('motoroff')
myConfig = {
    "identity": {
        "orgId":"kc06ni",
        "typeId": "abcd",
        "deviceId": "123"
    },
    "auth": {
        "token":"12345678"
    }
}
client= wiotp.sdk.device.DeviceClient(config=myConfig, logHandlers=None)
client.connect()

database_name="sample1"
my_database = clientdb.create_database(database_name)
if my_database.exists():
   print(f"'{database_name}' successfully created.")
   cap=cv2.VideoCapture("C:\python\Python37\monkey.mp4.mp4")
if(cap.isOpened()==True):
    print('File opened')
```

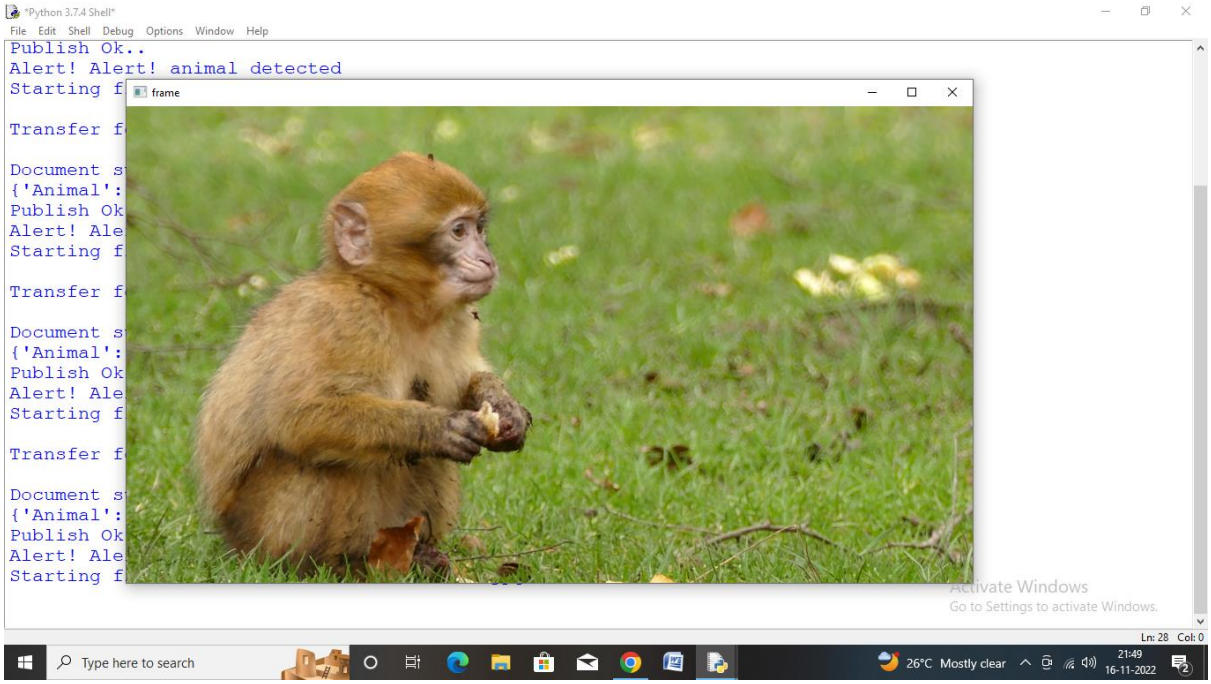
```
else:
   print ('File not found')

while(cap.isOpened()):
   ret, frame = cap.read()
   gray =cv2.cvtColor(frame ,cv2.COLOR_BGR2GRAY)
   imS=cv2.resize(frame,(960,540))
   cv2.imwrite('ex.jpg',imS)
   with open("ex.jpg","rb") as f:
      file_bytes = f.read()
   request = service_pb2.PostModelOutputsRequest(
      model_id='general-image-recognition',#'aaa03c23b3724a16a56b629203edc62c',
      inputs=[resources_pb2.Input(data=resources_pb2.Data(image=resources_pb2.Imag
e(base64=file_bytes))
      )])
   response = stub.PostModelOutputs(request ,metadata=metadata)
   if response.status.code != status_code_pb2.SUCCESS:
      raise Exception("Request failed,status code :" + str (response.status.code))
   detect=False
   for concept in response.outputs[0].data.concepts:
      if(concept.value>0.98):
         if(concept.name=="animal"):
            print("Alert! Alert! animal detected")
            #playsound.playsound('alert.mp3')
            picname=datetime.datetime.now().strftime("%y-%m-%d-%H-%M")
            cv2.imwrite(picname+'.jpg',frame)
            multi_part_upload('adalin' ,picname+'.jpg',picname+'.jpg')
            json_document={"link":COS_ENDPOINT+'/'+'adalin'+'/'+picname+'.jpg'}
            new_document = my_database.create_document(json_document)
            if new_document.exists():
              print (f"Document successfully created.")
            time.sleep(5)
            detect =True
   moist=random.randint(0,100)
   temp=random.randint(0,100)
   humidity =random.randint(0,100)
   myData={'Animal': detect,'temperature':temp,'moisture':moist,'humidity':humidity}
   print(myData)
   if(humidity!=None):
      client.publishEvent(eventId="status",msgFormat="json", data=myData, qos=0,
onPublish=None)
      print("Publish Ok..")
   client.commandCallback = myCommandCallback
   cv2.imshow('frame',imS)
   if cv2.waitKey(1) & 0xFF == ord('q'):
      break
client.disconnect()
cap.release()
cv2.destroyAllWindows()
```

Output:


Python 3.7.4 Shell
File Edit Shell Debug Options Window Help
Python 3.7.4 (tags/v3.7.4:e09359112e, Jul 8 2019, 20:34:20) [MSC v.1916 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
======== RESTART: C:\python\Python37\python modified project code.py ========
2022-11-13 12:00:04,390 wiotp.sdk.device.client.DeviceClient INFO Connected successfully: d:kc06ni:abcd:123
'sample1' successfully created.
File opened
{'Animal': False, 'temperature': 29, 'moisture': 63, 'humidity': 21}
Publish Ok..
{'Animal': False, 'temperature': 80, 'moisture': 24, 'humidity': 9}
Publish Ok..
{'Animal': False, 'temperature': 45, 'moisture': 100, 'humidity': 13}
Publish Ok..
{'Animal': False, 'temperature': 3, 'moisture': 97, 'humidity': 38}
Publish Ok..
{'Animal': False, 'temperature': 5, 'moisture': 80, 'humidity': 4}
Publish Ok..
{'Animal': False, 'temperature': 75, 'moisture': 7, 'humidity': 38}
Publish Ok..
{'Animal': False, 'temperature': 48, 'moisture': 56, 'humidity': 4}
Publish Ok..
{'Animal': False, 'temperature': 86, 'moisture': 15, 'humidity': 46}
Publish Ok..
{'Animal': False, 'temperature': 10, 'moisture': 26, 'humidity': 51}
Publish Ok..
{'Animal': False, 'temperature': 3, 'moisture': 69, 'humidity': 27}
Publish Ok..
{'Animal': False, 'temperature': 19, 'moisture': 46, 'humidity': 85}
Activate Windows
Go to Settings to activate Windows.
Ln: 43 Col: 4
Type here to search
Raining now
12:00
13-11-2022

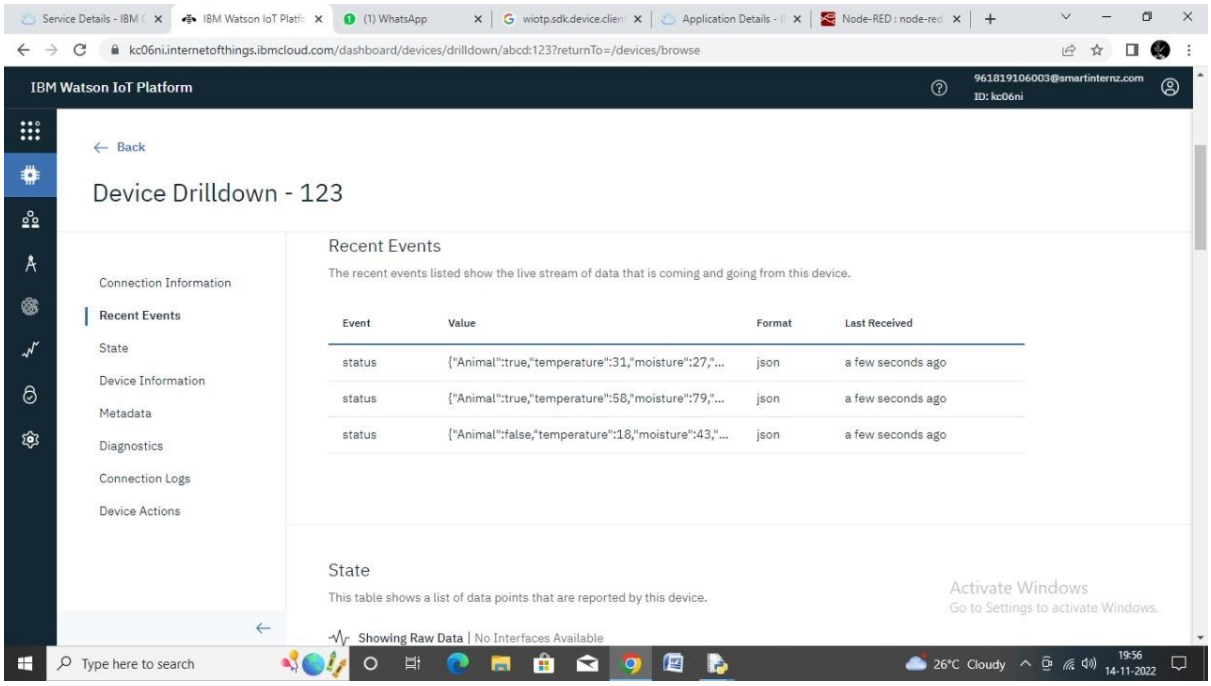

Application Details - IBM Cloud
Node-RED : node-red-qwdga-20
Node-RED Dashboard
how to stop python running in t
node-red-qwdga-2022-10-08.mybluemix.net/red/#flow/3cd2b5cee692b063
frame
Deploy
IOT SMART C
IBM IoT
connected
Click on button
http requ
all nodes
all
022, 12:00:33 PM node: f2f2649a.0d0d98
e/abcd/id/123/evt/status/fmt/json : msg.payload :
022, 12:00:34 PM node: f2f2649a.0d0d98
e/abcd/id/123/evt/status/fmt/json : msg.payload :
nimal: false, temperature: 14,
ure: 93, humidity: 23 }
Activate Windows
Go to Settings to activate Windows.
Type here to search
Raining now
12:00
13-11-2022

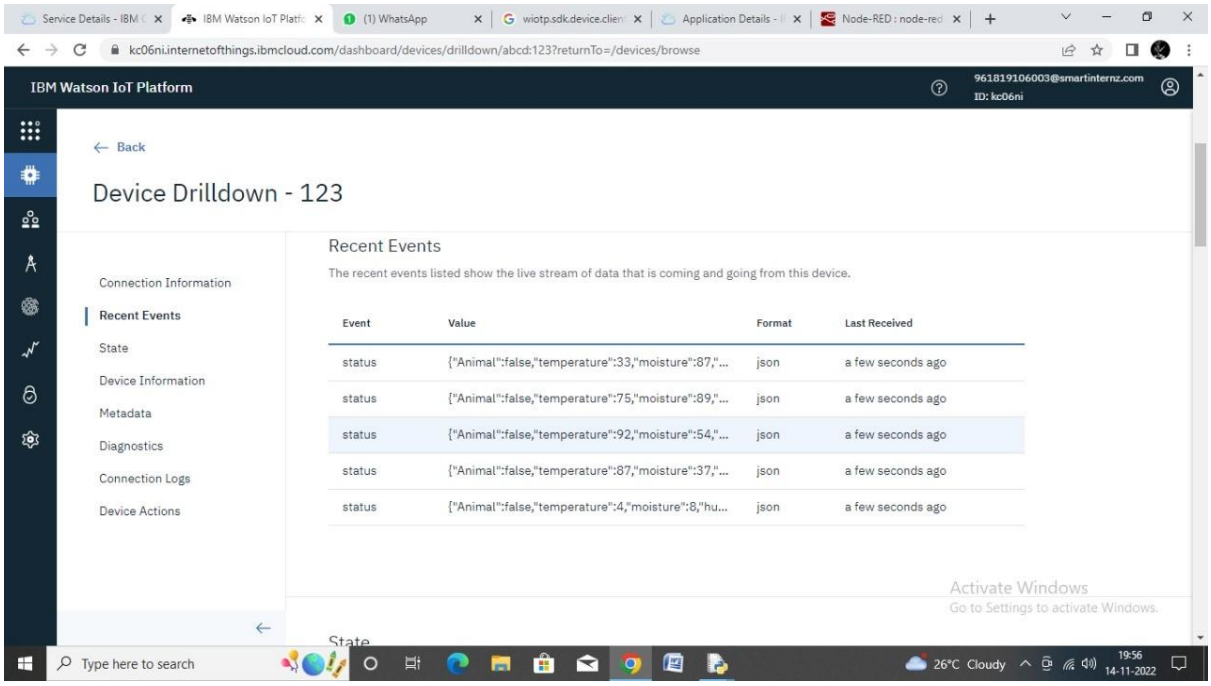




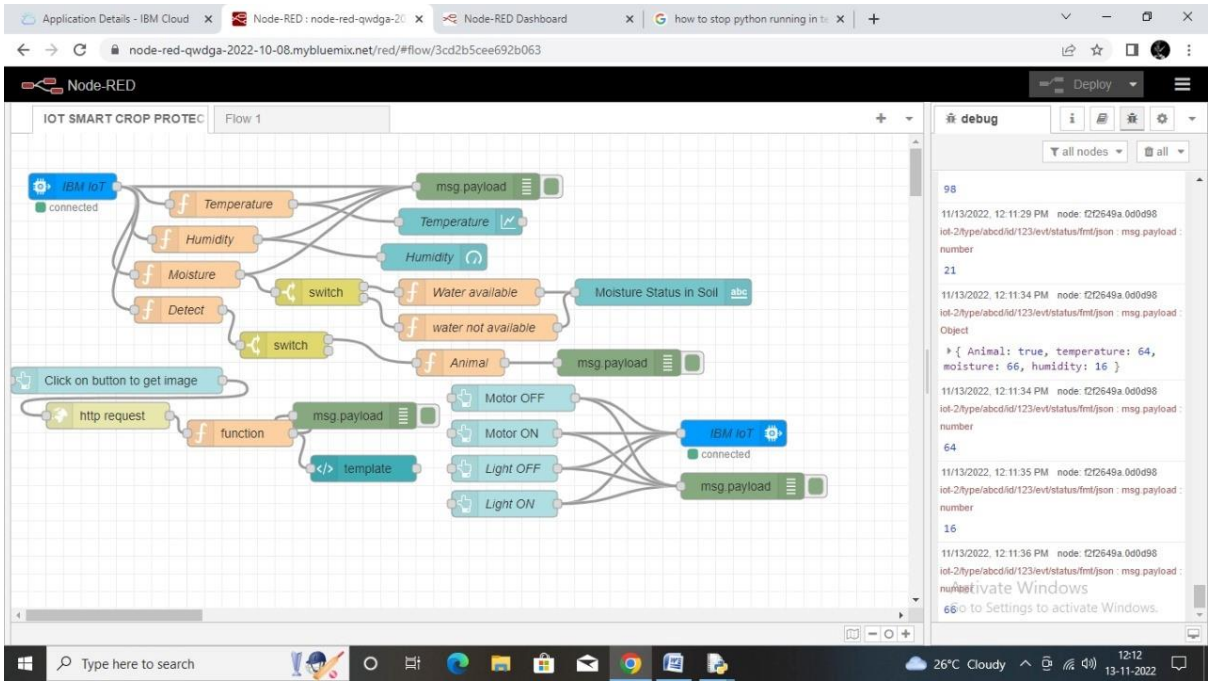
7.b.Feature 2:

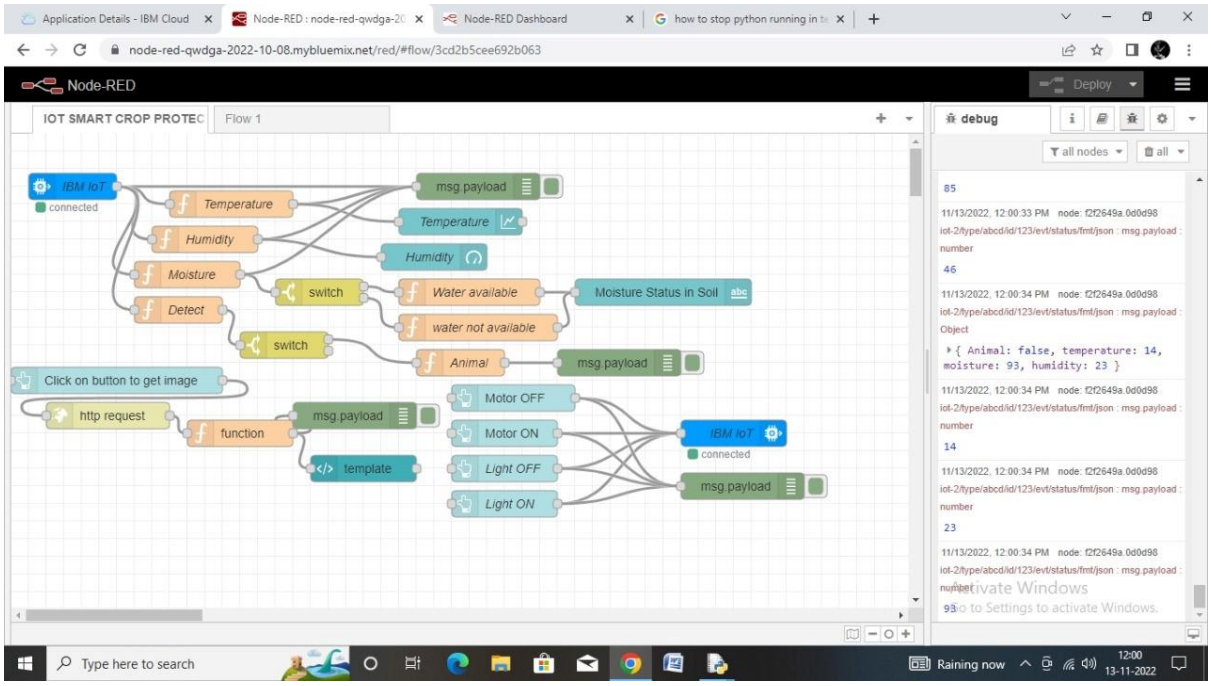
IBM Watson Service:



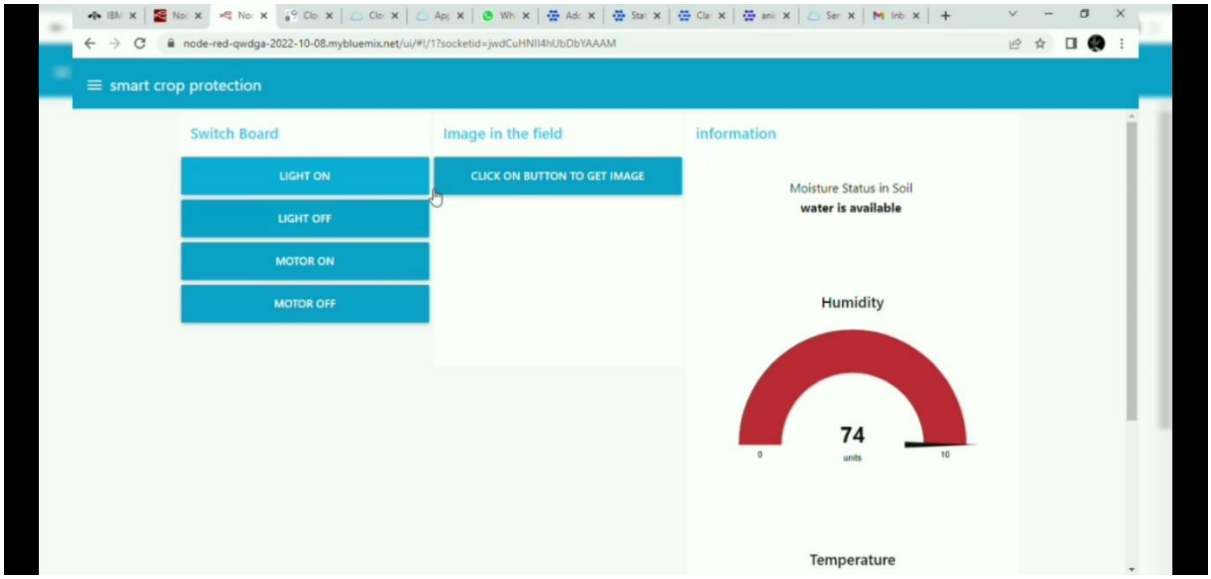


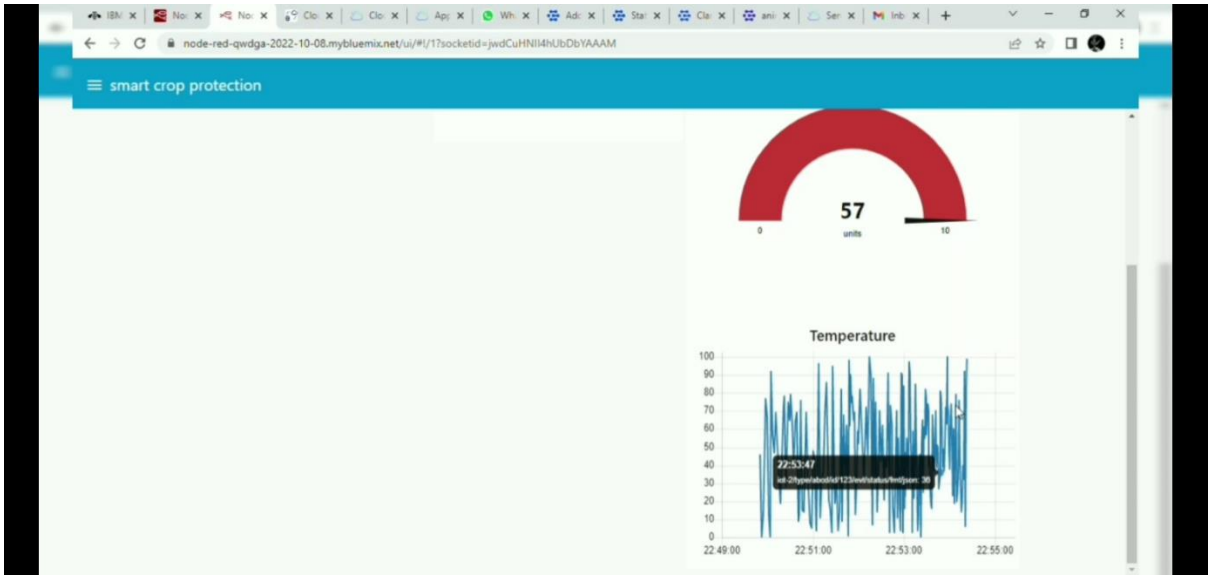
Output in Node RED:





Output in Node-RED Dashboard(User Interface):


node-red-qwdga-2022-10-08.mybluemix.net/ui/#!/1?socketid=jwdCuHNlI4hUbDbYAAAM
smart crop protection
Switch Board
LIGHT ON
LIGHT OFF
MOTOR ON
MOTOR OFF
Image in the field
CLICK ON BUTTON TO GET IMAGE
information
Moisture Status in Soil
water is available
Humidity
74
units
0
10
Temperature


node-red-qwdga-2022-10-08.mybluemix.net/ui/#!/1?socketid=jwdCuHNlI4hUbDbYAAAM
smart crop protection
57
units
0
10
Temperature
100
90
80
70
60
50
40
30
20
10
0
22:49:00
22:51:00
22:53:00
22:55:00

8.Testing

8.a.Test Cases:

Test case ID	Feature Type	Component	Test Scenario	Pre-Requisite	Steps To Execute	Test Data	Expected Result	Actual Result	Status	Commnets
IBM Cloud	Functional	Home page	\Verify user is able to see the Login/Signup popup when user clicked on that button	Login into the IBM Cloud Service	1.Enter URL for the IBM Cloud Service 2.Click on the login/signup button to get into the cloud service 3.\Verify login/Singup popup displayed or not	https://cloud.ibm.com	Login popup message should display	Working as expected	Pass	Steps are clear to
IBM Watson	Functional	Home Page	\Verify user can login to the watson service and can monitor the field status in it.	Login to the IBM Cloud Service and then to the IBM Watson Service	1.Enter URL and click login to IBM Cloud Service 2.In the dashboard login to the IBM Watson service 3.So that farmer can monitor the field status	https://ke06ni.internetofthings.ibmcloud.com/dashboard/devices/browse	Application should show below elements: Animal Status, Humidity, Temperature, Soil Moisture.	Working as expected	Pass	Steps are clear to
Node-RED Dashboard	User Interface	Home page	\Verify user is able to log into IBM Cloud Service with \Valid credentials and then into the Node-RED App and then to Node-RED dashboard.	Login to the IBM Cloud Service and then to Node-RED	1.Enter URL for IBM Cloud Service and click login 2.Click on Node-RED App URL 3. In the Node-RED Dashboard farmer can view the termperature, humidity, moisture status. 4.If the moisture level in the soilnis decreased below 50 then farmer can switch ONthe motor in the dashboard or else switch OFF the motor. 5.Farmer can light ON/OFF the button and if animal is detected in the field, frame will be displayed in the dashboard.	https://node-red-qwdga-2022-10-08.mybluemix.net/ui/#!/1?socketid=S93kvKzf2H-V0nFAAAB	User should navigate through the dashboard and monitor all the field status.	Working as expected	Pass	Steps are clear to
Cloudant Database	Functional	Home Page	\Verify user is able to log into application with \Valid credentials and farmer can view the frame image link in it.	\Verify user can get into cloudant database.	1.User should login into the cloudant datasbase and click on the recently created document. 2.Inside the document farmer can see the link of frame in the field.	https://fc0b7457-1856-4d19-a8d4-985e0054e85f-bluemix.cloudant.com/dashboard.html	Application should show the frame link in it.	Working as expected	Pass	Steps are clear to
Cloud Object Storage	Functional	Home page	\Verify user is able to log into application with \valid credentials	\Verified user can login to IBM Cloud and then to IBM Cloud Object Storage.	1.User should login into the Cloud Object Storage and click on the bucket created where you can see the frame from the field being stored. 2.Inside the document farmer can see the link of frame in the field.	https://cloud.ibm.com/objectstorage/crn%3Av1%3Abluemix%3Apublic%3Acloud-object-storage%3Aglobal%3Aa%2Fc3c1d2d11b42464d9c706832c28b8074%3A880fafe0-68e8-44f0-9abb-e880ae484b83%3A%3A?panelId=manage	Application should show frame image in it.	Working as expected	Pass	Steps are clear to

8.b. User Acceptance Testing:

Purpose of Document :

The purpose of this document is to briefly explain the test coverage and open issues of the IOT based Smart Crop Protection project at the time of the release to User Acceptance Testing (UAT).

Defect Analysis :

This report shows the number of resolved or closed bugs at each severity level, and how they were resolved

Resolution	Severity1	Severity2	Severity3	Severity4	Subtotal
By Design	10	4	2	3	19
Duplicate	1	2	3	0	6
External	2	0	2	1	5
Fixed	15	12	10	4	41
Not Reproduced	0	1	1	0	2
Skipped	2	0	1	1	4

Won'tFix	0	5	2	1	8
Totals	30	24	21	10	85

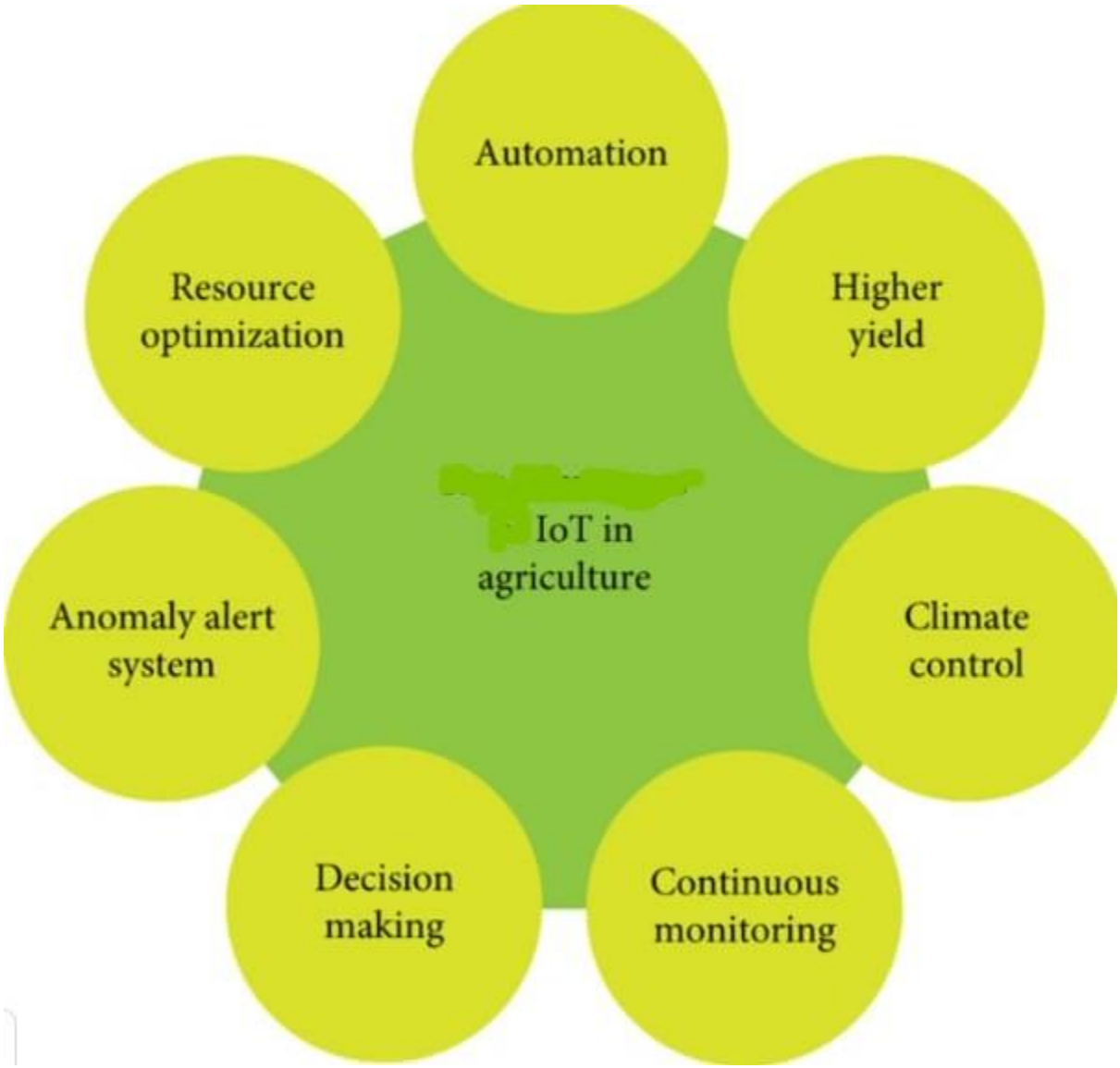
Test Case Analysis :

This report shows the number of test cases that have passed, failed, and untested.

Section	TotalCases	Not Tested	Fail	Pass
Print Engine	12	0	0	12
Client Application	54	0	0	54
Security	4	0	0	4
Outsource Shipping	3	0	0	3
Exception Reporting	10	0	0	10
Final Report Output	6	0	0	6
Version Control	1	0	0	1

9.RESULTS

9.a.Performance Metrics:



10.ADVANTAGES AND DISADVANTAGES

Advantages:

- Detecting soil moisture level, we can use water only when it is needed.
- Farmers can visualize soil moisture , temperature ,humidity in real time and remotely.
- This system can reduce resource consumption, human error and overall cost.
- All informations can be viewed from anywhere . So, it saves time of a farmer.
- Farmers get insights fast, can predict issues before they happen, and make informed decisions on how to avoid them.
- It helps the farmers to increase profit.
- Animals and Birds which damages the crop can be monitored by the farmer and the image of an animal or bird can be viewed by a farmer.
- Less Labour cost.

Disadvantages:

- This system needs availability of internet continuously. Rural part of most of the developing countries do not fulfil this requirement.
- Because of the slow network availability the information may not reach the farmer at time .
- Even if the farmers adopt IoT technology they won't be able to take benefit of this technology due to poor communication infrastructure.
- Farmers should be updated with knowledge of using this system.

11.CONCLUSION

IOT Based Smart Crop Protection for Agriculture System Stick for Live Monitoring of Temperature ,Humidity and Soil Moisture has been proposed using IBM Cloud, NODE-RED services,IBM Cloud,IBM IoT Platform,IBM Cloudant DB,IBM Cloud Object Storage and other Devices. The stick has high efficiency and accuracy in fetching the live data of temperature, humidity, and soil moisture. The IoT based Smart Crop Protection for Agriculture System stick being developed through this paper will help farmers in increasing the agriculture yield and take efficient care of food production as it will always provide a helping hand to farmers for getting accurate live feed of environmental temperature and soil moisture with accurate results. With the help of these systems, various problems faced by farmers in daily life are being solved to a greater extent. Therefore, this system avoids excessive irrigation, under irrigation, soil erosion, and reduces water wastage. The main advantage is that the action of the system can be changed depending on the situation (plants, climate, soil, etc.). Therefore, this program is cheaper and more efficient compared to other types of automation systems. For larger applications, higher sensitivity can be performed in large areas of agricultural land. A soil moisture level monitoring system was developed and the project provided an opportunity to study existing systems, as well as their features and constraints. The proposed system can be used to turn off / off the water spray according to soil moisture levels thus making the irrigation process one of the most time-consuming agricultural activities. Agriculture is one of the biggest uses of water. The problem of crop damage by wild animals and birds has become a major social problem in current time. It requires urgent attention as no effective solution exists till date for this problem. Thus this project carries a great social relevance as it aims to address this problem. This project will help farmers in protecting their orchards and fields and save them from significant financial losses and will save them from the unproductive efforts that they endure for the protection their fields.

12.FUTURE SCOPE

In the future, there will be very large scope, this project can be made based on Image processing in which animals and birds can be detected and if it comes towards farm then system will be directly prevent them from entering into the field by automatic harshing sounds. Prevention should not lead animals or birds to loss their life.By implementing the faster Network Facilities ,we can monitor all resorces at a quick rate.

13.APPENDIX

Source code:

```
import cv2
import numpy as np
import wiotp.sdk.device
import playsound
import random
import time
import datetime
import ibm_boto3
from ibm_botocore.client  import Config,ClientError
#Cloudant DB
from cloudant.client import Cloudant
from cloudant.error import CloudantException
from cloudant.result import Result, ResultByKey
from clarifai_grpc.channel.clarifai_channel  import ClarifaiChannel
from clarifai_grpc.grpc.api import service_pb2_grpc
stub=service_pb2_grpc.V2Stub(ClarifaiChannel.get_grpc_channel())
from clarifai_grpc.grpc.api import service_pb2, resources_pb2
from clarifai_grpc.grpc.api.status import status_code_pb2
metadata =(('authorization','Key 2248806a90084c6a8ee5dce662a0542b'),)#clarifi
service credential
COS_ENDPOINT ="https://adalin.s3.jp-tok.cloud-object-storage.appdomain.cloud"
COS_API_KEY_ID ="uK89t2Ead9kwv4PKtIvpo7UdN5TZSzF095U2_JsMGtTv"
COS_AUTH_ENDPOINT ="https://iam.cloud.ibm.com/identity/token"
COS_RESOURCE_CRN ="crn:v1:bluemix:public:cloud-object-
storage:global:a/c3c1d2d11b42464d9c706f832c28b807:380fafe0-66e6-44f2-9abb-
e989ae484b63::"
clientdb=Cloudant("apikey-v2-
17ohzcgg9s8gag385pikw8c0rvg66om8u9rdhnbdj4pb","d2c0c50d290716c4f3a6c1637
54fd4d2",url= "https://apikey-v2-
17ohzcgg9s8gag385pikw8c0rvg66om8u9rdhnbdj4pb:d2c0c50d290716c4f3a6c163754
fd4d2@fc0b7457-1856-4d19-a6d4-985e0054e85f-
bluemix.cloudantnosqldb.appdomain.cloud")
clientdb.connect()
#create resource
cos = ibm_boto3.resource("s3",
   ibm_api_key_id=COS_API_KEY_ID,
   ibm_service_instance_id=COS_RESOURCE_CRN,
   ibm_auth_endpoint=COS_AUTH_ENDPOINT,
   config=Config(signature_version="oauth"),
   endpoint_url=COS_ENDPOINT
)
def multi_part_upload(bucket_name, item_name, file_path):
   try:
      print("Starting file transfer for {0} to bucket:{1}\n".format (item_name,
bucket_name))
```

```
        part_size = 1024 * 1024 * 5
        file_threshold = 1024* 1024 * 15
        transfer_config=ibm_boto3.s3.transfer.TransferConfig(
          multipart_threshold=file_threshold,
          multipart_chunksize=part_size
        )
        with open(file_path, "rb") as file_data:
          cos.Object(bucket_name, item_name).upload_fileobj(
            Fileobj=file_data,
            Config=transfer_config
          )
        print ("Transfer for {0} Complete!\n".format(item_name))
    except ClientError as be:
        print ("CLIENT ERROR: {0}\n".format(be))
    except Exception as e:
        print("Unable to complete multi-part upload: {0}".format(e))

def  myCommandCallback(cmd):
    print("Command received: %s" % cmd.data)
    command=cmd.data['command']
    print(command)
    if(command=='lighton'):
        print('lighton')
    elif(command=='lightoff'):
        print('lightoff')
    elif(command=='motoron'):
        print('motoron')
    elif(command=='motoroff'):
        print('motoroff')
myConfig = {
    "identity": {
        "orgId":"kc06ni",
        "typeId": "abcd",
        "deviceId": "123"
    },
    "auth": {
        "token":"12345678"
    }
}
client= wiotp.sdk.device.DeviceClient(config=myConfig, logHandlers=None)
client.connect()

database_name="sample1"
my_database = clientdb.create_database(database_name)
if my_database.exists():
   print(f"'{database_name}' successfully created.")
   cap=cv2.VideoCapture("C:\python\Python37\monkey.mp4.mp4")
if(cap.isOpened()==True):
    print('File opened')
```

```
else:
   print ('File not found')

while(cap.isOpened()):
   ret, frame = cap.read()
   gray =cv2.cvtColor(frame ,cv2.COLOR_BGR2GRAY)
   imS=cv2.resize(frame,(960,540))
   cv2.imwrite('ex.jpg',imS)
   with open("ex.jpg","rb") as f:
      file_bytes = f.read()
   request = service_pb2.PostModelOutputsRequest(
      model_id='general-image-recognition',#'aaa03c23b3724a16a56b629203edc62c',
      inputs=[resources_pb2.Input(data=resources_pb2.Data(image=resources_pb2.Imag
e(base64=file_bytes))
      )])
   response = stub.PostModelOutputs(request ,metadata=metadata)
   if response.status.code != status_code_pb2.SUCCESS:
      raise Exception("Request failed,status code :" + str (response.status.code))
   detect=False
   for concept in response.outputs[0].data.concepts:
      if(concept.value>0.98):
         if(concept.name=="animal"):
            print("Alert! Alert! animal detected")
            #playsound.playsound('alert.mp3')
            picname=datetime.datetime.now().strftime("%y-%m-%d-%H-%M")
            cv2.imwrite(picname+'.jpg',frame)
            multi_part_upload('adalin' ,picname+'.jpg',picname+'.jpg')
            json_document={"link":COS_ENDPOINT+'/'+'adalin'+'/'+picname+'.jpg'}
            new_document = my_database.create_document(json_document)
            if new_document.exists():
              print (f"Document successfully created.")
            time.sleep(5)
            detect =True
   moist=random.randint(0,100)
   temp=random.randint(0,100)
   humidity =random.randint(0,100)
   myData={'Animal': detect,'temperature':temp,'moisture':moist,'humidity':humidity}
   print(myData)
   if(humidity!=None):
      client.publishEvent(eventId="status",msgFormat="json", data=myData, qos=0,
onPublish=None)
      print("Publish Ok..")
   client.commandCallback = myCommandCallback
   cv2.imshow('frame',imS)
   if cv2.waitKey(1) & 0xFF == ord('q'):
      break
client.disconnect()
cap.release()
cv2.destroyAllWindows()
```

Github and Project Demo Link:

Github link: https://github.com/IBM-EPBL/IBM-Project-48332-1660806690

Project Demo Link: https://youtu.be/Lr0TKduo2_8