For use by the Project lecturer	Approved		Revision required	

Feedback

To be completed by the student

PROJECT PROPOSAL 2022

Project no	AO5	Revision no	0

Title	Surname	Initials	Student no	Study leader (title, initials, surname)
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Project title

A school intercom system that filters inappropriate phrases and plays emails as announcements in the voice of the sender.

Language editor name	Language editor signature
Student declaration I understand what plagiarism is and that I have to complete my project on my own.	**Study leader declaration** This is a clear and unambiguous description of what is required in this project. Approved for submission (Yes/No)
Student signature	Study leader signature and date

1. Project description

What is your project about? What does your system have to do? What is the problem to be solved?

The problem addressed in this project is the lack of physical contact between teachers and students in schools due to the recent change in schooling systems. Teachers that make announcements and students that hear them are often not able to be in the same physical location and employing an individual to collate announcements would not be an efficient solution to this problem. Thus, the problem addressed in this project is to develop a school intercom system that will make announcements on behalf of the teacher, eliminating the need for announcers or any human intervention.

The concept is to have a system that receives a text-based email from a teacher and then announces this email to the students, in the voice of the teacher that sent the email. This may be accomplished without the need for human intervention by integrating natural language processing techniques, speech synthesis, and digital signal processing into a single intercom system. The system should also account for any inappropriate phrases received from the email and should be able to play the announcement over an integrated speaker so that multiple students in a classroom are able to hear it.

2. Technical challenges in this project

Describe the technical challenges that are *beyond* those encountered up to the end of third year and in other final year modules.

2.1 Primary *design* challenges

A general system design challenge consists of the collection of data, in terms of audio, and storing this data in the system so that it is accessible by the synthesis algorithm. Another design challenge is hardware allocation of the system resources. The overall system should be designed to work in real time, so all training of artificial intelligence systems will have to be conducted prior to final product compilation. Also, selecting a correct linguistic analysis technique will have an affect on the processing time of the overall implementation.

2.2 Primary *implementation* challenges

One implementation challenge is ensuring that the mail client is compatible with any type of email domain. Another challenge is correctly determining the sensitivity of the output audio in an environmentally open system so that it correctly adheres to the specification. A system implementation challenge is managing waveforms and assigning it to analyzed text correctly. Testing results of synthesized audio when compared to natural language audio might be difficult to conduct unless extra functional components are developed for.

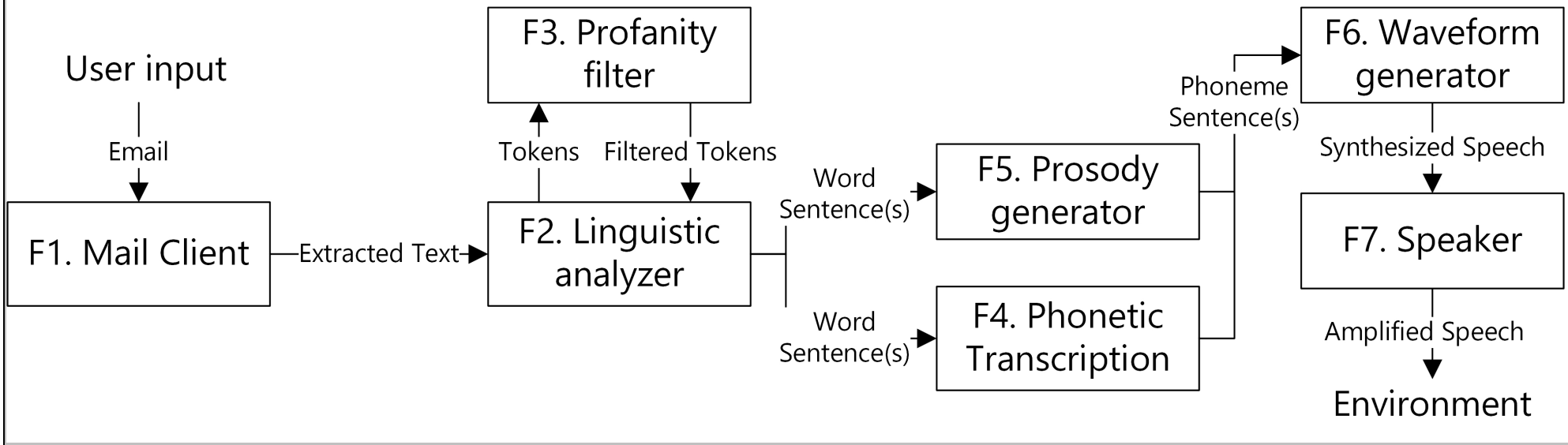
3. Functional analysis

3.1 Functional description

Describe the design in terms of system functions as shown on the functional block diagram in section 3.2. This description should be in *narrative format*.

The user input to the system will be an email text announcement that is sent to the system via the internet. F1 is a mail client that is designed to receive emails. The text is extracted from the email and put through F2, a linguistics analysis function. The linguistics analyzer will be used to detect sentences, and create tokens from those sentences. The tokens are run through a profanity filter F3. The profanity filter will remove all inappropriate phrases contained within a set of tokens and will return the output to the linguistic analyzer. F2 will then go through a lemmatization and cleaning process to ensure the sentence is correctly formatted, and then tag each token with its part of speech. Each tag is then run through a linguistics analysis technique that will determine what they mean. The words are then sent to F4, a phonetic transcription function, that will append symbols to every part of the word representing what it will sound like. The symbols correspond to certain sounds as well decided by F5, a prosody generation function that appends these sounds. The phoneme sentences obtained from the combination of F4 and F5 are then used in F6, a waveform generator or synthesizer, to map the voice of the user to the words. Synthesized speech is then amplified by F7, a speaker that will relay the announcement that was received by the user. The output is heard in the classroom environment by students.

3.2 Functional block diagram



4. System requirements and specifications

These are the core requirements of the system or product (the mission-critical requirements) in table format IN ORDER OF IMPORTANCE. Requirement 1 is the most fundamental requirement.

	Requirement 1: the fundamental functional and performance requirement of your project	**Requirement 2**	**Requirement 3**
1. Core mission requirements of the system or product. Focus on requirements that are core to solving the engineering problem. These will reflect the solution to the problem.	The intercom system will have to broadcast an announcement over a speaker to a group of students.	The announcement to be broadcast will have to be processed so that it is correctly perceived by the students, i.e. it should be linguistically analyzed.	The announcement has to be broadcast in the same frequency range of the person that is sharing the announcement so that it sounds like that person is speaking.
2. What is the target specification (in *measurable* terms) to be met in order to achieve this requirement?	The sensitivity of the audio playback speaker should range between 70-75 dB.	The word error rate (WER) should be proportional to the incorrectness of the text. Correct texts should contain WERs of 0%.	Generated waveforms of synthesized speech should be in the same fundamental frequency range of the persons voice Males typically have fundamental frequency ranging from 85-155 Hz and females are 165-255 Hz. Variations of these are included.
3. Motivation: *how* or *why* will meeting the specification given in point 2 above *solve the problem*? (Motivate the *specific* target specification selected)	The range of a normal speaking voice is between 65-70 dB. To accurately hear an announcement in a noisy environment of 65-70 dB, the sound output should be at least 5-10 dB higher than the environment.	WER measures the amount of changes made to an incorrect sentence. If the linguistic analyzer makes no changes to the received text then it means that the email received is at an acceptable level and thus the WER is 0%.	The fundamental frequency of the persons voice delivers an impression of a persons voice. By narrowing this parameter down, a better sound could be obtained for a synthesized speech.
4. How will you demonstrate at the examination that this requirement (point 1 above) and specification (point 2 above) has been met?	An arbitrary 60 dB sound will be played on a series of devices in a small room and measured. The intercom will then broadcast a message and it should be heard over the rooms noise level. The output of the intercom will also be measured individually.	A simulated version of a linguistics analyzer will be presented with a data set of grammatically correct and incorrect sentences. The majority of correct sentences should have 0% WERs and incorrect sentences should indicate arbitrary WERs.	Recordings of multiple announcers voices will be played in conjunction with the synthesized speech for auditory comparison. Waveforms of the speech will also be displayed and fundamental frequency ranges will be compared.
5. Your own design contribution: what are the aspects that *you will design and implement yourself* to meet the requirement in point 2? If none, *remove this requirement.*	Amplification and power circuitry will be developed in order to correct the output of a speaker component.	The front-end of a text-to-speech synthesizer consisting of Natural Language processing and linguistic analysis will be designed and implemented.	The back-end of a text-to-speech synthesizer consisting of prosody generation and phonetic transcription will be designed and implemented.
6. What are the aspects to be taken off the shelf to meet this requirement? If none, indicate "none"	A speaker component will be purchased.	None.	A microcontroller board capable of digital signal processing will be purchased.

System requirements and specifications page 2

	Requirement 4	**Requirement 5**	**Requirement 6**
1. <u>Core mission requirements of the system or product.</u> Focus on requirements that are core to solving the engineering problem. These will reflect the solution to the problem.	The message that is transmitted should be filtered of all inappropriate phrases.	A mail client should be integrated with the intercom system with the ability to receive emails.	
2. What is the <u>target specification</u> (in *measurable* terms) to be met in order to achieve this requirement?	The accuracy, recall and precision of a large sample set, should be above 94% each to ensure that the profanity filter is accurate enough.	Emails should be received and recognized within 10 seconds of sending it to the mail client from any location with Internet access.	
3. <u>Motivation</u>: *how* or *why* will meeting the specification given in point 2 above *solve the problem*? (Motivate the *specific* target specification selected)	There are often phrases that seem inappropriate but are not. High accuracy, recall and precision ensures that False Positives are identified from the True positives in the model as well as the model being a reliable one.	Mail clients are generally fast, and are capable of sending mail from any location with Internet access. If the time of receiving mail is comparable to already implemented systems, then the requirement has been met.	
4. How will you <u>demonstrate</u> at the examination that this requirement (point 1 above) and specification (point 2 above) has been met?	A large data set of phrases containing profanity and False Positives will be input into a simulated profanity filter. The outcome of accuracy, recall and precision will be measured by the models filtered output in comparison to the expected output.	A display screen should indicate that an email is received within 10 seconds of sending an email to the system.	
5. <u>Your own design contribution:</u> what are the aspects that *you will design and implement yourself* to meet the requirement in point 2? If none, *remove this requirement.*	A text-based profanity filter will be developed.	A mail client software capable of receiving email and verifying reception will be developed.	
6. What are the aspects <u>to be</u> taken off the shelf to meet this requirement? If none, indicate "none"	None.	A Wi-Fi module capable of Internet connection and an LCD screen for debugging and display purposes will be purchased.	

System requirements and specifications page 3

	Requirement 7	**Requirement 8**	**Requirement 9**
1. <u>Core mission requirements of the system or product.</u> Focus on requirements that are core to solving the engineering problem. These will reflect the solution to the problem.			
2. What is the <u>target specification</u> (in *measurable* terms) to be met in order to achieve this requirement?			
3. <u>Motivation</u>: *how* or *why* will meeting the specification given in point 2 above *solve the problem*? (Motivate the *specific* target specification selected)			
4. How will you <u>demonstrate</u> at the examination that this requirement (point 1 above) and specification (point 2 above) has been met?			
5. <u>Your own design contribution:</u> what are the aspects that *you will design and implement yourself* to meet the requirement in point 2? If none, *remove this requirement.*			
6. What are the aspects <u>to be</u> taken off the shelf to meet this requirement? If none, indicate "none"			

System requirements and specifications page 4

	Requirement 10	Requirement 11	Requirement 12
1. Core mission requirements of the system or product. Focus on requirements that are core to solving the engineering problem. These will reflect the solution to the problem.			
2. What is the target specification (in *measurable* terms) to be met in order to achieve this requirement?			
3. Motivation: *how* or *why* will meeting the specification given in point 2 above *solve the problem*? (Motivate the *specific* target specification selected)			
4. How will you demonstrate at the examination that this requirement (point 1 above) and specification (point 2 above) has been met?			
5. Your own design contribution: what are the aspects that *you will design and implement yourself* to meet the requirement in point 2? If none, *remove this requirement.*			
6. What are the aspects to be taken off the shelf to meet this requirement? If none, indicate "none"			

5. Field conditions

These are the REAL WORLD CONDITIONS under which your project has to work and has to be demonstrated.

	Field condition 1	Field condition 2	Field condition 3
Field condition requirement. In which field conditions does the system have to operate? Indicate the one, two or three most important field conditions.	The intercom system has to work in a noisy indoor room environment. And should be operable from any location as long as it is connected to the internet.		
Field condition specification. What is the specification (in measurable terms) for this field condition?	A standard noisy environment for a classroom of students should range between 65-70 dB.		

6. Student tasks

6.1 Design and implementation tasks

List your primary design and implementation tasks in bullet list format (5-10 bullets). These are *not* product requirements, but *your* tasks.

The intercom system must be designed and implemented.
An appropriate linguistics analysis technique has to be selected.
Audio data from multiple people will have to be collected.
Large sentence text data sets with profanity have to be collected and sorted.
A physical cover for the system will have to be designed and built.
The system should be integrated onto a PCB board.
Amplification circuitry should be simulated with LTSpice.
Simulated versions of the functions should be developed for debugging and demonstration purposes.
A noisy room experiment should be tested and recorded with measurements.

6.2 New knowledge to be acquired

Describe what the theoretical foundation to the project is, and which new knowledge you will acquire (*beyond* that covered in any other undergraduate modules).

The student will be required to master theoretical background knowledge on Natural Language Processing and Speech Synthesis.
The student will need to gain knowledge on mail clients.
The student will need to learn how to work with audio data sets.
The student will be required to learn about rulings of speech in the English language.