Exploring the role of AI and Fuzzy Logic in enhancing the safety measurements of smart assistants

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Introduction

Everyday people strive to find ways to simplify their life, as technology continues to be integrated into society's daily life the most popular solution is the smart assistant. Smart assistants come in many forms and on a basic level they are included on nearly all major smart phones. Due to their prevalence, simplicity and functionality it has made many people rely on their devices for some life's most basic tasks. The questions this coursework tries to answer are; is our trust in smart assistants justified? Is it wise to rely on these devices? Is it safe to do so?

The world is changing, across society the time spent at work or working is increasing **[1]**. This has caused the amount of time spent with family and friends to decrease. This means that for many the time with their family is becoming increasingly more precious, the best way to enjoy this time is to clear the mind of any troubles. So in this regard anything that simplifies life and allows someone to spend less time worrying about menial things like livings costs and remembering deadlines is more than welcome. Allowing them to spend some well needed stress-free time with their family.

Discussion

Background

Smart assistants can be followed back to the shoebox project, this device was created by IBM. Launched in 1961, for its time it was highly advanced although by today's standards it has a limited scope. However, it was able to recognise the numbers 0-9 and it was also able to understand the words representing basic arithmetic functions. This would allow the machine to receive the command "five minus 2" it would then calculate and print the result, in this case it would print the number "3". The shoebox was developed 20 years before IBM's first person computer was released. This makes it much more impressive, due to the fact it was unable to make use of the more traditional programming methods it goes someway to show the importance of their device. The machine takes in voice inputs and maps it to electric impulses. These impulses were then compared the impulses to various sounds. This essentially means they are creating an electronic representation of a sound on the device, similar to the way the way it is possible to create a visual representation using an oscilloscope.

A common form of smart assistant is through a smart speaker, such as an amazon "echo" or google "Home". These speakers both utilise their companies' respective smart assistant, amazon's assistant goes by the name of "Alexa" whereas google has chosen to remain unnamed with "Google Assistant". When talking about smart speakers there is plenty to discuss. Amazon echo has undoubtedly secured its place as the most used smart speaker **[2]**. This has been due to many factors, but the most probable reason is simply because it was released before its current competitor. Along with its early release the echo benefits from the already popular amazon ecosystem. Amazon is visited by millions of users a month **(1) [3]** at some point whilst visiting an amazon page they will most likely see some advertising for an amazon echo product. This helps spread awareness for their product this can cause massive surge in sales during amazon sales **(2)** where an echo device will be marked down in price. At the same time google will likely have a price drop but they must rely on advert on websites that may not be directly relatable.

Despite the market share difference between Amazon Echo and Google Home, there is a large debate which assistant is actually "smarter". A lot of research has been done into the capabilities of the two and comparing them. **[2]** "360i" created a proprietary piece of software to test the two main smart speakers. It does this by asking the two assistants 5000 questions in the travel sector, 5000 in retail, and 3000 in finance and automotive sectors. **Figure 1** shows the response rate to these questions. These statistics do not consider correct information only if they provided a response. And it is clear from their research that the Google Assistant can answer a significantly larger percentage of questions.

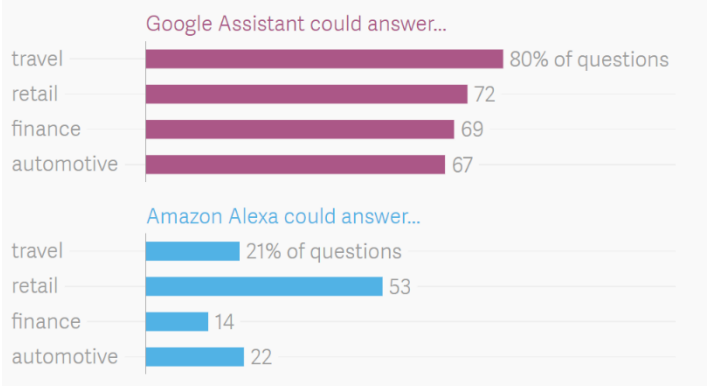


Figure 1 Smart Assist Quiz by 360i

Besides smart speakers, smart assistants can appear as an independent application on a phone o as a piece of computer software. The most recognizable phone based smart assistant is "Siri" this smart assistant appears on almost all of Apple's devices **(3).** Although Siri is the most recognisable, Google Assistant is the most prevalent among phones. This is since Google Assistant comes pre-installed as part of the android operating system. When used on phones the assistants are capable of opening apps, setting alarms and undergoing basic commands within apps (such as searching for something using a web browser). Using a tool such as a smart assistant can save the user a large amount of time. Such as hands free calling in a car. If a user were to use the command "hey Siri" they would then be able to call someone whilst keeping both hands on the wheel.

The way these assistants work is using artificial intelligence, neural networks and fuzzy logic. This allows them to take the initial voice input, analyse the raw data and map this to a command. In the most intelligent systems, for example Apple's "Siri", these machine learning techniques allow the system to respond only to the owner of the device. This requires the user to say the wake command several times and some sample commands. Doing this the assistant learns the owners voice, meaning only one person can interact with the smart assistant. This allows an added layer of security in what is a very private and personal matter. For many people smart assistants are used for little more than hands free calling. However, they offer a larger functionality. Directions and google searches whilst driving a car can be useful operations in certain situations.

Mobile smart assistant have seen an increase in many ways in both user base and capability. When first implemented smart assistants, such as siri, were brought under the spotlight due to cases where the smart assistant has given vastly different directions or recommending something illegal. A common controversy was the ability to find drug dealing services. A user may ask a smart assistant where to buy this product. And despite the product being illegal it would answer the request. Rather than refuse to offer the information. This could potentially encourage the user to commit a crime such as taking drugs. **[4]**

On mobile phones it is important to talk about operating systems. Android has a much larger ecosystem than iOS. iOS is only present among Apple devices, such as iPhones iPads and even devices using OSX. Whereas Android is licensable, there are many independent brands with their own android devices, this can be phones or even tablets. All these devices include their brands smart assistant, this means that Google Assistant is massively more present than Siri. Windows phone owns a very small amount of market share in the mobile phone industry and yet this operating still comes

with Microsoft's answer to the smart assistant boom. Cortana is a smart assistant that is available on windows phone **(4)** as well as the Windows 10 operating system. Windows 10 is running on over 400 million devices across the world **[5]** this does not directly mean that 400 million devices are making use of this smart assistant. For example, many of these devices may not be connected to the internet. And perhaps many of them have the Cortana feature disabled **(5).** There are also considerations to be made for Google Assistant. As mentioned, Google Assistant is now pre-installed on all android devices. However, this is only present on devices running on the Android update "Nougat" and higher. There are currently a reported 1.4 billion devices running android globally, and of this number only 29.6% are running compatible operating systems **[6]**. This reveals a similar value of roughly 414 million devices with the ability to run Google Assistant. It is clear, perhaps even without knowing it, the majority of modern society has access to at least one form of smart assistant.

As mentioned, Artificial intelligence and fuzzy logic plays a large part in these assistants. This can be used at several points within the command to action process. For example, neural networks are used to predict the most likely command the user gave. If, for example, the user said, "What's my age again?" there are several possible commands the assistant might execute. The most obvious response would be to tell the user their age, if the assistant has access to that information. However, there is also a song with that title. If that song was played often and in the user's library, it may assume the user wants to listen to that song. The response would be due to the output of neural networks and machine learning.

Not only are smart assistants becoming more present in our lives, they are also gradually becoming smarter and more interactive with other connected devices **(6)** the best examples of this are the video integration options with Alexa and Google Assistant. Both amazon and google have video enabled devices, Fire TV and Chromecast respectively, and it is now common place to request a film to be played on one of these devices. This will then make the smart assistant interact with the device in question and play the requested content.

Literature Review

Smart Assistants have only recently become sought after devices. This means journals and papers are incredibly uncommon on this subject. However, lots of research has been done into using artificial intelligence to implement health and safety features in modern technology and industries. Along with physical safety concerns there is also a great need for keeping everyone's private data safe. Due to the nature of these devices, they are collecting hundreds of pieces of information from their user. This creates a lot of uncertainty around the security of these devices and the necessity to store all this information about the user base.

Of course, the best reason for storing this data is to aid the machine learning algorithms that all these devices use. For example, a user may regularly search for football results. In many occasions Google Assistant will learn information about the user or prompt the user to provide it. This could be information about the team they support, this information will be sued to provide notifications for the user when their team is playing this can be extremely useful for sports as it will give the user the live score from their notification tray rather than a traditional search result.

Along with these features Google Assistant also gives local recommendations when near public locations. For example, when near a restaurant it will show the user a link to see reviews. This at first may seem incredibly useful information for the user. However, with this information it must mean that google is also consistently collecting location data. This location data can only be view by google as well as from the users google account. This has proved helpful but can leave a user feeling vulnerable. A user may access this data at any time by going to the location history tab on google

maps. This will show the user a view of their movement throughout the day. It will also show the user the location of devices that have logged on to a google service this day. Due to the fact a user may access this inherently means this information is stored by google thus can be subject to a cyber-attack **[7]**.

Location data is a hot topic when discussing smart assistants. Despite the dangers that come with storing a user's location, there are many positive features that arise with the inclusion of location information. Aside from the previously mentioned advertising, there is also traffic information. A smart assistant will learn your most common routes to and from work, school and your home. If there is heavy traffic in these areas it will notify the user with a notification on their phone, or in the case of a speaker it will mention this if asked about traffic conditions. This can be used not only to save time but it may prevent any accidents due to this delay. Sadly, due to the demand of location data from several apps on a user's phone many people have chosen to turn this feature off **(7)** This can affect the usefulness of data from smart assistants. A good example of this is search results. Search results are highly dependent on location data, some nations have been proven to hide certain search results, if it goes against the current government's agenda. And because of this smart assistant, and speakers, can act differently depending on their geographic location.

Not everything provided by a smart assistant requires a form of computational intelligence. A good use for smart assistants, particularly smart speakers, is time-based actions and reminders. This acts like an alarm, a time can be set with an action tied to it. This interaction can be extremely useful when integrated into a smart home situation. A smart home is a house that makes use of several smart devices, such as Wi-Fi enabled lightbulbs and a smart heating system. And these time-based reminders can be used to turn on lights at a certain time. Or set the heating system to a desired temperature for a certain time. This functionality provides a lot of benefits. The main being the ability to simplify life, saving time waiting for the heating to come when getting home from work can make the user's day to day life significantly more comfortable. This also can allow the user to save money on their electricity costs, during winter it can be tempting to leave the heating on to ensure a warm home to come back to. However, this obviously comes at a cost. If the user, implements a daily task for the heating to turn on an hour before they arrive it will save them significant money throughout the year. As an additional note, if the heating is left on unattended it can be a fire hazard. This means an argument can be made that not only do these systems simplify the user's life but they also save the user money and make their home a safer environment.

These systems can also bring some downsides. For example, if the user forgets to disable the actions when they are not needed. Such as leaving an automatic heating system on during the summer. This can cause an uncomfortable surrounding, which is opposite of the intended outcome. In this situation it could also cause an unsafe environment causing appliances to exceed their operating temperature and break. It can also cause minor health issues such as light headedness due to a large change in heat. Although these are smart systems, many of the products available on the market **(8)** simplify follow instructions given through an app and are only smart in the sense they can be controlled through a network. For systems that have AI capabilities the user must pay a large price premium to access these features, which is currently not present in the entry level or most commonly purchased system. In this case the proposal suggests that a smart assistant should be able to control the system, acting on its own, to prevent an unsafe environment

The practice of using artificial intelligence to aid the safety of a device is already present. Autonomous Vehicles use AI for many critical applications in their aim to get the passenger to the desired location. Throughout the cars journey many decisions are needed, such as route. To calculate the route not only is distance of each route considered but also current traffic and road works. The

self-driving cars also are required to follow the same laws as a typical driven car, this means the car must understand the meaning of road signs and traffic lights. They also need to have built in measures to avoid car accidents and collisions with unexpected objects. This can create a moral dilemma for those who are implementing these features. As it can result in the death of the passenger or a bystander, the decisions made can have a true and meaningful impact on the user. By nature, people are far more interested in self-preservation than the wellbeing of others. This may mean that the public would not like a logic driven system. A logic driven system uses the information available to calculate which outcome causes least harm. For example, if a car is about to get struck by an oncoming car and the only available route to avoid this car is by driving into a family of pedestrians on the path next to the road. In this situation the system must decide if the life and health of the passenger is more important than the health of the pedestrians. Clearly, by numbers the family is more important but there are larger moral conundrums involved. Simply put, would anyone purchase a car that is built, in certain situations, to intentionally harm the passengers?

Despite these mentioned issued that are being raised, artificial intelligence within autonomous vehicles provides a great deal of positive features. The ability to fully invest in a conversation is a simple task however is rare to experience when driving a car. Other than lifestyle improvements, they also bring plenty of safety features. Due to the speed of these technologies they can, surprisingly, be quicker and more efficient than a driver's reflexes. This can come in the form of swerving to avoid an obstacle or stopping when there is an engine error that a driver may not notice. These systems make use 360° cameras which gives the system information that perhaps a typical driver would not notice. Such as a car driving far too close behind. All these features allow the system to be safer.

This approach to safety is proportional to the danger that could occur. If an autonomous vehicle did not have a robust set of safety features it could lead to multiple injuries including fatalities, this can be considered a direct correlation. This seriousness is not present with smart speakers, they are universally considered safe devices. Without any consideration to safety these devices could lead to many users to unknowingly put themselves in unsafe conditions. Sadly, there are several situations that any amount of safety measures could not prevent.

If, for example, a smart speaker is used to set a daily reminder to take medication. This would be very useful for many people suffering from memory-based problems. However, if the internet is not working at that time or the user is not within hearing range they may miss their reminder. This reliance may mean they receive no other reminder and they do not take their required medication. In this situation the speaker fulfilled the actions as stated.

In the current market, there is no single solution to a fully smart, yet safe, system. Even at the high end with Amazon Echo Plus, Google Home Max and Apple's Homepod. These smart speakers each cost over £100. And this would require the user to further purchase smart light bulbs and heating systems. It would also require the development of an addon **(9)** that currently does not exist to enable a motion sensor to control these lights as well. And include methods to disable the motion sensor if necessary. The always on nature of a smart speaker makes it ideal to control smart devices, therefore it is important that safety features should be present here instead of just in the devices themselves.

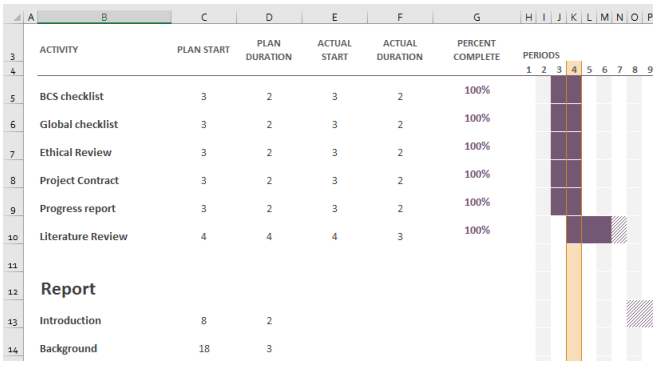
Development Stages

Planning / Management

To tackle these issues, a software solution was planned. Creating a full system would be out of the scope of this coursework. However, creating a software simulation would be a more appropriate alternative. To create a successful program a checklist was created to ensure the program not only met the requirements for a final year project. But met those set by the project supervisor and the expectations of those involved. Some of these software requirements are listed below;

- Individual light control, an array of lights that can be switched on or off
- Simulated motion sensor, Motion control which can turn on the lights when there's motion
- Time delay, Lights switch off after a specified amount of time
- Current temperature in local area
- Calculate a recommended temperature
- Set an automatic temperature. And identify system required – heating or air conditioning

Along with planning the functionality of the system and its goals. The progress of the project needed to be planned and controlled. This was a combination of time management and meetings with a project supervisor. There are several ways this project had planning involved, the main method was personal time-based goals. This was particularly important towards the end of the development. Even with a robust time management plan in place it is possible to become side tracked and go off course. The initial planning was primarily through a "Gantt" chart. This itemises different development stages and applies a time limit to it.



ACTIVITY	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
BCS checklist	3	2	3	2	100%
Global checklist	3	2	3	2	100%
Ethical Review	3	2	3	2	100%
Project Contract	3	2	3	2	100%
Progress report	3	2	3	2	100%
Literature Review	4	4	4	3	100%
Report					
Introduction	8	2			
Background	18	3			

Figure 2 Gantt Snippet by James Bielby

Throughout the development of the software, and writing this report, it was important to monitor progress and identify any shortcomings in either the approach or the design of the Gantt chart. During this coursework there were many external distractions, the first external issue prevented development of the temperature system. During the initial stages of the development there was no internet at the accommodation. This meant that development of this system either had to be postponed or a different development environment needed to be used, such as the library. As there were many other deadlines the prior option was chosen. In hindsight this choice resulted in very poor time management, along with this giving priority to other pieces of coursework was a large issue.

Addressing these issues was crucial to the continuation of the development of this project. To address and work through these issues the project supervisor agreed upon regular meetings to track weekly progress. Along with the agreement to attend an unsupervised lab session for several hours following these meetings. This improved the ability to focus and commitment to the project, resulting in the development accelerating from that point.

Once caught up to the initial project plan, the weekly meetings with the project supervisor ceased. This had 2 outcomes. The process of development was more relaxed and came at a more comfortable pace, it will also allow the supervisor to see the final product from a new perspective as it will be significantly different from the last meeting.

Evolution

Throughout the development of this project the ideas and execution changed considerable. Initially the program was to be written in C++. This choice was based on previous history with that language. Many previous coursework submissions had been based purely around C++. This provided a robust knowledge and experience which led it to be a natural first choice. However, through discussion and putting more thought toward it, it was clear this would not be an efficient choice. If C++ was chosen this would mean only two approaches were possible. Create a terminal-based solution which, simply put, would not be user friendly. The other option would be to use a graphics library such as SFML **[8]** this also came with many downsides. The main issue with SFML, and other graphics libraries for C++, is that it does not handle resources efficiently meaning if this was further developed beyond this coursework it may struggle on less then high end systems.

The next two methods would be to use either WPF or windows forms. This would require the programming languages C# and XML. Both of these are light weight graphical interface-based solutions. Between the two Windows Forms offers a slightly faster experience and more control over certain features of the operating system, however this part would not be used. WPF allows for more choice when it comes to design, and due to the ability to create a more unique and tailored experience allows for a more user-friendly design.

Once a development environment was chosen and implementation began it was clear that the system needed more functionality. Through meetings with the project supervisor two solutions had been suggested. The first solution remained software based this was to offer a indication into energy usage and costs. The idea was to create an interface for the user to select the devices used. This could be selecting which smart light bulb being used or the energy rating for the heating system etc. This would then calculate the costs over a year and offer advice on saving money.

The outcome of this meeting resulted in including the second choice. The second solution that was devised was a hardware-based solution. This required the development of a secondary program which would be run on an Arduino **[9]**. An Arduino is a small low powered board which allows for many different inputs such as sensors and use this data to send an output to a motor or similar device. It was important to the success of this project that the program would be functional with or without the Arduino connected. The implementation of an Arduino would allow control over actual led lights. It would also allow for a drastically more accurate temperature reading using a BMP temperature sensor. An Arduino could also provide the ability to make use of a motion sensor.

The inclusion of this added several points to the list of required features;

- Control LEDs through the application
- Receive motion sensor data and display within the application
- Allow control of LEDs through the motion sensor
- Temperature sensor

To make the hardware section of this coursework successful it not only needed to receive commands from the application, it also needs to send information from the board to the application. This level of planning truly helped identify an “end point” of the coursework. An issue which has been consistent through other pieces of coursework is identifying when a piece of software is finished. Creating a checklist made sure the time management aspect of this coursework was adhered too.

Implementation

Application

As expected, the application had the largest time allocation. This is due to the nature of the program. The initial program was developed independently, then when the initial requirements had been fulfilled the focus moved towards the hardware portion of the development.

When starting development, the first section that needed to be implemented was a series of variables. These variables will store important information that is needed by the system. The first that was created was 3 Boolean variables to store the state of 3 lightbulbs. Boolean variables are binary variables that can be set to either true or false. This allows for easy manipulation of labels within the application. If the light state is true, then this clearly denotes that the light is on.

When creating functionality, there are several parts that need to be considered. How is it going to be used? Is additional information required? And how will the information be displayed?

Simulating smart lights means the system needs multiple ways of turning on and manipulating the lights. In this scenario the user is able to individually address a single light, or the user can turn all lights on in one go.

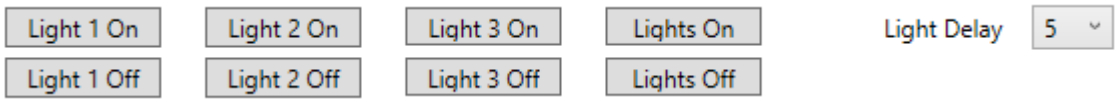


Figure 3 Light Control by James Bielby

Figure 3 shows the array of buttons that are accessible by the user. Upon pressing one button several things will happen. Firstly, it will set the variable "light1State" to "true". This will then cause the appropriate label to change to the current state. Along with this, it will output a message to user through the output terminal. The light delay options allow the user to select the amount of time the light will remain on without motion. This can be chosen from no delay, meaning lights are on whilst there is motion. Then the user can also select that the lights remain always on. This can be combined with the simulated motion functionality or a connected Arduino which when motion is detected will reset this delay.

The groupbox "Output" simulates the output of a smart assistant or smart speaker. Where a speaker would use a text to voice system. This application purely outputs a text result, this is first seen when the user launches the application. **Figure 4** is the output given upon loading the application. The time delay on lights is initialised. An Arduino board is not connected, this is due to no device connected to the chose COM port. And since the system running the application has an internet connection, it outputs this information also.

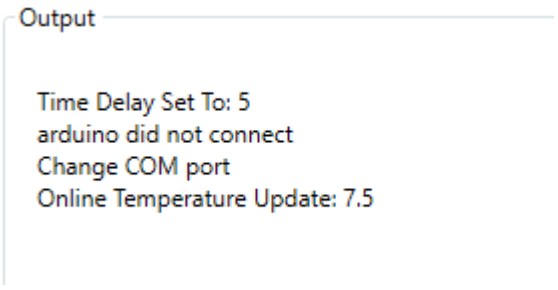


Figure 4 Output Groupbox by James Bielby

Simulating a temperature control was tricky, however, this helped dictating the order of development. Within this coursework temperature can be approached from two angles. Setting a value for the simulated temperature system. This would store a value for a future heating system to use. It must also include an auto setting which would calculate the ideal temperature for the room.

To make this calculation the system also offers a boundary option. The user can select a lower boundary and an upper boundary. Using this information if the temperature exceeds or goes under these values it will turn on this automatic system. The other half of the temperature section is receiving temperature values from the environment. Due to the nature of the application it cannot rely on always having the Arduino board connected. It must have a backup system in place to receive a temperature value. In the application the system receives temperature values from 2 sources online and the Arduino.

Getting a valid temperature from an online source proved difficult. “openweathermap.org” offers an online API to receive weather information anywhere in the world. Each user is allocated a key, due to the nature of this project the free version is appropriate. The free version allows the user to make up to 60 requests a minute. This number will be incredibly difficult to reach. As temperature is fairly consistent throughout the day the system only needs to make this request once every 10 minutes (maximum) using their API it is easy to make a web request to get the temperature and weather information for Leicester. However, once received this information needs to be parsed. This information is always presented in the same format, this makes it easy to get the information needed. The temperature value is always at the character position 78 or 79, this is due to some information before it. If the character at index 78 is a colon “:” then it will take the following 5 characters from index 79. If it is not a colon then it shall do the same from index 78. Once this value has been received it will then compare the value to the boundaries set by the user. It is important to note this value is given in the unit Kelvin. Despite further calculation being needed this is incredibly useful. If the value was given in Celsius and it was below 0 further parsing would be required to receive this information as it is given in kelvin it is always positive and 5 characters long (when calculating to one decimal place). This temperature value would also be used to calculate the ideal temperature for the system, the automatic value. This is calculated by taking the midpoint between the two boundaries and finds the average between this value and temperature value that has been received. This allows the system to set a value that will let the user adjust to the local temperature. As mentioned earlier this value is the temperature given by a weather API thus is an outdoor temperature for the city. The system would also benefit from the temperature of the immediate environment, this is why the Arduino is making use of a temperature sensor. The system will also make a note of what system would be used, for example if it was hot and the auto value chosen was below the local temperature it would use an air conditioning system. This is an added feature which improves the user experience.

Figure 5 Shows the environmental conditions groupbox, this is where the data from various sources is displayed. The first line contains temperature data, ambient temperature is the temperature received from the Arduino sensor. As an Arduino is not connected at this time no value is displayed. Next to this value is the online temperature. This is the temperature received through a web request next to this are the buttons. These buttons, when clicked, run a function to receive these values. During the initial development, the code for the web request was tied directly to these buttons. This mean to receive this information at another time or through an automated system was

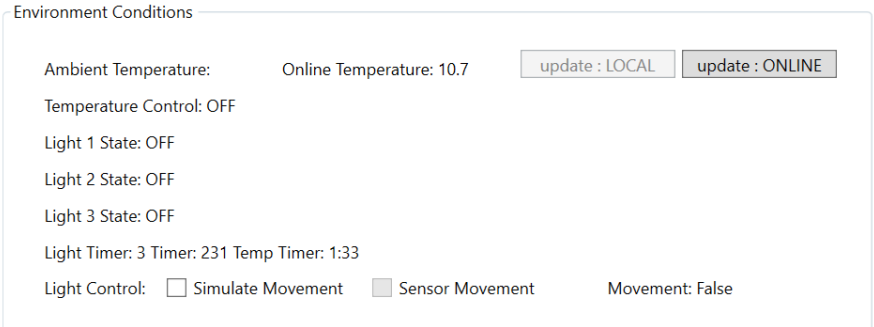


Figure 5 Environmental Conditions by James Bielby

impossible. The first work around was simply copying and pasting the code. This proved to be very inefficient and very poor code standard. Creating an independent function allows it to be called at any point whilst maintain a high standard of code elegance. This function "`getOTemp()`" is called automatically at several points whilst the application is running, the first is on start-up followed by 10 minute intervals.

The system also has 3 time counters. In WPF these are referred to as dispatch timers, these dispatch timers are started when the main window has loaded. Each timer is controlling a different aspect of the program, this is incredibly helpful as each timer needs to be restarted on occasion. This is particularly present with the light functionality. The first dispatch timer controls the light delay, this updates every second. The second timer is for typical use, such as updating the state labels this timer will run every millisecond. The third and final dispatch timer is used to control the temperature cycle. This dispatcher updates every second and tracks minutes. This timer is on a 10-minute loop. Once a minute it shall update the temperature from the Arduino board then when it has reached 10 minutes

The light timer also interacts with the motion sensor systems. When no Arduino is connected, there is the option to simulate motion. This will set the movement variable to true. As the light timer runs every second, every second the value for time is incremented and when this value is equal to or exceeds the light delay it resets back to 0 and the variables for lights are set to false (only if they were previously true). If at any point the lights are switched on, this time value is reset to 0. If the movement variable is set to true, every time the light dispatch timer runs it will reset the time increment to 0. This will effectively simulate the timer resetting every time there is movement. This is a very robust method of simulating movement, it is also the way movement works when an Arduino is connected.

As mentioned these dispatch timers are initialised when the window is loaded. As the window is handled by XML, it was easy to create a function that was run when the window had loaded. The function "Window_Loaded()" starts the timers and runs two functions. One of these is what is referred to as a Boolean function. This is a function that contains codes which will output either true or false. The output of this function ("checkConnection()") checks to see if the user has an internet connection. This function is very simplistic but offers a very quick solution. The system will make a web request to "google.com". This makes use of a try catch statement, if the web request is unsuccessful it will return an "exception" in this specific case it will throw an exception of type "WebException". By default, only the code within the try block is run. In this case the catch block has been given the parament of "WebException" meaning if there is an error with the web request it will skip the following code and run the catch block and return the bool false.

```
<Window x:Class="FYP.MainWindow"
        xmlns="http://schemas.microsoft.com/winfx/2006/xaml/presentation"
        xmlns:x="http://schemas.microsoft.com/winfx/2006/xaml"
        xmlns:d="http://schemas.microsoft.com/expression/blend/2008"
        xmlns:mc="http://schemas.openxmlformats.org/markup-compatibility/2006"
        xmlns:local="clr-namespace:FYP"
        mc:Ignorable="d"
        Loaded="Window_Loaded"
        Title="Simulation"
        Height="720"
        Width="1280"
        ResizeMode="NoResize"
        >
```

Figure 6 XML Code Snippet by James Bielby

Arduino (Board and Sensors)

When creating the hardware, it was important to justify the use of each component, particularly the board. The board used for this project is an Arduino Uno, in comparison to many other Arduino boards this is considered rather large. The alternative board that could've been used for this project is the WeMos D1 or D1 mini. These two boards are a part of a series of Arduino style boards which offer a built-in Wi-Fi chip. This would allow for a remote connection to the application. Theoretically the WeMos board would make use of the temperature sensor and motion sensor then send this information through the internet for the application to manipulate and display, among other uses. As the aim to simulate a smart assistant the motion sensor data would also need to be received by the application then a message would be sent back to the board to activate the LEDs. The main reasons against these boards is that the system of sending messages through a network would produce a rather significant delay in receiving a piece of data from a sensor to displaying it. Even longer in the case of the LEDs. Along with this delay there is also an issue with support given to the boards. Very few libraries are supported by these boards and alternative, less sophisticated libraries would be required. Although not necessary for this project these boards also do not have as much power as the Arduino Uno.

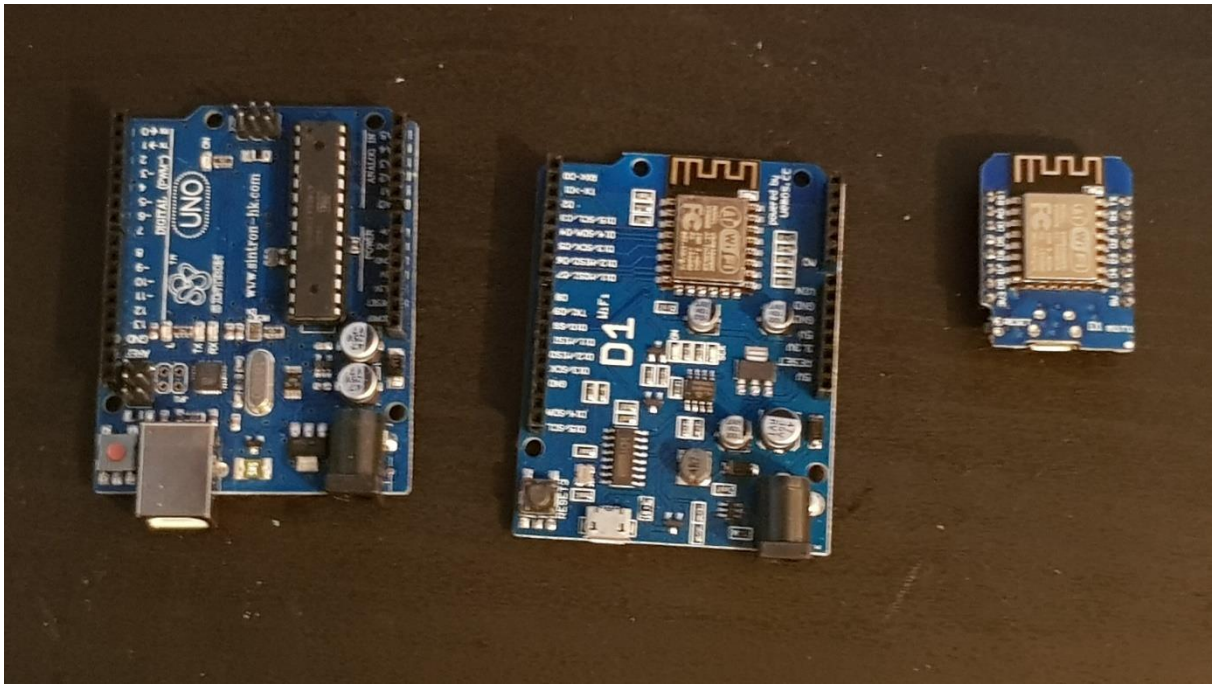


Figure 7 Arduino Uno, WeMos D1, D1 mini Captured by James Bielby

As shown in **Figure 7** the three boards are very similar. As displayed the two boards on the right are the WeMos boards, the smaller of which is the D1 Mini. The D1 mini was discarded due to number of analogue and digital pins. This board would need to accommodate the number of sensors and LEDs that needed for the coursework. The benefit of the Arduino Uno is the board itself also has a pair of addressable LEDs, this can be used to indicate a connection or received messages.

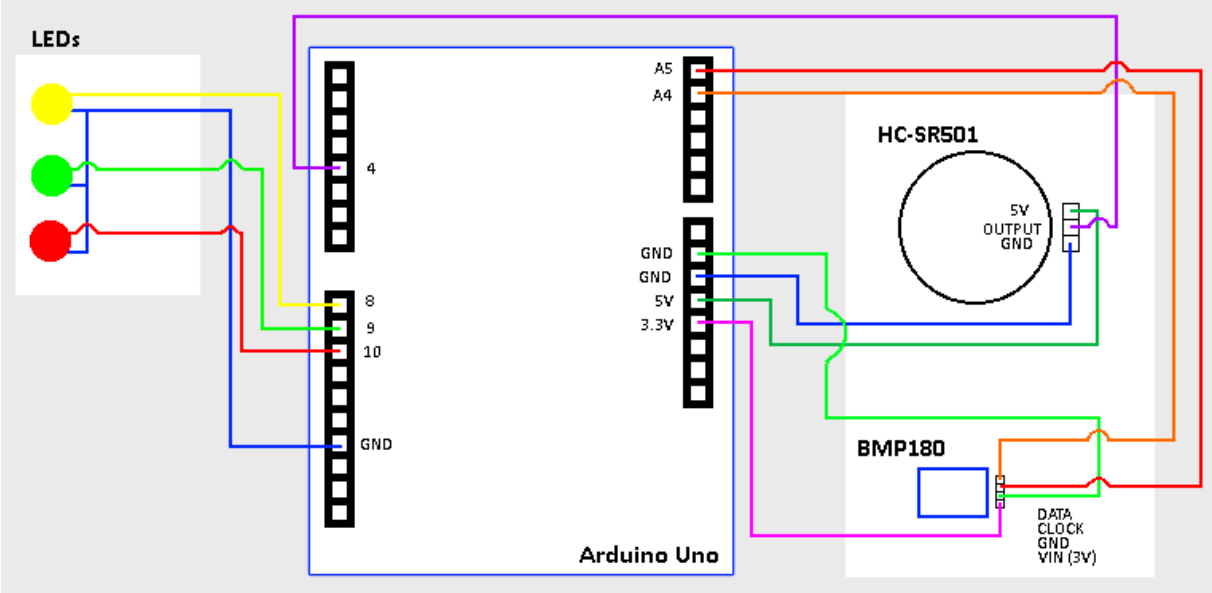


Figure 8 Board Schematic by James Bielby

Figure 8 shows a schematic diagram of the Arduino Uno board and the accompanying sensors. The Arduino makes use of two separate breadboards **(9).** This design allows one board to be allocated to input sensors whilst the other, smaller, board is used for outputs.

The blue rectangle on the lower right indicates the BMP180 sensor. This sensor is capable of measuring temperature in the immediate environment, this functionality is what is used in this coursework. The BMP180 sensor is also able to measure barometric pressure, although useful information it was not required for this coursework. For this sensor to function correctly a library was needed to interpret the input from the sensor. There are many libraries available for this sensor. This is due to the sheer number of variants of this board. As only the temperature aspect will be used for this coursework there is no need for a complex or sophisticated solution. In this situation the lightest and most simplistic library is a better choice. The BMP085 library from Adafruit was developed for an earlier model and is far less resource intensive than the libraries developed for the model used in this coursework. The downside of this library is if, in the future, a pressure value was needed then a more recent version would be required.

The top right sensor is the HC-SR501 motion sensor. This, unexpectedly, is far simpler to operate than the temperature sensor. The sensor makes use of three pins, as expected there are power and ground pins along with an output pin. This pin connects to a digital pin on an Arduino. Using this pin the board reads the input from the sensor, if the input is recorded as “HIGH” then this means the sensor has registered movement. However, if the output is “LOW” this means it is not registering movement. This sensor has additional built in features which can be used within this project the most useful of which is the inclusion of two dials. One controls a time delay, while the other controls the sensitivity. Specifically, for this project the sensitivity is extremely useful. Is this project is intended to track the motion of humans the sensitivity might need to be quite low. If a higher sensitivity was used simple objects may trigger the sensor such as wind or small insects. For this project the time delay is set to the minimum value. This delay, unfortunately, cannot be set to 0. When the sensor gets a movement input it sets the output to “HIGH” the time delay is responsible for how long this signal is set for the minimum of which is 5 seconds. This can be set up to 5 minutes if needed. The reason this has been set to 5 seconds is due to the implementation of the systems on time delay functionality. This adds some ambiguity to the system, the instant movement is registered the LEDs

are switched on, once motion has ceased the sensor will continue to output “HIGH” for a further 5 seconds. After this time the application will then change the state of the movement variable to “False” allowing the countdown to continue. This means if the delay in the system is set to 5 seconds. From the moment movement stops it will take 10 seconds for the lights to go off. The sensor also offers another method to manipulate the sensor data. On the base of the sensor there is a jumper connection that initially is set to Re-triggerable, this means that when movement stops if the sensor detects movement before it turns off it will restart the timer. If however, the jumper has been moved to non-Re-Triggerable this means once the sensor has detected movement it must output “LOW” before it can detect any further movement. This allows for many different use cases for this specific sensor. As the aim of this is create a safe environment it is clear the first, and default, setting is required for this project.

As mentioned, the breadboard on the left of the Arduino is the board responsible for housing the output components. In the coursework’s current state, the only output components present LEDs. The 3 LEDs can be individually address by the application. Each LED has its on colour. This is purely for cosmetic reasons and helped during development to identify any errors that occurred. Referring to **Figure 8,** the “light1state” variable is represented by the yellow LED “light2state” is represented by green and finally “light3state” is red.

Arduino (Programming)

Along with implementing code for the application, code needed to be developed for the Arduino board. Not only does the system need to send information to the board. The board also needs to communicate with system, for example sending the temperature value. This code is written and developed within a separate development environment. The Arduino IDE not only allows code to be written and sent to an Arduino board, the IDE also allows the user to read the information sent through the serial port. It can also be used to write data to the serial port for the Arduino to receive. This is similar to the way the application communicates with the board.

The Arduino IDE uses the programming language C, despite the difference in language it was rather simple to develop the program for the board. Having experience developing for Arduino massively helped the development pace. When starting development, it was clear which libraries were needed. The BMP180 temperature sensor is what is referred to as an I2C device these are devices that make use of the data and clock pins (A4 and A5 on the Arduino) these means the “Wire.h” library along with this the “Adafruit_BMP085.h” was needed to declare and address the BMP180 sensor.

Arduino code is developed in 3 parts, libraries, “setup” and “Loop”. The setup function is ran once when the Arduino is first switched on. This function is used to initialise variables **(10)** and declare the pins which are being used. As shown in **Figure 9** the first part of this code is declaring 3 pins as outputs. These are used to operate the LEDs, “pinMode” dictates the direction of communication, as shown towards the end of the code pin 4 is declared as an input this is used

```
void setup()
{

    pinMode(8, OUTPUT);
    pinMode(9, OUTPUT);
    pinMode(10, OUTPUT);

    Serial.begin(9600);
    if (!bmp.begin()) {
      Serial.println("Could not find a valid BMP180 sensor, check wiring!");
      while (1) {}
    }

    pinMode(4, INPUT);
    digitalWrite(4, LOW);
```

Figure 9 Arduino Setup Function written by James Bielby

by the motion sensor to write to the board. Along with this, as pin 4 is declared as an input the system writes to that pin “LOW” this means no power will be sent out of the pin.

“Serial.begin(9600);” opens the serial communication using Baud Rate 9600, the board rate dictates the number of oscillations per second. If the serial port was not initialised the Arduino would not be able to communicate with the application, and vice versa.

Along with this the if statement checks to see if the BMP sensor has been declared by the library. If not, it will output an error to the serial port then keep the application in a while loop until it has connected. This code is purely for debugging. Due to the implementation of the Arduino the serial port output will not be seen by the user, only by the system when receiving temperature values and motion sensor data.

The communication between the board and the application was implemented in an unorthodox yet efficient method. The best example of this is turning on a light. When the use presses the button to turn on light 1. This changes the state of the appropriate variable. Once this variable changes, the dispatch timer (running every millisecond) changes the labels within the application along with this, it also writes a character to the serial port. If light 1 was switched on the character “1” would be sent to the Arduino.

The Arduino “Loop” function will be constantly ran whilst the board has power, this function reads the serial port for incoming characters if a character is sent it will run the appropriate code. When the character “1” has been received by the Arduino it sets the appropriate LED to “HIGH” this will cause the LED to be on until the character to turn it off has been received. The character “q” is required to turn off LED1. This is sent when the state is set to false. The sending of these characters is handled by a dispatch time which runs code every millisecond so there is very little delay between the state being set and the character being sent. Since the Arduino code is within conditional clauses it will be refreshing too frequently to create any noticeable delay.

This same method is also used for receiving the temperature. When function to get the local temperature is ran the character “7” is sent to the Arduino. This then runs the appropriate if statement. The Arduino then writes the current temperature, in degrees Celsius, to the serial port. The application, having just sent “7” is reading the serial port until data is received. The temperature is read as a string, this string is then cast to an integer to be stores as the ambient temperature variable.

As the motion sensor requires regular messages, the character is sent to Arduino once a second. The character “r” is sent to the Arduino and depending if the system has registered it will send the required string. One representing movement the other meaning no movement has been registered. While sensor movement is enabled the system will be constantly reading the serial port for these messages. When the system receives a registered movement, it will then set the states of the lights to true. Due to these variables being true the characters for each light will be sent to the Arduino thus turning them on.

As mentioned earlier, the system runs the “Window_Loaded()” function when the application launches. Part of this function is to connect the Arduino. The “connectArduino()” function runs a try catch statement. This sets the Baud Rate to match that by the board (9600) as well as setting the COM port. Due to many computers having different mapping of their USB controllers the Arduino may be connected to COM4 on one device and COM3 on another.

The addition of the Arduino brings a physical element to the simulation. This offers the actual temperature value of the immediate environment, this is a rather significant improvement over the alternative. Although there is plenty of information to be gained from the outside temperature. This only contributes a small amount to the automatic temperature system.

This coursework shows what additions could be made to the current suite of smart assistants. The inclusion of a temperature sensor within a smart speaker will not only provide the user with more accurate information but may also can create a safer living environment for the user.

Design Aspects

Despite this coursework being a simulation, it was important to optimise the user experience. Creating a user friendly experience is a key factor to the projects success. From the beginning of the development the design had played a key part. Implementing certain functionality first made it clear how the design should be approached. The application is split into 4 separate sections;

- Environmental Conditions
- Setting values
- Connection Data
- Output

These 4 sections have been displayed with thought in mind. The left-hand side, Environmental Conditions, contains all the values for the user to observe, in this area no values will be entered. Environmental Conditions, as expected, displays values such as temperature and the state of the various lights. There are also buttons to update these values as well check boxes to enable motion detection.

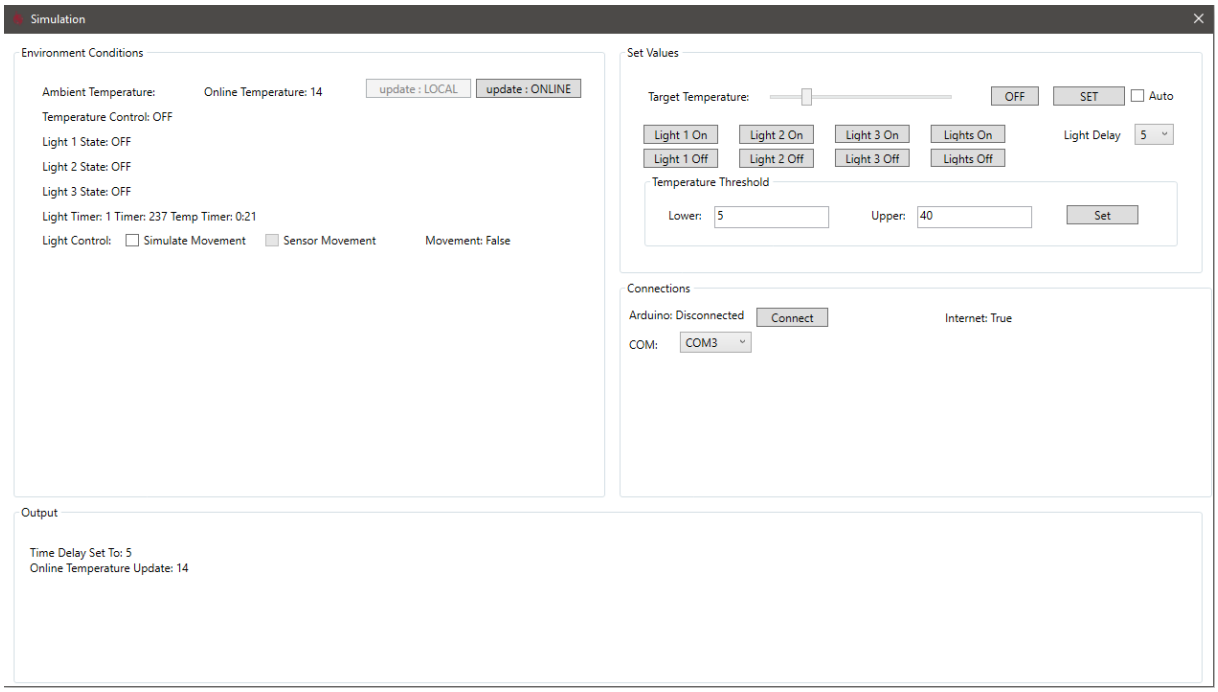


Figure 10 Application Screenshot by James Bielby

Figure 10 shows the application, as it currently stands. As shown the "Set Values" groupbox contains the functionality that a typical user may wish to make use of. This section will simulate using a typical suite of smart devices. Offering different functionality depending on the groupbox they are in clearly segregates the type of information they represent. The output taking up the width of the application

also draws the eye. The output is very important to the user experience, despite being a simulation the output needs to be as clear and concise as possible. Overall the design of the application has met expectations and can be considered a success.

Testing

Testing the application proved to be a lengthy process. To undertake a full unit test, the limit of each functionality needs to be tested. **Table 1** was created to log the findings from this testing.

Despite being monotonous, the findings of all the functions regarding lights and temperatures all acted in the expected manner. The testing was conducted by calling every function in all possible ways. For example turning light 1 on can be done by pressing the button. Light 1 can also be turned on by using a motion sensor and also the simulated motion function. This was done under several situations, turning a light on that was previously off. After the result of this was recorded, the function was ran again to see how the system would react. In the case of the light, the output would read "`Light 1 already ON, no changes made.`" This rigorous testing continued throughout the application. Fortunately, there were no unexpected errors (or errors of any kind) from the application side. The Arduino had less consistent results. The test which required the Arduino were ran, these all produced the expected results. Then to ensure knowledge of the system, the Arduino was dismantled from the connected components. **(11)** Once the Arduino had been reconnected the tests were ran once more. However, upon running the application it would immediately crash and close. Upon reading the console it was clear the Arduino was producing errors in its output. Whilst the Arduino was still connected a serial monitor application was used, Arduino IDE contains this functionality. When the Arduino was restarted it was clear the temperature sensor caused the application to constantly run the error while loop. When it was clear which component was the issue, this was removed and replaced with a spare component. Changing the component still produced the same error. This lead to the visual inspecting the entire system, as well as referring to the schematic diagram. From this it proved that when re installing the temperature sensor the data and clock pins had been swapped when wiring the component to the board. This led to some ideas about the future of this project.

Critical Analysis

This project was to develop a simulation of a smart assistant which offered improvements to the service provided by the current suite of assistants. Although many of these improvements are safety-minded there is some functionality simply developed to provide a better user experience and offer more options to the user.

In the first stage of development a series of targets were set in order to create a successful end product. Along with this several points were end during development to add further functionality and a better, more interactive, experience. Due to these goals being clear and concise it allows an easy measure to show that this project is a success by these definitions.

Although this project can be considered a success there are ways this project can be improved. Along with these improvements there are also several directions this project could be taken to develop the ideas further. The main improvement that could be made would be to improve the way the Arduino connects to the system. As mentioned briefly, the WeMos D1 board would allow for a wireless connection to the internet. The time difference created by sending and receiving messages in this manor would be noticeable. However, these boards can also act as an access point for the application to connect to, as this would be a direct connection there would be very little latency. This design would have an additional cost as the system running the application would be required to

connect to the network created by the D1 board. A typical computer would only have a single network card, meaning the computer would only be able to connect to one network at a time either the D1 board or the internet.

Creating a wireless solution would be a significant improvement to the current implementation as it could then be extended to a modular system. The cost of creating multiple access points for each module would be far too great for the outcome it would provide. However, the information being transferred between the modules would be rather small. A module that could be create would simply contain a temperature sensor and a motion sensor this would then send the information to a host board to communicate with the application. A cheaper and more lightweight option would be to use an Arduino Nano, or similar small form factor development board, and communicate to the host board using an RF transmitter. RF transmitters and an Arduino Nano would provide a similar result with less latency. The modules could be dotted around the room and still be within range of the RF receiver. This would allow the motion sensors to have a greater reach and cover the entire room. This would also allow the system to target a specific lighting area, for example if one sensor registered movement but another did not it would only turn on a specific light and could be used to track motion and create dimming affects with the lights. For this specific project the LEDs could be dimmed using PWM to limit the power sent to the LED. Along with the benefits of multiple motion sensors. Having multiple temperature sensors would mean the temperature would be massively more accurate as an average of all values could be taken. The only disadvantage of this approach is the modules would require a power. Either from a plug socket or from a battery. If battery powered it would need be a high standard to avoid the constant need for charging.

Due to this being a simulation voice recognition was not implemented. Aside from the proposed module solution, the next logical step for the project would be to implement voice recognition. This could be approached in several manors, the first option would be develop a new unique system but this would require advance knowledge on natural language and behaviour as well as implementing the required neural networks to analyse this data. The alternative method would be to use an existing API to receive and analyse the language data. Google has created a public API to handle this data. Typically, this service is free for occasional use although there are available plans for regularly use. This may cause some confusion for the user as they may confuse an assistant using Google's API with Google assistant. Another important note would be the ability to create a better listening experience. If the modules were used a microphone could be connected to each module and allow for listening anywhere within the room. The current method of a single high quality microphone very clearly works, however, having several lower quality microphones may offer a similar experience and could potential save money on development costs. This would be a good next step as currently this project does not have functionality which requires any advanced computer intelligence such as fuzzy logic or neural networks. Perhaps the temperature system could benefit from a fuzzy controller which takes into account the time of year to suggest a temperature that could be set

The work done on this project puts an emphasis on the user experience. Making it as sleek and elegant for the user as possible, this is why many of the systems are automatic. The idea of a smart assistant is to simplify the user's life and make their life easier. The automation provided by a tradition smart assistant may not go far enough. Allowing more automation can also create a safer environment. A key example of this is that most users do not know the maximum and recommended operating temperatures of their devices. Receiving regular automatic temperature could allow the system to take precautions and potentially save the user money on a replacement.

The final criticism and recommended improvement to this coursework would be to create a hard wired version. The use of a breadboard makes the system as a whole delicate and rather bulky. Using

traditional methods to hard wire the components onto a development board would allow for a more compact and professional looking product. This could also allow for an enclosure to be built around it.

Conclusion

Smart assistants have undergone a huge shift in popularity in the recent years. Due to the sheer presence of these assistants they need to be monitored and systems need to be put in place to prevent harm being caused to the user, both physical and emotional. By creating these functions with foundations in safety it inherently offers a more user-orientated experience and can lead to safer operation of these devices.

Developing this project further would require a big step in programming knowledge. Creating neural networks to develop a new voice recognition, although impressive, would be out of scope for this project and could take a considerable amount of time compared to that which was given. Overall this project can be considered a success. Clearly defined development goals was a massive help to creating this application. Meeting these requirements clearly marked when the project was finished and created a concise product which provides the user with an efficient and clear experience.

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Appendices ()

(1) Across multiple domains such as .co.uk and .com

(2) Amazon has many sales throughout the year such as Christmas, mothers/ fathers day etc and almost always includes a discount of an echo and fire device

(3) Apple has a large range of smart phones and tablets which include the Siri smart assistant.

(4) Cortana was release on windows phone with the Windows Phone 8.1 update

(5) There was a large controversy regarding the telemetry features of windows 10. Due to the privacy concerns so many people turned off the telemetry features which included disabling Cortana

(6) This can be anything such as a fire stick or fire tv which comes with Alexa pre-installed. Or can be similar to the Chromecast which can be control from a Google Assistant which is on the same local network. Such as a google home.

(7) Constantly having location data turned on can cause a mobile phone to use battery at a faster rate as it needs more resources. This can also in turn slow the device down if many apps are making requests

(8) This is through research into the available smart home systems and package that are sold by companies such as Hive and nest.

(9) A breadboard is a board which allows components to be connected without the use of wires. Although commonly jumper wires are used to connect the lanes of the bread board together as well as connecting the breadboard to the Arduino

(10) Typical the variable is declared alongside the libraries and then a value is attributed in setup

(11) This was done to take pictures of the board by itself

Acknowledgements/Libraries

- System.IO.Ports was used to interact with the serial ports using .NET framework (WPF)
- Adafruit_BMP085 library was used to receive temperature values from the bmp180 sensor
- Arduino IDE was used to code and test serial output/input the Arduino board.
- Visual Studio was used to create the application
- Arduino Uno board
- 3 3v LEDs (1 red, 1 yellow, 1 green)
- HC-SR501 Motion sensor
- Alternatives tested using a WeMos D1 board
- Along with the previously mentioned references. literature from the initial literature review was used to support the discussion.
- MATLAB was used shortly but was disregarded due to the simplicity of the task being used.

Tables

Function	Use	Performance			Comments
		Not as expected	Expected	Better than expected	
Light1On_Click	Turn on light 1		X		Turn on when already on resulted in the comment “no changes made”
Light1Off_Click	Turn off light 1		X		Turning off the light while it was already off had the same outcome
Light2On_Click	Turn on light 2		X		Same outcome for all lights
Light2Off_Click	Turn off light 2		X		
Light3On_Click	Turn on light 3		X		
Light3Off_Click	Turn off light 3		X		
LightsOn_Click	Turn all lights on		X		
LightsOff_Click	Turn all lights off		X		
delayComboBox	Set time delay to 0 seconds		X		Turned the lights off when no movement was registered.

delayComboBox	Set time delay to 5 seconds		X		
delayComboBox	Set time delay to 10 seconds		X		
delayComboBox	Set time delay to 15 seconds		X		
delayComboBox	Set time delay to 20 seconds		X		
delayComboBox	Set time delay to 30 seconds		X		
delayComboBox	Set time delay to 60 seconds		X		
delayComboBox	Set time delay to Always on		X		Sets delay to 9999999999999 seconds (317097.9 years)
TempSlider_ValueChanged()	Small change on slider (mouse click)		X		
TempSlider_ValueChanged()	Big change on slider (mouse click)		X		
TempSlider_ValueChanged()	Small change on slider (keyboard)		X		Slider needs to be selected as expected

TempSlider_ValueChanged()	Set max Value		X		
TempSlider_ValueChanged()	Set min Value		X		
TempSlider_ValueChanged()	Setting value to 0		X		Turns all heating system to off
tempOffBtn_Click()	Sets temp slider to 0 and turns heating off		X		
TempSet_Click()	Set temperature to value shown		X		
autoTempCheck	Checking Box manually No internet no Arduino		X		Uses boundaries to create a suggested
autoTempCheck	Checking Box manually no Arduino		X		Average of boundaries and local temp value
autoTempCheck	Checking Box manually No internet		X		Average of boundaries and ambient temp from Arduino
autoTempCheck	Checking Box manually		X		Average of all values
connectArduino()	When run on start-up	X		Even when connected to correct COM port it requires manually pressing the connect button. This is because the COM port is allocated by the selected item on the drop down. The function to connect the Arduino is run before the drop down is created so cannot get the value. System has been removed	

connectArduino()	Manually connect to the board with the button (correct COM port connected)		X		Connected
connectArduino()	Manually connect to the board with the button (incorrect COM port)		X		Did not connect and stated reason why. Prompted to change com port.
Button_Click()	Set upper and lower bound to those set in the text boxes		X		Works as expected
Button_Click()	Set lower bound to a number high than upper bound		X		Values swapped
getLTemp()	Pressing when Arduino is not connected		X		Button disabled cannot be pressed
getLTemp()	Function should be run when first connected		X		Temperature is received when connect
getLTemp()	This function should be run once a minute		X		Worked as expected
getLTemp()	Get temperature when button pressed		X		Worked as expected
getOTemp()	Should be run when application launched		X		Values received
getOTemp()	This function should be run once every 10 minutes		X		Worked as expected

`getOTemp()`	Get temperature when button pressed		X		Worked as expected
`getOTemp()`	Button pressed when no connection to the internet		X		Button disabled
`simulatedMovementCheckBox`	Should set movement to true and all lights should be true (no Arduino)		X		Values set to true when checked and false when unchecked (after time delay)
`simulatedMovementCheckBox`	Set to light values to true when checked and turn on LEDs (Arduino connected)		X		LEDs turn on as expected
`sensorMovementCheckBox`	Checking box with Arduino Connected (no movement)		X		Starts to receive current state of motion sensor “No Movement” in console
`sensorMovementCheckBox`	Checking box with Arduino Connected (with movement)		X		Outputs “Registered” in console and turns movement to true and turns LEDs on
`sensorMovementCheckBox`	Checking box with no Arduino connected		X		Check box is disabled when no Arduino is connected

Initial Submission

IMAT3451 Project Contract Template

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Exploring the role of AI and Fuzzy logic in enhancing the safety measures of smart assistants Mario Gongora

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Introduction

A research and development project looking into potential safety concerns not being taken into consideration, this is likely to come from a user giving an order, which may cause potential risks. It will also cover moral questions such as should a device be able to ignore and override the users input.

Project Background

My project address problems in the growing world of smart assistants, having owned a smart assistant and being accustomed to using it daily. With the user adoption rates increasing it is important to consider any possibility of making the system itself inherently safer. I will also talk about the implications of a smart assistant being able to ignore or contradict a command given by a user and how society will react to such a system. My personal use of a smart assistant is what has given me motivation for this project I have experience of a smart assistant becoming a device I use regularly throughout the day every day. I have realised throughout the use of my device that when using it I tend to change the way I speak to it. This shows that using a smart assistant regularly does have some behavioural effects. This is something I'd like to explore throughout my project.

Aim/Objectives/Deliverables

Aims: I am going to present some safety issues that lie within the current set of available smart assistants I will also offer a software based simulation to provide an example of how these safety measures may be implemented. I will also talk about the practicality of this and any cost added to the manufacturing process and subsequently how this can affect adoption rates

Objectives:

My main objective is to create a competent simulation of a smart assistant with a choice of environmental variables. Such as time, temperature, weather, light levels etc this system would not only provide some safety benefits but could also add some extra efficiency and potentially some cost benefits (suggesting not turning a light on when the ambient light is already high)

These are some more of the objectives I wish to fulfil

- To investigate the needs of my project and provide a software solution
- To research moral and social issues that come with the idea of a super-smart assistant
- To research any safety issues that could come from a fully obedient system
- To follow my project/time plan to the best of my ability to ensure the appropriate deliverables are met to a high standard and on time.

To undertake literature review(s) that will take difference stances on the theme of smart assistants. Ideally, I would like to focus on the concept of safety but I feel like the idea of smart assistant's place in society would be a good place to start a conversation about moral topics and how they affect people day to day. This would help me create a valid counter argument against the need for any safety measures.

For my development portion of the project I will create a software solution to the issue I have proposed this will be developed using different software methods including visual studio with options of MATLAB and Arduino IDE where needed. To gauge how successful my software is I will stage several unit tests to test the output under many different environmental conditions. As it is a simulation I will not be able to test this program using a traditional smart assistant (Siri, Alexa and Google Assistant) this may be due to several reasons the main being the current set of physical smart assistants (amazon echo, google home) do not have the hardware needed to fulfil my aims. Such as a temperature sensor.

Deliverables: a list of your Project's deliverables with some general description.

	Research Projects	**Development Projects**	**Hybrid Projects**
First Submission (first deliverable) Week 7	• Project contract • Ethics form • Project Plan (e.g., Gantt Chart) • Global Checklist • Scoping Review (mapping out the key concepts and work in the field) • Research Questions	• Project contract • Ethics form • Project Plan (e.g., Gantt Chart) • Global Checklist • Literature Review • Requirements • BCS checklist (if pertinent)	• Project contract • Ethics form • Project Plan (e.g., Gantt Chart) • Global Checklist • Literature Review • Requirements • BCS checklist (if pertinent)

Final Submission (final deliverable) These are some examples: each project will need a complete set of objectives/deliverables Week 29	• Full literature Review • Updated (if needed) Research Questions • Report on the field study • Findings and analysis • Conclusions etc. • Reference list • Appendices (surveys, interviews evidence etc) • Maximum word count (main body): 15.000	• Use Case Diagrams/Use Case Descriptions/Class diagrams/ER model/State transition diagrams • Story boards/Interface Designs • Design Documentation • Test Plan • Prototype • Final report, including critical evaluation • Software • Appendices (e.g. further design documentation, test logs) • Maximum word count (main body): 15.000	• Use Case Diagrams/Use Case Descriptions/Class diagrams/ER model/State transition diagrams • Story boards/Interface Designs • Design Documentation • Test Plan • Prototype • Final report, including critical evaluation • Software • Appendices (e.g. further design documentation, test logs, surveys, interviews evidence) • Maximum word count (main body): 15.000
Viva examination: attended by the supervisor and the 2nd marker Weeks 30-32	• Oral examination (presentation of your work) During week 28 supervisors and students will need to start communication for setting up the Viva	• Oral examination (demo of your work) During week 28 supervisors and students will need to start communication for setting up the Viva	• Oral examination (presentation and demo of your work) During week 28 supervisors and students will need to start communication for setting up the Viva

Resources and Constraints

The development of my software simulation will require a mix of different software, below is a list of the software I will use, why/how I will be using and any constraints this may cause.
Visual Studio, I will be using visual studio for prototyping my simulation. As I have this software on my computer there are no constraints with using this software.
MATLAB. May be used in the situation where a fuzzy logic controller is needed to evaluate environmental conditions and variables. For example, temperature and current time maybe used as inputs to create a fuzzy inference system.
Arduino IDE, during my project I will be creating a hardware example of how a smart assistant could receive environmental information. Such as a temperature sensor to find out the current temperature of the room. Arduino IDE is a free piece of software which I have on my computer and laptop. I also have a large inventory of hardware that I can use, if I find a better alternative this may invoke a cost, but this will be an insignificant cost less than £5

Sources of Information

A list of sources you intend to use. These could include:

- Literature on the topic, referenced in the first deliverable
- MATLAB fuzzy logic toolbox and help documentation
- Arduino IDE
- Internet
- DMU library website for literature review
- DMU staff relevant to fuzzy logic, in case of issues

Risk Analysis

A greater risk comes from the lack of internet in my accommodation. This is an ongoing issue and have already been using a work around (library and downloading any documents and lab sheets in advance to us in my flat) one potential issue is accessing the library website or any online sources this will require major planning and forward thinking. I have been given reassurance that this issue will be resolved. However, no time frame for this has been given.

As this is a development project the vast majority (potentially all) of my work will be in digital format this inherently comes with the risk of data loss to prevent this I will make use of the cloud storage space the university has provided taking extra care with important documents by using portable hard drive or USB sticks.

Schedule of Activities

I will start by fulfilling the first deliverables. This includes:

- Project contract
- Ethics form
- Project plan
- Periodic project Report
- Global Impact Checklist
- BCS checklist

These will be fulfilled by the agreed upon date, 27th October. I will then start work on the research aspects of the project, beginning with the literature review (due week 7) then after this has been submitted and looked over by my supervisor I will begin work on my introduction and conclusion to my final report. Pre-writing the conclusion will help me as a sort of checklist it will outline and act as a reminder for what I will need to cover in my report. After writing the theoretical portion of my report I will start to fully develop my software solution. During this time, I will also consider and test any hardware possibilities. After I have finished my software development I will then return to the report writing to talk about how my project will help change the smart assistant eco system and talk about any issues, including a critical analysis of my work and results. If I discover and major issues I will attempt to fix these, however if they are small issues I can use this to talk about improvements and further developments to the software.

Student_____*James bielby*_____ **Date**____**24th Oct 2017**__

Proposer _____*Mario Gongora*_____ **Date**____**24th Oct 2017**__

Supervisor_____*Mario Gongora* _____ **Date**____**24th Oct 2017**__

Keep the signed copy somewhere safe: include it with your initial submission. Your supervisor will require a copy as well.

IMAT3451 FINAL YEAR PROJECT - ETHICAL REVIEW FORM

The University requires all undergraduate final year projects to undergo an ethical review and, where human research ethical issues are identified, to ensure that these issues are addressed.

For the majority of Computing Final Year Projects, the outcome will be either 'No ethical issues' or 'Minor/Major ethical issues which have been addressed'; in these cases approval can be given by the supervisor. In the unlikely event that the outcome is 'Ethical issues that have not been addressed', the completed form will need to be forwarded to the Faculty Research Ethics Committee.

Student Name

James Bielby

Programme

Intelligent System

Project Title

Exploring the role of AI and fuzzy logic in enhancing the safety measures of smart assistants

Brief description of proposed activity and its objectives:

Researching possible safety concerns with the current selection of smart assistants and propose alternatives and ways of introducing new safety measures I will also develop a piece of software to simulate commands given by a user under certain environmental situations. The user would be able to simulate the environment and then choose commands and depending on the environment it may give different outputs. For example if the room the device is in is very hot and the user asked to turn the heater on it would first warn the user it is already hot and may cause issues if it were to turn the heater on.

Ethical Issues Identified: (see overleaf)	**How these will be addressed:**
I will be researching possible safety concerns. This may include references to a person (or group of people) involved in an accident or have injured because of a command being followed by a smart assistant. I will also consider behaviour impacts that smart assistants have caused both in the past and making assumptions of how this will change/ if it will change	I will try my best to contact the source of the information to gain consent in order to reference the events in my report, although this should not be necessary as I plan to use already publicly available publications and reference them fully. I will carefully consider what I put into my report and ensure I am being sensitive and respectful to everyone that could be effected by a smart assistant. In terms of safety/risk of injury issues I will work only with either publicly reported events, and with hypothetical simulations in my computer, so in reality no one will be put at risk. Further, this is just a preliminary study and simulation, so I do not envisage actual user behaviour to be affected, rather just raising awareness of the issue in the first instance.

Checklist

Has the project proposal identified any of the following research procedures?

1. Gathering information about human beings through: Interviewing, Surveying, Questionnaires, Observation of human behaviour	No
2. Using archived data in which individuals are identifiable	Yes
3. ~~Researching into illegal activities, activities at the margins of the law or~~ activities that have a risk of personal injury	Yes
4. Supporting innovation that might impact on human behaviour e.g. Behavioural Studies	Yes

If 'Yes' to any of 1-4 above: have you considered the following?

- ☑ Providing participants with full details of the objectives of the research
- ☑ Providing information appropriate for those whose first language is not English
- ☑ Voluntary participation with informed consent
- ☑ Written description of involvement
- ☑ Freedom to withdraw
- ☑ Keeping appropriate records
- ☑ Signed acknowledgement and understanding by participants
- ☑ Consideration of relevant codes of conduct/guidelines

Ethical Review Outcome

- ☐ 1. No ethical issues
- ☑ 2. Minor ethical issues which have been addressed and concerns resolved
- ☐ 3. Major ethical issues which have been addressed and concerns resolved
- ☐ 4. Ethical issues that have not been resolved/addressed

Authorisation

If the outcome is no. 3 or 4 above, this form should be forwarded to the Faculty Research Ethics Committee.

Signature of student _____James Bielby_____ Date ___24th Oct 2017__

Signature of supervisor _____ Mario Gongora _____ Date ____24th Oct 2017__

Signature of 2nd supervisor _____ Date _____

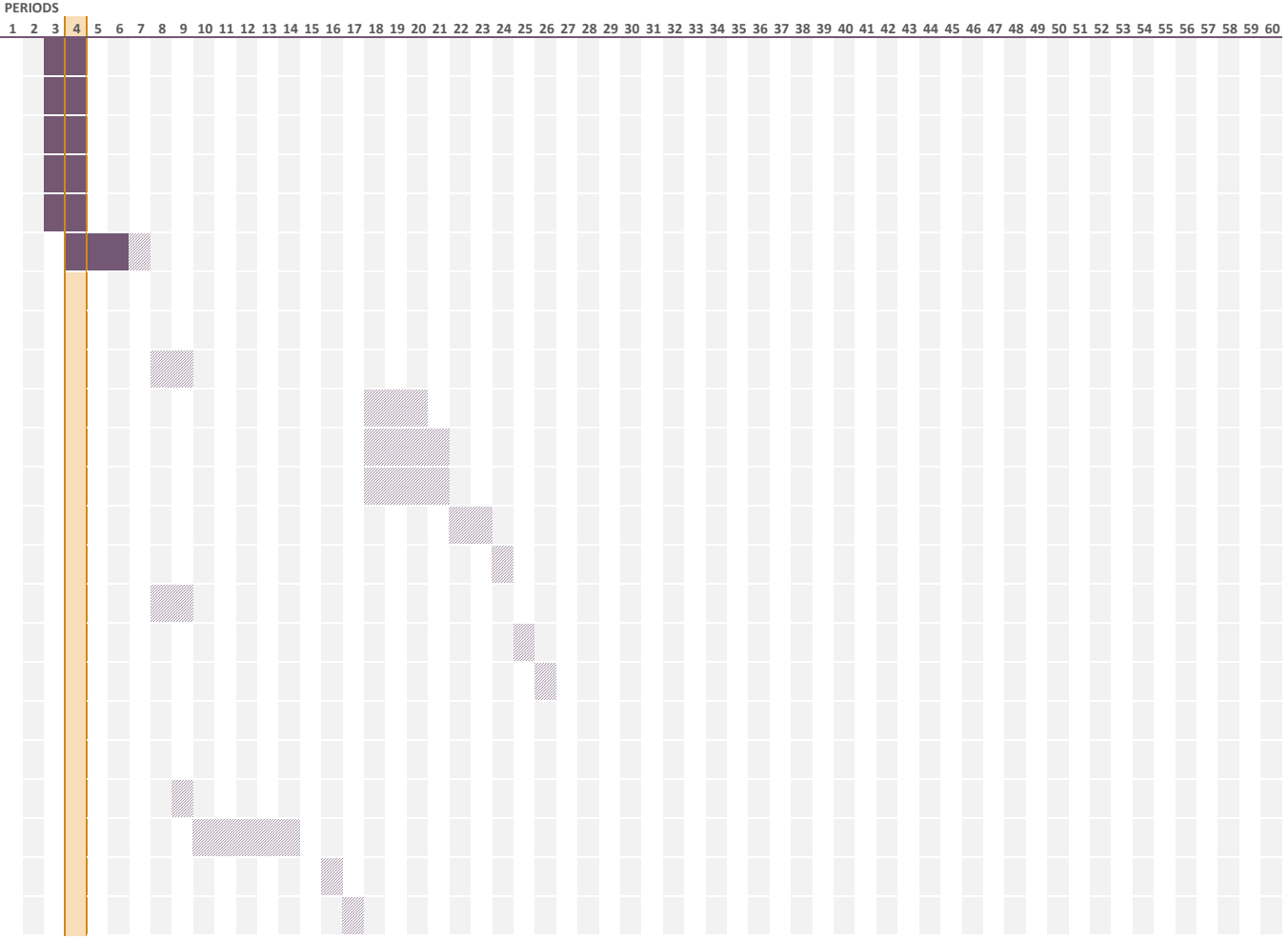
Project Planner

Select a period to highlight at right. A legend describing the charting follows.

Period Highlight: 4

Plan Duration | Actual Start | % Complete | Actual (beyond plan) | % Complete (beyond plan

ACTIVITY	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
BCS checklist	3	2	3	2	100%
Global checklist	3	2	3	2	100%
Ethical Review	3	2	3	2	100%
Project Contract	3	2	3	2	100%
Progress report	3	2	3	2	100%
Literature Review	4	4	4	3	100%
Report					
Introduction	8	2			
Background	18	3			
Literature Review	18	4			
Implentation	18	4			
Results and Evaluation	22	2			
Future work	24	1			
Conclusion	8	2			
Reflection	25	1			
References	26	1			
Software					
Software Design	9	1			
software Development	10	5			
Testing	16	1			
Finalisation	17	1			



IMAT3451 FINAL YEAR PROJECT - Global Checklist

The University requires all undergraduate final year projects students to undertake a global review of their project. Here is an International Impact Checklist for you to complete, which can be done in consultation with the project supervisor.

Student Name

James Bielby

Programme

Intelligent System

Project Title

Exploring the role of AI and Fuzzy Logic in enhancing the safety measures of smart assistants

Please indicate which of these possible attributes is addressed by your undertaking of this project.

Possible Global Experience	Addressed by Project
Ability to work collaboratively: teams from a range of backgrounds and countries	✓
Excellent communication skills with a sensitivity to speaking with and listening to non-native English speakers	
An ability to embrace multiple perspectives and challenge thinking in a range of cultural context	✓
A capacity to develop new skills and behaviours according to role requirements	✓
An ability to negotiate and influence clients across the globe from different cultures	
An ability to form professional, global networks	
An openness to/respect of a range of perspectives from around the world	✓
Multi-cultural learning agility (i.e. able to learn in any culture or environment)	

Brief description of how the ticked attributes have been addressed:

I will be addressing certain aspects of safety relating to the use of smart assistants. Due to nature of my project I will be focusing mainly on countries where these devices are readily available so it would be difficult to address the topic of cultural difference. However, there is a case to be made about the future of the industry. As this topic is hypothetical and makes some suggestions on the direction that smart assistants should be going and potential for growth in foreign markets. I will be using techniques and tools learned throughout my degree to aid me in the production of my project. As well as using new skills learned in the coming year, such as the use of a fuzzy controller to help create my simulation.

Signature of student _____James Bielby_____ Date ___24th Oct 2017_____

Signature of supervisor _____Mario Gongora_____ Date __24th Oct 2017__

Literature Review

James Bielby

De Montfort University

Intelligent Systems (MCOMP)

Exploring the role of AI and Fuzzy Logic in enhancing the safety measurements of smart assistants

Over the last 5 years smart assistants have slowly crept into society and have become a part of our everyday lives, often in ways we don't expect. A smart assistant is a program that recieves an input through a voice command, It then interprets the natural language and performs the desired task.

Smart assistants have been around several years now (in one form or another). They can be traced back all the way to 1961 with IBM's 'shoebox' project which can perform simple voice recognition. There are also some relevant modern roots in the form of chatbots. This bot takes text input and it will search for keywords then output a prewritten response to the user. As interest grew, artificial intelligence was implemented. It is unsure what truly led to the development of these smart assistants (as referred to as virtual assistant) however it is clear that they will continue to be a part of society and have a deeper implementation into our daily technology.

The first of the modern representations of smart assistants was produced by Apple and came in the form "Siri" a smart assistant which came with the IOS 5 update to the iPhone series. Siri was capable of simple voice commands such as "Siri, phone Dave" this would cause the phone to call Dave. As updates were applied to the phone, more functionality came to the virtual assistant. Shortly after google addressed the competition with an android alternative, Google Now, android had supported voice to text within the google keyboard for a while before this however it was only as a replacement for typing. There has been some discussion on what counts as a smart assistant, is voice interaction required to meet this definition?

A good argument for this is the introduction of autonomous vehicles. They use an array of cameras and using Artificial intelligence they map a safe and legal route for the car to drive. This use of AI is very comparable to the uses within smart assistants, however, the artificial intelligence used in autonomous vehicles is very safety driven. Whereas there are no/very little (unnoticeable) safety measures built into the current suite of smart assistant, both on mobile phones and smart speakers.

The main goal of an autonomous vehicle is to get from A to B within the bounds of the law and keeping all passengers and pedestrians safe. If we compare this to a typical smart speaker, which does follows the directions given by the user then performs the desired command. There is a lot of decision making involved however this is not related to the user's safety (for example asking it to play a song it will find one it thinks you like). If the user were to try force an autonomous vehicle into a dangerous situation it would not do so, it would either proceed with the safest possible route or simply stop in a safe manner. If this were a smart speaker it would simply follow the command, and could potentially influence the health of the user.

Along with AI these autonomous vehicles employ a significant amount of fuzzy logic, one example is the application of fuzzy logic in headlight control, while driving at night there is a large safety concern with the brightness of some driver's headlights. If a car has its full beams turned on whilst a car is approaching the driver of the oncoming car may experience some temporary visual impairments, unfortunately not everyone has quick enough reaction time to prevent this safety issue this shows the need for an automated system. This system uses an array of sensors to measure the distance of oncoming traffic and dims the lights accordingly. This means that a car in the far distance (if registered) will allow the lights to be at a high brightness, however as the car approaches it will decrease meaning the oncoming driver has a much a safer experience.

Should we allow AI to have an impact on our health?

A large topic within this research is whether we should put or safety in the hands of computational intelligence. When researching health related issues, with regards to AI, there is a large polarity in opinion. Artificial intelligence can either be a great life-saving asset to our society or it can also be a detriment. Because of artificial intelligence many jobs have been made redundant this can be for many reasons, either the job is performed better by a machine then a human although there are many situations where it is simply unsafe for a human to do the job. This has led to some groups of people being untrusting of this technology, on the other hand artificial intelligence has already proven to have a life saving impact on many peoples lives. Prosthetic limbs for example has shown there is a real need for an AI and fuzzy logic controlled healthcare solution. With modern prosthetic limbs they need precise movements and to be able to judge how much pressure is needed for the situation.

Clearly there is a lot of research done on the use of artificial intelligence and fuzzy logic and how they can improve safety, however, this research has been directed at specific situations for example the safety measures in an autonomous vehicle. These are obviously big safety concerns where if something were to go wrong it could be potentially fatal. These means most of the work is going towards safety features that will affect on a few individuals. There is a debate whether it is better to save lots of people from small danger or if it is better to save a small amount of people from a large danger. Obviously, the clear answer would be to spread the work load, have a large focus on the issues that cause the most damage then have a small focus on the smaller problems. This is what this research covers, the smaller, often self-inflicted issues. The safety measures that could be implemented into smart speakers are unlikely (although possible) to save a life but there is a chance it may mean that no damage will be done to the environment or to the device itself. For example, if the device is overheating due to high operation and a high ambient temperature there is a chance that there could be some serious electrical damage due to a overheating component.

With the types of incidents that can occur it will usually be self-inflicted. So there is a question to be answered here, do these smart assistants actually NEED the safety precautions proposed in this project? There are many who believe the responsibility should rely on the user not to put themselves into a dangerous environment. For example scheduling a WIFI enabled light bulb to turn off at a specific time may cause someone to not be able to see there surrounding and end up harming themselves. But there is an argument that if there is any danger in the device then it should be resolved. But this causes more issues, if there were a situation were a smart speaker was fully safe then there would be an uproar by consumers complaining that it is too over-bearing and needing a second confirmation to override any warnings. A line needs to be drawn at the point where the user's health is not an issue however the usability of the product has not been hindered.

Due to the nature of an AI assistant it becomes a very personal issue, this is because for a lot of user the smart speaker (or however they interact with their assistant) will be part of their day to day lives and the machine learning algorithms will be tuned into the user. For example predicting what song they want to listen to. Because the assistant has learned the likes of the user this becomes a

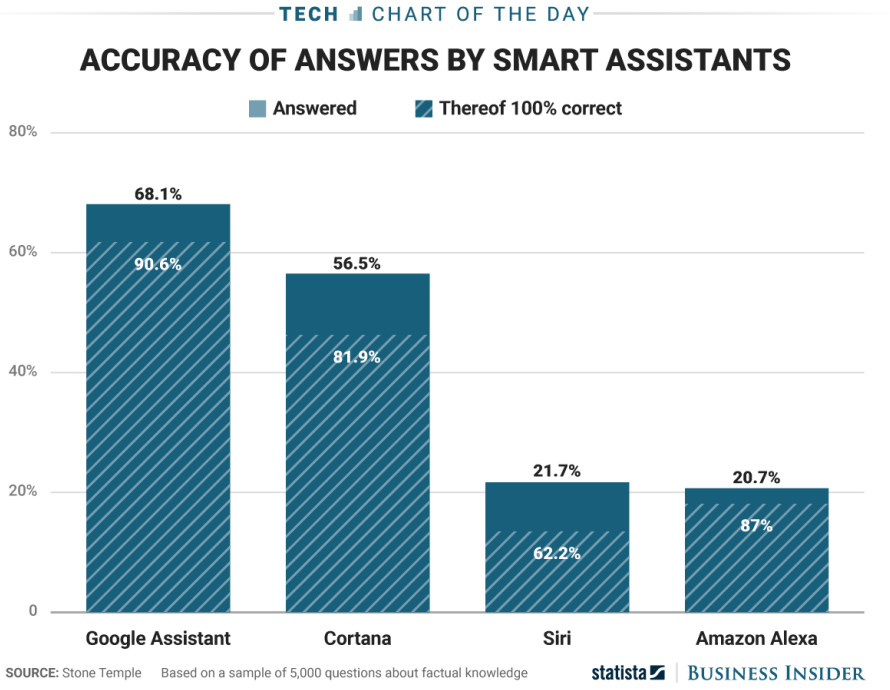
personal issue when it comes to changing aspects of the AI as it could change how they go about their daily routine. As an example there was an update to Siri, apples virtual assistant, this update included many things along with the update it changed the way you request the assistant to call a contact. Originally you had to say “Siri, call alex” with the update they changed it to “Siri, phone alex” this switch was primarily due to avoid some issues with different local accents and being unable to distinguish the word “call” under some dialects. As time passed and the assistant matured the issue of accents was resolved but this resulted in many users being unhappy that they were forced to change their natural language to use this feature.

Siri has also had controversy in the past with its location recommendations, there have been cases where it will recommend escort services or where a person may buy drugs. This shows that they use a well-rounded AI that understands what the user wants, however, it also doesn’t take the law into consideration or the safety of the user. This could be remedied by offering a helpline or counselling links. A great fix was eventually offered. If a user were to say something along the lines of “siri I want to kill someone” it would show a list of mental health agencies both close by and online. This shows apple have now taken a genuine interest in the mental health of the user.

With this in mind should there also be a push for a smart assistant tailored for those users who may be affected by a mental illness. For example those with anxiety or depression may benefit from a more conversational smart assistant where it could maintain a full conversation and ask the user questions. This could also prove useful for those who are prone to phobias or impulse control disorders. For example someone with Obsessive-compulsive disorder may be triggered by a wifi enabled heating system being turned on automatically. This could be very damaging to a vulnerable person. Should the current suite of smart assistant be tailored to meet the needs of these at-risk individuals. Or would it be wise for these individuals to simply avoid using these types of devices altogether. Potentially causing more social issues especially among younger users, where they tend to show off and boast about their latest technology.

Siri is the most mature smart assistant, but does this mean it is the best available? After all it will have more years of feedback to work from. As time goes on clearly there will be a larger repository of user data, not only does that mean they know what people have been asking they also store information about the way you talk this is what helps their artificial intelligence become more knowledgeable. Although this information only helps the assistant understand the user there are still situations where the phrasing of the sentence may effect the outcome of the AI or may influence the way google search is written. This may cause it to give the user false information.

Exploring the role of AI and Fuzzy Logic in enhancing the safety measurements of smart assistants



This chart shows the accuracy of smart assistants when asked a range of factual questions (5,000) this shows that Siri is in third place for accuracy, despite being available for longer. This makes a great deal of sense as google has a much larger user base on its search engines. This is the same with Cortana (developed by Microsoft for windows phone devices) as this AI will have access to the bing search engine and its searching algorithms it is more likely to output a correct answer for a factual question. Both Siri and amazon Alexa will have to use these search engines but as they are not the developers of these search engines they may suffer from misunderstood wordings or maybe even location data. Google and Microsoft will both have large amounts of data to go on on how people word their questions from years of people using their search engines this is what allows them to understand natural language better than their competition.

With all this data being stored about the user and their searching habits, there is a lot of concern about the safety of their personal data. If a person uses their smart speaker everyday there is a lot information that this assistant will have on the user, firstly it will have usage data. This includes how often the user will interact with the device meaning it knows when the user is likely at home. It can include purchase history (amazon Alexa for example allows for seamless purchasing off amazon) if this data were to be accessed by an intrusion or a third party this could be very harmful and upsetting to the user. This is why there is a lot of security built into these devices, thankfully the companies that have developed these smart assistants, Google, Apple, Microsoft and Amazon all have many years of security experience safely storing users search information and purchasing and banking information. So it is clear that they have used their full abilities in keeping everyone’s data safe.

There’s some other security risks too, for example that has been a lot of research into the safety of these devices. And it was found that the microphones on these devices are incredibly sensitive, so sensitive that it can pick up sounds and commands that are not audible by a human. This is a

genuine issue when you consider the fact that some people have ‘smart’ security systems. It is possible that a security system could be unlocked using this method of silent commands meaning the occupants of the house will not hear the commands being said and the system will just assume it is a normal person unlocking the door. It doesn’t just stop there, there are other smart devices that are also susceptible to intrusion, there have been several cases where a wifi baby monitor has been hacked, allowing the intruder to maliciously communicate with the child in that room and also give them access to the built in camera. Not only is this a violation of cyber security it is also deeply upsetting to the parents knowing that a stranger has been watching and speaking to their child.

As society gets more reliant on the use of Artificial Intelligence and the ‘smart’ ecosystem more and more safety related issues show themselves. Although physical wellbeing is a big issue, the developers of these assistants and systems also need to take mental health into consideration. To many people these are considered an equal threat as mental stress can cause just as much distress and pain as a physical injury. This can also be considered the same as cyber security a person who is deeply reliant on online services may be very cautious about their online data, and in some cases, may consider their personal information more valuable then a minor injury. It is clearly important that there are procedures in place to prevent any harm, serious or minor, to the users of these devices. There are many questions left unanswered such as; Is it the developers responsibility to concern themselves with how the customer uses their products or should the user be responsible for their own safety? If it is on the user, how does this affect situations where a cyber intrusion has occurred and gained access to the smart system in place at the users home? Would it be, for example, Amazon’s fault for leaving a flaw in their security? Or would it be the user for putting these devices in their home in the first place?

As we move toward a more technologically advanced future it is important that these questions are answered. Obviously, these gaps in safety (of any type) should be addressed but it’ll be difficult to decided which should be addressed more prominently. This project aims to provide a solution to physical harm; however, lessons can be learned as to how similar problems can be tackled. A good aim to keep in mind is the usability of these solutions, if they offer a solution but can seen as annoying by the user then this cannot be seen as successful. A key part of this research is to make the assistant safety conscious without being obtrusive. An example would be trying to turn a heater on, if the assistant then replied with a speech about global warming this would be incredibly intrusive. And there would be a noticeable response by the users and would probably turn this setting off.

A common theme across these papers is simply providing a solution to the problems they specifically address. However, very few address the topic comprehensively. For example, one paper discusses safety issues with AI when used in autonomous vehicles this is perfectly acceptable considering that is the topic of the paper. However, it doesn’t include how their solutions can be implemented in other facets of AI. The concept of safety is a very broad term, which is why many varieties of paper were included in this review. For many people physical health is more important than mental, but as shown in these papers they should all be taken with the same approach. These issues can affect the users in very serious ways and they need to be addressed.

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Functional Requirements

This project aims to deliver a software solution to address the safety concerns with smart assistants. Smart assistant have to the ability to connect and control devices in a local smart eco system, this can include, light bulbs, heating, door locks and security cameras. Due to the nature of smart assistants if the user gives it a command the assistant will simply follow through with the action. This can on occasion lead to potentially harmful situations, both for the user and possibly dangerous for the device itself. Typical operating temperatures range from 0-40 °C (Amazon technician, Amazon support, 16/11/17) in a situation where the ambient temperature is already high (in summer perhaps) and then the user asked for the heating to be put on, or even if it mishears and puts it on by accident. This may cause the temperature of the device to exceed the recommend operating temperature, and could potentially cause irreversible damage to the device which may lead to the device being unusable.

The software simulation that is being created throughout this project, will allow the user to select environmental conditions and then see how popular commands will be affected. For example, turning on the light in a room that has already got high ambient light levels will output a warning saying that this may not be needed and to consider saving energy. These systems being put in place will have many different affects the main aim is to avoid any potential accidents from occurring. However, there is also the aim that the device will also be in a safe condition along with this it will also advice situations that may not be needed or may make the environment more pleasant for the user.

As it is a simulation of a smart assistant this will provide a couple constraints. For example, the commands will have to be pre-written and given as options. Rather than talking to the user will simply choose different commands from a list, this will require the project to be very robust and provide an extremely wide range of choices. Perhaps some that don't have any affect at all, this will ensure it is as true to life as possible. Following this path there will also be settings which let the user choose how much control the assistant has. For Example, if it is already bright in the room and someone asks for the light to be turned on, there would be 3 settings the first one is off, so it will simply follow the command. The next setting will be warnings, so in this example the echo will tell you that It may not be needed and should consider saving energy instead. The final setting will demonstrate a very insistent assistant where it will reply saying it doesn't need to be on so it hasn't turned it on. This will hopefully put any uncertainty at rest as to how much control these devices will have over our homes. Because the user will be able to determine their level of input.

A good measure of how successful this project is, is how effective the software is. This can be in several ways if it works effectively and offers valuable safety or efficiency improve suggestions. It will also be a success if it manages to make these suggestions whilst being unobtrusive and does not affect the user's day to day life. A good measure of success would be reliability, the software needs to be consistent and robust, and if anything is not consistent it will need justification for example if a setting relies on the time of day. If all these requirements for success are met this will be a very useful system to use and learn from with regards to improving the safety of smart assistants.

IMAT3451 BCS Accreditation Checklist

James Bielby
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Intelligent Systems
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Exploring the role of AI and fuzzy logicin enhancing the safety measures of smart assistants
Mario Gongora

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Supervisor

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BCS Accreditation

Your supervisor needs to check your contract against this list and sign if you are on a BCS accredited course. Take note of this and be sure that you mention all requirements.

This contract contains an elucidation of the problem, the objectives of the project and a risk analysis	**Yes** [v]	**No** [ ]
The contract states that the project will include an in-depth investigation of the context and literature, and where appropriate, other similar products	**Yes** [v]	**No** [ ]
The contract states that the final report will contain a clear description of the stages of the life cycle undertaken	**Yes** [v]	**No** [ ]
The contract states that the final report will contain a description of how verification and validation were applied.	**Yes** [v]	**No** [ ]
The contract states that the report will contain a description of the use of tools to support the development process	**Yes** [v]	**No** [ ]
The contract states that the final report will contain a critical appraisal of the project, indicating the rationale for any design/implementation decisions, lessons learnt during the course of the project, and evaluation (with hindsight) of the project outcome and the process of its production (including a review of the plan and any deviations from it)	**Yes** [v]	**No** [ ]
The contract states that there will be a description of any research hypothesis	**Yes** [v]	**No** [ ]
The contract states that all research will be fully referenced	**Yes** [v]	**No** [ ]

Contract is suitable for BCS Accredited Project	**Yes** [v]	**No** [ ]	**Supervisor Signature**	*Mario Gongora*

Student_____*James Bielby*_____ **Date**__**24th Oct 2017**___

Proposer ____*Mario Gongora*_____ **Date**__**24th Oct 2017**___

Supervisor____*Mario Gongora*_____ **Date**__**24th Oct 2017**__

Then keep the signed copy somewhere safe: include it with your initial submission. Your supervisor will require a copy as well.