Group 38 IoT (Internet of Things) application

Name of App: **IBotanist**

Contributors:

Jessica Davies

Avery Calvin

Elliot Smith

Yusen Yang

Internet of Things Systems Design – Group Answer Sheet

PART I - Advance Features

- Your IoT application will be evaluated from eight different aspects, as highlighted below.
- Additionally, you should also nominate two aspects to claim additional marks where you may have put more effort than the rest of the aspects.
- In order to express your areas of focus, please copy and paste 5 marks and 10 marks symbols from the advanced feature column into any of the eight columns. Please note that you cannot put both into one aspect/column.
- The demo video is marked for quality, clarity, and demonstration of problem-solving.

10 5	Applications and Use cases	Architecture	Sensing and Actuation	Networking and Communications	Data Management and Analytics	Privacy and Security	Human Factors and Interaction	Design Strategies and Prototyping
Advanced Feature Marks					5		10	

PART II (A) – Individual Effort (Hours Spend / Percentage)

- Each student should provide how many hours they spent working on each aspect (Please mark them in percentage as well).
- We are collecting the following information only for later analysis and improving this coursework.
- It is a MUST for all students in the group to provide the following information.

Student Name		Applications and Use cases	Architecture	Sensing and Actuation	Networking and Communications	Data Management and Analytics	Privacy and Security	Human Factors and Interaction	Design Strategies and Prototyping	Total
Student 1 Jessica Davies C21074926	Number of Hours spent					3			4	7
	Percentage (%)					43			57	100 %
Student 2 Elliot Smith C21075246	Number of Hours spent	4		1		1		1		7
	Percentage (%)	58		14		14		14		100 %
Student 3 Avery Calvin C21083376	Number of Hours spent	4			3		7			14
	Percentage (%)	29			21		50			100 %
Student 4 Yusen Yang C22085637	Number of Hours spent		4	2	2				2	10
	Percentage (%)		40	20	20				20	100 %

PART II – Who did what

- No word limit
- Please explain who did what tasks in detail
- Following details may be used to adjust the individual marks especially if the contributions are heavily unevenly distributed among group members

Student 1 Jessica Davies C21074926	Wrote out the strengths & weaknesses of the IoT application Filled out the 'data management and analytics' section Filled out the 'system designs and prototyping' section Booked room(s) in Abacws for weekly group meetings Created & shared the final report document Completed Part I with the help of teammates
Student 2 Elliot Smith C21075246	Created the overview/description of our product put in data in 'applications and use cases' Completed sensing and actuation section Completed human factors and interaction
Student 3 Avery Calvin C21083376	Created Git repository, put in data in 'applications and use cases' for [Domain, Current marketplace, Hardware technologies] Added in potential product names Filled in Value proposition Created data flow diagrams Completed Networks and Communication section Completed Privacy and Security section
Student 4 Yusen Yang C22085637	Built the hardware components of the IoT application. Tested the components Developed and wrote the Arduino IDE code Configured the ThingsBoard platform. Create the app Completed the architecture section

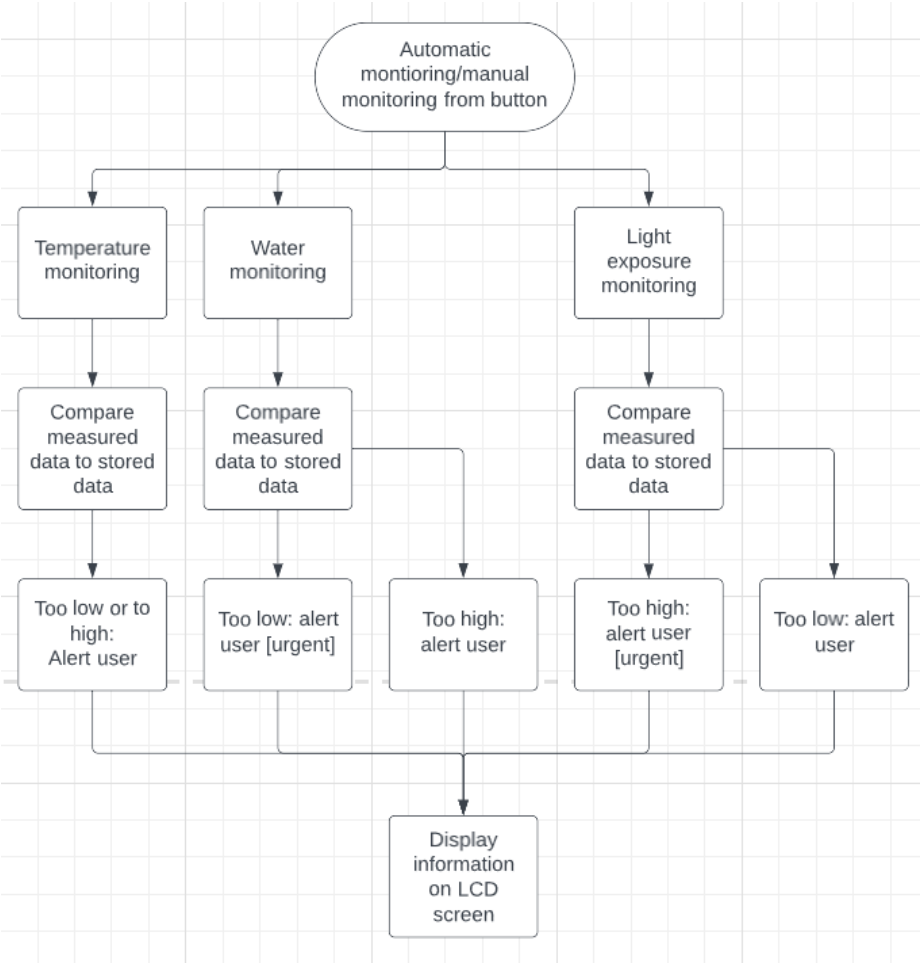
PART III – Project Details Description

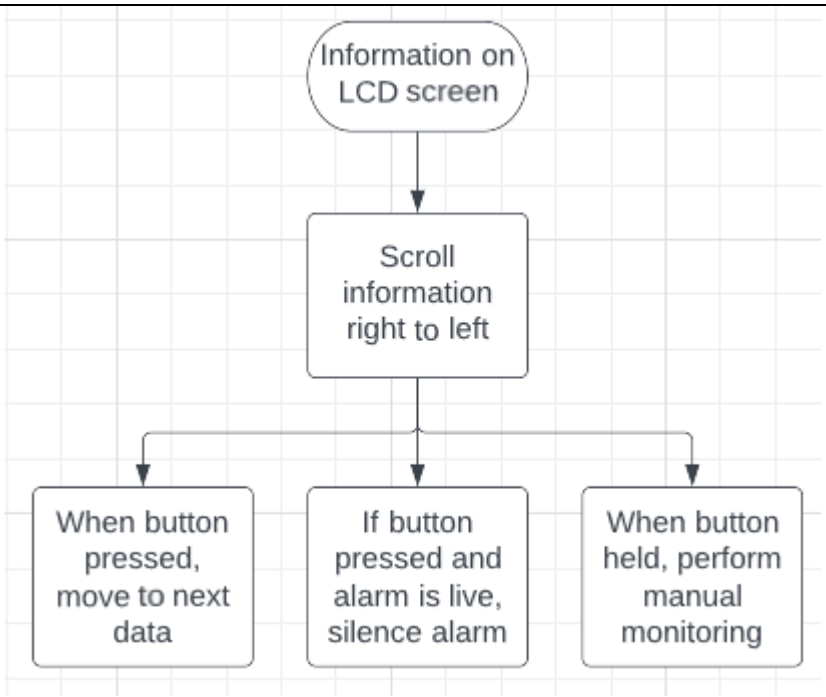
The total word limit for this section is 300-1000 words.

Applications and Use cases	
Domain	Home Gardening
Title	iBotanist
Description	This project will aim to create a system that will be able to remotely monitor the welfare of a plant and provide a user with tips and reminder about their plant. For example, they may receive a notification to their phone reminding them to water their plant each day, as well as updates on the plant's health from real-time data. This system will incorporate multiple sensors as detailed below with a breakdown of how each will be used.
Current Marketplace	The current marketplace is for anyone who is growing their own plants at home. It is to provide a low-cost alternative to monitoring the wellbeing of plants in any environment.
Explain the Value Proposition	Unlike other Smart plant sensor devices, ours is not designed to monitor a single plant or a small area. Ours is made for both small indoor gardens/plants, outside gardens/flower beds, and even greenhouses. There are many devices for the monitoring of plants, but there is a deficit for compatible devices for larger areas/greenhouses. This is what we are providing. This device, despite its large size, will be easily portable as it will be contained within a case. The sensors inside the case can also be taken out to adapt to the environment.
The technology used (Both Hardware and Software)	**Hardware:** Temperature sensor, Light sensor, Humidity sensor, LCD display, Buzzer, Button **Software:** ThingsBoard

Link to Gitlab Account	https://git.cardiff.ac.uk/c21083376/G38-IOT-CW

- Create an architecture / data flow diagram (e.g., mini poster) to visualise and explain your IoT application
- Label all components, data types your collect, sensors and actuators use, network protocols and communication technologies used, data analytics developed (i.e., what happened to data), security and privacy techniques you implemented, etc.





PART IV – From theories, Concepts and Ideas to Practice

- Explain how you applied what you learnt through lectures and labs into practice
- For each category use 300 - 800 words MAX.

How did you apply what you learnt into practice (300 - 600 words MAX)

Architecture (Yusen)

Hardware Components:
We integrated temperature, humidity, and light sensors to collect environment data. Use an LCD display to provide real time data, while a buzzer and button enabled user interaction with the system.

Data collection and transmission:
The IoT device, using the integrated sensors, continuously collected data on the plant's environment. We employed ThingsBoard to process the sensor data and facilitate communication between the hardware components and the cloud server.

Cloud server and data analytics:
We used the cloud server for storage, management, and analysis. The server will consider the data from sensors and set a limitation.

User notifications and alerts:
The system was designed to send notification to user's phones, informing them about the plant's condition. And the information will be shown on LCD screen as well. These notifications were generated based on real-time data and analytics results, ensuring timely and relevant information.

User Interface and Configuration:
We created a basic mobile App interface that allowed users to observe the iBotanist system, view real-time data and receive notifications. We created a user-friendly mobile app interface using the Expo Go platform, which allowed us to run the app on both iOS and Android devices. The app interface displayed real-time sensor data, notifications, and a button to refresh data.

Sensing and Actuation (Elliot)

<u>Temperature sensor</u>
Will read the temperature around the plant and will sound the alarm & send an alert to the user's phone if it reaches unsafe levels. There will be a lower and upper limit for the warner, so it will alert for both a too hot and too cold scenario.

<u>Light sensor</u>
Will monitor the light levels so it can alert the user if the plant does not have the recommended sunlight exposure. This will work by monitoring exposure levels of the light, for example how long it has been since the plant was last exposed to sunlight.

<u>Humidity sensor</u>
This will monitor the water levels in the soil and moisture levels around the plant, this will

be used to calculate the approximate time since the plant was last watered as well as working out whether the plant needs watering again.

<u>LCD display</u>
The screen will relay data, in a scrolling fashion, about the current statistics of the monitored plant. It can also show alerts and recommendations about plant care. This will be used to show hints and tips about plant care as well as allowing the user to see the real time data of their plant.

<u>Buzzer</u>
Will be used to announce to the user if there is something that requires their attention urgently. This will be used in tandem with the phone alerts to ensure the user is made aware of any critical issues with their plant.

<u>Button</u>
Will have multiple functions; silencing the alarm, manually scroll through the statistics and cycling through any tips.

Networking and Communications (Avery; ~220 words)

The primary method of communication is via Wi-Fi. The device will relay updated information onto the user's home wi-fi to communicate to their phone that the device has measured new data. The information can be interfaced with using the mobile app where the user can get real-time data.

Data recorded by the application will be sent to the ThinkBoard server where the user will be interfacing with the application from an external location. This will allow the user to monitor their plant from any internet-connected device.

The method of transferring data between the device and ThinkBoard we are using is Message Queuing Telemetry Transport (MQTT). The main reason for this choice is that MQTT is suitable for lightweight sensors, in our case the Arduino. It also allows for collected sensor data to be sorted into topics and sent to the user.

Using MQTT here is suitable as it designed for:

- Remote connections; for when the user is not at home
- Limited bandwidth; good for when many other devices are sharing the same LAN
- Small-code footprint; to allow less data tracing

(Networking and Communications, Presentation slides, 63)

The architecture of MQTT allows for buffering to occur with telemetries. The information is

buffered at the message broker (in our implementation, the broker is ThinkBoard) so the user can be offline, and their plant will still be monitored.

Data Management and Analytics (Jessica)

Every minute, we will monitor the temperature, humidity, and the light around the plant. We will have a pre-set minimum and maximum values for all measured attributes, called thresholds, so that when the measured values exceed, an alert will be sent to the user's phone, and prompt them with a solution.

Over time, more and more data will be collected and recorded so the user can trace their history to ensure that the monitor is functioning correctly. For a small houseplant, the volume of data collected will be minimal as it is only for a small area that will remain consistent.
However, for greenhouses (as an example), the environment may change more frequently, which in turn creates more variety in the data collected. The sensors we have make use of different formats in which data is collected, notably the light sensor uses analog signals whereas the other sensors do not.

Privacy and Security (Avery; ~510 words)

<u>Privacy</u>
As the system is actively monitoring data about the plant, it is classed as an A/IS system. For the user to understand what is occurring, we must be transparent about what data is being measured and why.

On the initial startup, the user will see a message that shows what data is being used for. Essentially terms and conditions, but won't delve into any personal data (like name, location, email, etc.)

The less data that our device collects, the more likely the user is to purchase and use this product as many people are concerned about what data is being collected and how it is being used in the system.

<u>Security</u>
A potential issue with our device is that it is prone to a Man-In-The-Middle attack. While there is not much opportunity for a hacker to obtain user data (due to us not storing any, see above), it does provide a way for a hacker to spoof messages and manipulate information. This can lead to the user receiving endless notifications from what would appear as our device, or the data that the user views on ThinkBoard is fabricated.

To solve this prominent issue, we will ensure that all communication between devices is encrypted, to ensure that the signal can't be intercepted.

Another issue that may arise is the access of the user's measured data without their knowledge. We make use of ThinkBoard to host and distribute telemetries of the information, which the user will log into to access logs of the surrounding temperature, water levels, etc.
This way, we can ensure that only the user (or anyone else who has the relevant login credentials, I.e., a family member) has access. This will also keep the location of the device secure as ThinkBoard will store the address of the router of the LAN that it will be receiving data from.

Human Factors and Interaction (Elliot)

The main interaction with this product will be done through the LCD multipurpose screen, and the button on the device. The LCD screen will be used to display information to the user, it will use a scrolling style display due to the limitations of the display. It will show statistics such as temperature humidity etc, as well as having short tips for better plant health. The button will be used as the sole input method for the physical device, this will be used for very basic functions such as toggling the alarm and changing what is displayed on the screen.

Most of our interaction will take place within the online application which will be hosted using ThingsBoard. This will have buttons that the suer can interact with using either a touchscreen or with a keyboard and mouse. It will allow them to see the same information as is displayed on the LCD screen on the device but ion a more readable fashion.

Many of our Human Factors will be the features in the application however the physical button does also allow for easy and quick control of the device for basic tasks.

Design Strategies and Prototyping (Jessica)

Design Strategies

As we've explained previously, we will be using a piece of software called ThingsBoard which takes in the data from the IoT application and runs this data through many programs to check if the data hasn't gone above or below a defined threshold. If it has, alert the user with what the problem is, and provide a solution to how it can be fixed.

Prototyping

For our prototype, we got started by implementing some code from Lab 1, added the temperature and humidity sensor, monitored the atmosphere around us and outputted the results using an LCD display. We had quite a few ideas to add to our prototype, such connecting a phone via Bluetooth for sending alerts, but some of the ideas we had we quite difficult to implement and required a lot of technical expertise.

We decided as a group to connect our system to Wi-Fi, so that the user can choose their device using the multi-functional button and RGB display to alert them whenever a problem arises and suggest a solution.

Notes

This device would be a 'Plant sensor' - updates the user with new information about their plant

Pre-existing devices:
- GARDENA Wi-Fi Smart Sensor Control Set
- Parrot's Flower Power Sensor
- Parrot Pot
- PlantLink garden sensor
- Edyn Garden Sensor
- Motes Plant Sensor by Wimoto
- EasyBloom Plug-in Plant Sensor

References

- Lab 1 Code
- Networking and Communications, Presentation slides, 63

Quiz Scores

- Week 1

Group U38

General Results:

Average	96.67%
Completion	100%
Start Time	14/02/2023, 11:07:46
Duration	162s

Interactivity Results

Name	Score	Duration	Weighting	Completed
Applications and Use Cases Quiz	97%	137	1	✔

- Week 2

Group U38

General Results:

Average	94%
Completion	100%
Start Time	09/02/2023, 16:49:56
Duration	1923s

Interactivity Results

Name	Score	Duration	Weighting	Completed
Architectures Quiz	94%	1921	1	✔

- Week 3

Group U38

General Results:

Average	100%
Completion	100%
Start Time	2023/2/13 14:19:49
Duration	1840s

Interactivity Results

Name	Score	Duration	Weighting	Completed
Sensing and Actuation Quiz	100%	1827	1	✔

- Week 4

Group U38

General Results:

Average	96.67%
Completion	100%
Start Time	19/02/2023, 16:54:41
Duration	1005s

Interactivity Results

Name	Score	Duration	Weighting	Completed
Networking and Communications Quiz	97%	1003	1	✔

- Week 5

Group U38

General Results:

Average	93.33%
Completion	100%
Start Time	27/02/2023, 12:29:05
Duration	303s

Interactivity Results

Name	Score	Duration	Weighting	Completed
Data Management and Analytics Quiz	93%	302	1	✔

- Week 6

Group U38

General Results:

Average	100%
Completion	100%
Start Time	2023/3/7 13:35:37
Duration	217s

Interactivity Results

Name	Score	Duration	Weighting	Completed
Privacy and Security Quiz	100%	216	1	✔

- Week 7

Group U38

General Results:

Average	93.33%
Completion	100%
Start Time	2023/3/17 01:43:15
Duration	3500s

Interactivity Results

Name	Score	Duration	Weighting	Completed
Human Factors and Interaction	93%	3499	1	✔

- Week 8

Group U38

General Results:

Average	93.55%
Completion	100%
Start Time	24/04/2023, 21:56:03
Duration	1252s

Interactivity Results

Name	Score	Duration	Weighting	Completed
Design Strategies and Prototyping Quiz	94%	1251	1	✔