

The effects of chemical additives on the ultra violet output of MTV

by Joseph Slattery

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The effects of chemical additives on the ultra violet output of MTV

Author: Joseph Slattery

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Introduction:

A potential future threat could arrive from the use of ultra violet (UV) spectral imaging to identify targets such as aircraft and land vehicles in military settings. For this reason it is important for us as a nation to have a countermeasure to this threat should it every come to be a reality. This project there for will be looking into the production of UV light for the purposes of distracting or masking a target from the viewer. This project is worth investigating as if a solution is not found or research has not begun before the threat arises then a greater loss could be seen by the British armed forces while a solution is trying to be found.

Aims:

The aim of the project is to develop a greater understanding of the UV output of Magnesium Teflon Viton (MTV) and what effects different chemical additives may have on this output. This will be done by understanding the chemistry of EM productions from pyrotechnics by making up samples of differing compositions and testing them against a control base of pure MTV. For this project to be deemed a success a report detailing the current UV properties of MTV along with the findings of how chemicals effect this should be produced. As a stretch goal of completion a new composition should be manufactured and tested at full scale to show the full extent improvements made if earlier testing concludes there has been improvements made over the base samples.

Background:

Research on the matter of UV emission in pyrotechnic compositions is currently limited however research has been done into compounds that do produce UV which may be integrated into a pyrotechnic composition.

UV light is emitted between the wave lengths of 10-400nm however short wave UV <280nm is completely absorbed by the atmosphere [1] therefore the range we want to be looking to produce in would be the 280-400nm range.

A paper looking into alternatives for Teflon may prove useful due to there findings of a slight increase in UV output when using Caesium5-trifluoromethyletrazolate [2]. This paper shows the MgO produces UV which begs the question of whether increasing the oxygen concentration in the mix would increase the UV production. Caesium was also found to absorb a small amount of IR so may produce high UV in comparison to a base sample simply by producing less of unwanted by products.

Heptafluorobutyric acid plus a metal salt was also identified as a possible alternative to Teflon using the same chemical reaction of magnesium with fluorine which was shown to produce UV [2] but having a higher concentration of fluorine than found in Teflon so could be used as a booster by allowing more magnesium to be burned and therefore more UV production.

Lastly we have the use of sodium nitrate which was identified due to its use in aircraft parachute flares and in testing showed production of UV [3]. The equipment to measure this was very poor by modern standards so it may prove that the results were better or worse than initially recorded. They also looked into calcium nitrate although it gave comparable results for their intended purpose compared to sodium nitrate so was not looked into further due to the ease of manufacture of sodium nitrate so would be a contender for things to test as its never had full testing done.

Project design:

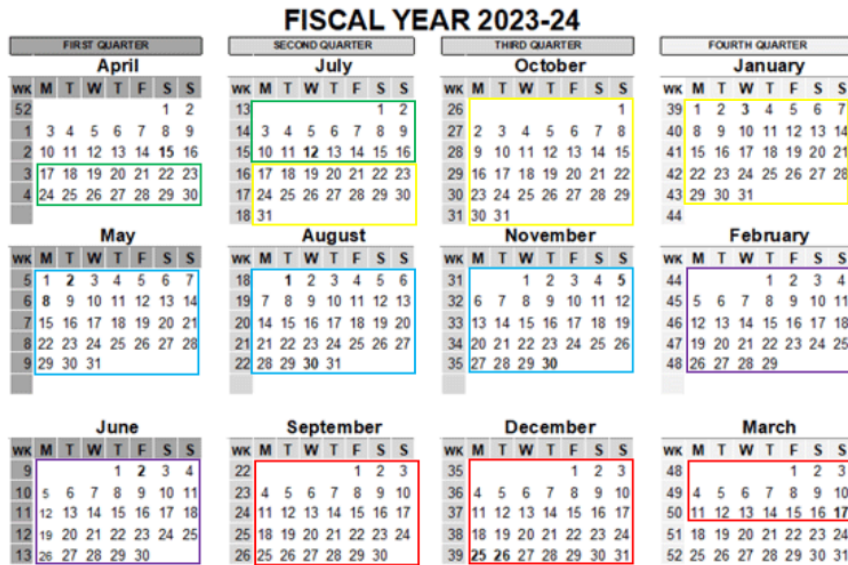
The first and most critical part of the project is to produce a comprehensive literature review to understand what has possibly been tested before and if there are any avenues of testing that can be ignored or should be focused on more heavily to avoid duplicating existing work. This will be carried out through online searches as well as database searches in academic and published works to see where people have already conducted research. I also plan to draw on the huge amount of experience from my colleagues who have worked in the industry for 10+ years to see where they may have looked as they may be able to provide extra information that was not published.

Next I would move on to the actual manufacture and testing of novel compositions, this is with the caveat of approved paper work ahead of time. This would involve making small samples and running them first through small scale hazard testing to obtain their safety information before pot burning tests could be carried out.

Data collect and analysis:

To collect all of the data I need in order to produce a report at the end I would be filling all of the pot burn tests with both a UV camera and an ONCA thermal imager. This allows me to record the intensity of the output in both of those spectrum over time and graph the results. These graphs could then be compared to the control MTV to identify if there are any improvements made. The IR imager although opposite from what is being tested would provide useful information as even if the UV has not increased we may see a decrease elsewhere that should be observed and recorded.

Projected timeline:



Initial research

Drafting test paperwork

Carrying out tests

Analysing data

Writing final report

Producing poster; First two weeks of April in the 24/25 financial year.

All the timings are first estimates and are subject to change based on outcomes from earlier sections of other unforeseen circumstances that could arise. The dates shown do not indicate exact dates on which work will be carried out but a time frame during which that stage of work will take place and estimated deadlines.

References

- [1] J. D. Haigh, "The Sun and the Earth's Climate. Living Rev. Sol. Phys.," 02 October 2007.
- [2] V. W. S. K. Ernst-Christian Koch, "Cesium based pyrolants combustion properties and emission spectroscopy," vol. 44th, no. International annual conference of ICT, June 2013.
- [3] MOD, "Defence technical information centre," p. 745.

Appendix A:

APPLICATION FOR ETHICAL APPROVAL

In order for research to result in benefit and minimise risk of harm, it must be conducted ethically.

The University follows the OECD Frascati manual definition of **research activity**: "creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications". As such this covers activities undertaken by members of staff, postgraduate research students, and both taught postgraduate and undergraduate students working on dissertations/projects.

The individual undertaking the research activity is known as the "principal researcher".

This form must be completed and approved prior to undertaking any research activity.

SECTION A: About You (Principal Researcher)

1	Full Name:	Joseph Robert Slattery
2	Student Number:	1907676
3	Email address:	1907676@student.uwtsd.ac.uk
4	Programme of Study:	OME degree apprenticeship
5	Director of Studies/Supervisor:	Gareth Collet

SECTION B: Internal and External Ethical Guidance Materials

	Please list the core ethical guidance documents that have been referred to during the completion of this form (including any discipline-specific codes of research ethics, location-specific codes of research ethics, and also any specific ethical guidance relating to the proposed methodology). Please tick to confirm that your research proposal adheres to these codes and guidelines. You may add rows to this table if needed.	
1	UWTSD Research Ethics & Integrity Code of Practice	☒
2	UWTSD Research Data Management Policy	☒

SECTION C: Details of Research Activity

1	Indicative title:	The effects of chemical additives on the ultra violet output of MTV		
2	Proposed start date:	April 1 st 2023	Proposed end date:	March 22 nd 2024
	Introduction to the Research (maximum 300 words in each section) Ensure that you write for a <u>Non-Specialist Audience</u> when outlining your response to the three points below: • <i>Purpose of Research Activity</i> • <i>Proposed Research Question</i> • <i>Aims of Research Activity</i> • <i>Objectives of Research Activity</i> Demonstrate, briefly, how <u>Existing Research</u> has informed the proposed activity and explain • <i>What the research activity will add to the body of knowledge</i> • <i>How it addresses an area of importance.</i>			
3	Purpose of Research Activity To develop a pyrotechnic composition that produces a large amount of ultra violet radiation (this box should expand as you type)			
4	Research Question Is it possible to increase the ultraviolet output of magnesium Teflon Viton by adding an extra chemical element or changing one of the existing chemicals with a better alternative. (this box should expand as you type)			
5	Aims of Research Activity The aim of the project is to develop a greater understanding of the UV output of Magnesium Teflon Viton (MTV) and what effects different chemical additives may have on this output.			

	(this box should expand as you type)
6	Objectives of Research Activity For this project to be deemed a success a report detailing the current UV properties of MTV along with the findings of how chemicals effect this should be produced. As a stretch goal of completion a new composition should be manufactured and tested at full scale to show the full extent improvements made if earlier testing concludes there has been improvements made over the base samples. (this box should expand as you type)
	Proposed data collection methods (maximum 600 words) Provide a brief summary of all the methods that may be used in the research activity to collect data, making it clear what specific techniques may be used. If methods other than those listed in this section are deemed appropriate later, additional ethical approval for those methods will be needed. You do not need to justify the methods here, but should instead describe how you intend to collect the data necessary for you to complete your project.
7	This should describe how you intend to collect data. It should not include a discussion of the theoretical basis for your data collection methods. Please note, that if you intend to collect any audio/video recordings of interviews with participants then these will be are classified as Personal Data under GDPR/DPA2018. If you intend to use these then note this in section H. All data collection with be done with camera equipment and computers on inanimate material with no human involvement. To collect all of the data I need in order to produce a report at the ned I would be filling all of the pot burn tests with both a UV camera and an ONCA thermal imager. This allows me to record the intensity of the output in both of those spectrum over time and graph the results. (this box should expand as you type)

SECTION D: Scope of Research Activity

	Will the research activity include:	YES	NO
1	Use of a questionnaire or similar research instrument?	☐	☒
2	Use of interviews?	☐	☒

3	Use of focus groups?	☐	☒
4	Use of participant diaries?	☐	☒
5	Use of video or audio recording?	☒	☐
6	Use of computer-generated log files?	☒	☐
7	Participant observation with their knowledge?	☐	☒
8	Participant observation without their knowledge?	☐	☒
9	Access to personal or confidential information without the participants' specific consent?	☐	☒
10	Administration of any questions, test stimuli, presentation that may be experienced as physically, mentally or emotionally harmful / offensive?	☐	☒
11	Performance of any acts which may cause embarrassment or affect self-esteem?	☐	☒
12	Investigation of participants involved in illegal activities?	☐	☒
13	Use of procedures that involve deception?	☐	☒
14	Administration of any substance, agent or placebo?	☐	☒
15	Working with live vertebrate animals?	☐	☒
16	Procedures that may have a negative impact on the environment?	☐	☒
17	Other primary data collection methods. Please indicate the type of data collection method(s) below.	☐	☒
	Details of any other primary data collection method: (this box should expand as you type)		

If you have ticked NO to every question then the research activity is (ethically) low risk and you may skip section E and continue to section F.

If YES to any question, then no research activity should be undertaken until full ethical approval has been obtained.

SECTION E: Intended Participants

	Who are the intended participants:	YES	NO
1	Students or staff at the University?	☐	☒
2	Adults (over the age of 18 and competent to give consent)?	☐	☒
3	Vulnerable adults?	☐	☒
4	Children and Young People under the age of 18? (Consent from Parent, Carer or Guardian will be required)	☐	☒
5	Prisoners?	☐	☒

6	Young offenders?	☐	☒
7	Those who could be considered to have a particularly dependent relationship with the investigator or a gatekeeper?	☐	☒
8	People engaged in illegal activities?	☐	☒
9	Others. Please indicate the participants below, and specifically any group who may be unable to give consent.	☐	☒
	Details of any other participant groups: Complete this only if your participants cannot give consent. This includes animals (this box should expand as you type)		

Participant numbers and source Provide an estimate of the expected number of participants. How will you identify participants and how will they be recruited?		
10	How many participants are expected?	Ballpark figures are fine, but make sure that you explain how you will identify and contact your participants. No participants will be involved as all works will be carried out by myself and the research is into inanimate materials. (this box should expand as you type)
11	Who will the participants be?	N/A (this box should expand as you type)
12	How will you identify the participants?	N/A (this box should expand as you type)

Information for participants:		YES	NO	N/A
13	Will you describe the main research procedures to participants in advance, so that they are informed about what to expect?	☐	☐	☒
14	Will you tell participants that their participation is voluntary?	☐	☐	☒
15	Will you obtain written consent for participation?	☐	☐	☒
16	Will you explain to participants that refusal to participate in the research will not affect their treatment or education (if relevant)?	☐	☐	☒
17	If the research is observational, will you ask participants for their consent to being observed?	☐	☐	☒
18	Will you tell participants that they may withdraw from the research at any time and for any reason?	☐	☐	☒
19	With questionnaires, will you give participants the option of omitting questions they do not want to answer?	☐	☐	☒
20	Will you tell participants that their data will be treated with full confidentiality and that, if published, it will not be identifiable as theirs?	☐	☐	☒
21	Will you debrief participants at the end of their participation, in a way appropriate to the type of research undertaken?	☐	☐	☒

22	If NO to any of above questions, please give an explanation
	You should be able to tick YES for all of these questions. If not, then explain why not in this box. <i>(this box should expand as you type)</i>

	Information for participants:	YES	NO	N/A
24	Will participants be paid?	☐	☐	☒
25	Is specialist electrical or other equipment to be used with participants?	☐	☐	☒
26	Are there any financial or other interests to the investigator or University arising from this study?	☐	☐	☒
27	Will the research activity involve deliberately misleading participants in any way, or the partial or full concealment of the specific study aims?	☐	☐	☒
28	If YES to any question, please provide full details			
	You should be able to tick NO for most of these questions. For any cases that you have ticked YES then provide details in this box. If you are using cameras/voice recorders to record interviews then please state that in this box. <i>(this box should expand as you type)</i>			

SECTION F: Anticipated Risks

	Outline any anticipated risks that may adversely affect any of the participants, the researchers and/or the University, and the steps that will be taken to address them.	
1	Risks to participants For example: sector-specific health & safety, emotional distress, financial disclosure, physical harm, transfer of personal data, sensitive organisational information. If you have identified in section D that there are no participants then enter N/A and go skip to question 3.	
	Risk to participants: There are always risks. Do not write N/A unless you have no participants. N/A <i>(this box should expand as you type)</i>	How you will mitigate the risk to participants: <i>(this box should expand as you type)</i>
2	If research activity may include sensitive, embarrassing or upsetting topics (e.g. sexual activity, drug use) or issues likely to disclose information requiring further action (e.g. criminal activity), give details of the procedures to deal with these issues, including any support/advice (e.g. helpline numbers) to be offered to participants. Note that where applicable, consent procedures should make it clear that if something potentially or actually illegal is discovered in the course of a project, it may need to be disclosed to the proper authorities	

	N/A <i>(this box should expand as you type)</i>	
3	Risks to the investigator For example: personal health & safety, physical harm, emotional distress, risk of accusation of harm/impropriety, conflict of interest	
	Risk to the investigator: There are always risks. Do not write NA. Due to the high energy nature of the material there is a chance of burns if a test where to breach its container or react faster than expected. <i>(this box should expand as you type)</i>	How you will mitigate the risk to the investigator: This will be mitigated by first doing small scale hazard testing to ensure that we fully understand the safety of material. During testing the investigator will be wearing protective equipment such a Nomex to ensure that they can not be burned. <i>(this box should expand as you type)</i>
4	University/institutional risks For example: adverse publicity, financial loss, data protection	
	Risk to the University: There are always risks. Do not write NA. All tests will be carried out at my companies site so there is no direct risk to the university <i>(this box should expand as you type)</i>	How you will mitigate the risk to the University: All tests will be carried out at my companies site so there is no direct risk to the university <i>(this box should expand as you type)</i>
5	Environmental risks For example: accidental spillage of pollutants, damage to local ecosystems	
	Risk to the environment: Some chemical can have damaging environmental effects and may be harmful to wildlife found on test sites. <i>(this box should expand as you type)</i>	How you will mitigate the risk to environment: Environmental chemical investigation will be carried out before any testing takes place to ensure only chemicals with minimal or zero environmental impact are used. <i>(this box should expand as you type)</i>

SECTION G: Feedback, Consent and Confidentiality

If you have identified in section D that there are no participants then enter skip this section and continue to section H.

1	Feedback What de-briefing and feedback will be provided to participants, how will this be done and when?
	You don't need to email your participants with your final report. A good alternative is to set up an email address that they will be able to contact for further details or results. N/A (this box should expand as you type)
2	Informed consent Describe the arrangements to inform potential participants, before providing consent, of what is involved in participating. Describe the arrangements for participants to provide full consent before data collection begins. If gaining consent in this way is inappropriate, explain how consent will be obtained and recorded in accordance with prevailing data protection legislation.
	If you are using a paper questionnaire then you should have the participants sign an appropriate consent form. These forms will count as personal data and should be noted as such in section J. If you are using an online questionnaire, then you should have a screen before the questions start that acts as a consent form, informing participants that by clicking on the NEXT button they are providing consent. N/A (this box should expand as you type)
3	Confidentiality / Anonymity Set out how anonymity of participants and confidentiality will be ensured in any outputs. If anonymity is not being offered, explain why this is the case.
	Do not collect names unless you really need them. Do not name participants or organisations in any research publications (including the thesis) without their explicit permission. N/A (this box should expand as you type)

SECTION H: Data Protection and Storage

	Does the research activity involve personal data (as defined by the General Data Protection Regulation 2016 "GDPR" and the Data Protection Act 2018 "DPA")?	YES	NO
1	"Personal data" means any information relating to an identified or identifiable natural person ('data subject'). An identifiable natural person is one who can be identified, directly or indirectly, in	☐	☒

	particular by reference to an identifier such as a name, an identification number, location data, an online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person. Any video or audio recordings of participants is considered to be personal data.		
	If YES, provide a description of the data and explain why this data needs to be collected:		
2	This includes audio/video data of participants, but can also include IP addresses and usernames. Names, addresses and emails also count, as do consent forms. (this box should expand as you type)		
	Does it involve special category data (as defined by the GDPR)?	YES	NO
3	“Special category data” means sensitive personal data consisting of information as to the data subjects’ – (a) racial or ethnic origin, (b) political opinions, (c) religious beliefs or other beliefs of a similar nature, (d) membership of a trade union (within the meaning of the Trade Union and Labour Relations (Consolidation) Act 1992), (e) physical or mental health or condition, (f) sexual life, (g) genetics, (h) biometric data (as used for ID purposes),	☐	☒
	If YES, provide a description of the special category data and explain why this data needs to be collected:		
4	What counts as ‘sensitive’ will differ between cultures. Any information on behaviour that is not in accordance with cultural norms would count as sensitive personal data. (this box should expand as you type)		

	Will data from the research activity (collected data, drafts of the thesis, or materials for publication) be stored in any of the following ways?	YES	NO
5	Manual files (i.e. in paper form)?	☒	☐
6	University computers?	☐	☒
7	Private company computers?	☒	☐
8	Home or other personal computers?	☐	☒
9	Laptop computers/ CDs/ Portable disk-drives/ memory sticks?	☒	☐
10	“Cloud” storage or websites?	☐	☒
11	Other – specify:	☐	☒

12	For all stored data, explain the measures in place to ensure the security of the data collected, data confidentiality, including details of backup procedures, password protection, encryption, anonymisation and pseudonymisation:
	If possible, save your data on computers that are secure and regularly backed up. Many cloud services only provide GDPR-compliant storage for business customers. An example of suitable text is given below. <i>All data will be kept on password protected computers within my companies network that is backed up as well as being stored on encrypted hard drives when being moved between air gaped machines. All paper records will be stores in key locked cabinets with only people relevant to the project having access to them.</i> <i>(this box should expand as you type)</i>

Data Protection			
	Will the research activity involve any of the following activities:	YES	NO
13	Electronic transfer of data in any form?	☐	☒
14	Sharing of data with others at the University outside of the immediate research team?	☐	☒
15	Sharing of data with other organisations?	☐	☒
16	Export of data outside the UK or importing of data from outside the UK?	☐	☒
17	Use of personal addresses, postcodes, faxes, emails or telephone numbers?	☐	☒
18	Publication of data that might allow identification of individuals?	☐	☒
19	If YES to any question, please provide full details, explaining how this will be conducted in accordance with the GDPR and Data Protection Act (2018) (and/or any international equivalent): This includes data such as drafts of your thesis as well as experimental or survey data. An example of suitable text is given below. <i>(this box should expand as you type)</i>		
20	List all who will have access to the data generated by the research activity: Normally the principal researcher, possibly also the supervisor and, if the project has an industrial partner, a representative of that partner. Possibly also external examiner or second marker? Myself, My employer (DSTL), my supervisor and if final examiner <i>(this box should expand as you type)</i>		
21	List who will have control of, and act as custodian(s) for, data generated by the research activity: Usually the principal researcher. Myself <i>(this box should expand as you type)</i>		
22	Give details of data storage arrangements, including security measures in place to protect the data, where data will be stored, how long for, and in what form. <i>All data will be kept on password protected computers within my companies network that is backed up as well as being stored on encrypted hard drives when being moved between air gaped machines. All paper records will be stores in key locked cabinets with only people relevant to the project having access to them.</i>		

	All data will be stored for 20 years in accordance with defence research policy. <i>(this box should expand as u type)</i>	
22	Confirm that you have read the UWTSD guidance on data management (see https://www.uwtss.ac.uk/library/research-data-management/)	☒
23	Confirm that you are aware that you need to keep all data until after your research has completed or the end of your funding	☒

SECTION I: Declaration

The information which I have provided is correct and complete to the best of my knowledge. I have attempted to identify any risks and issues related to the research activity and acknowledge my obligations and the rights of the participants. In submitting this application I hereby confirm that I undertake to ensure that the above named research activity will meet the University's Research Ethics and Integrity Code of Practice which is published on the website: https://www.uwtss.ac.uk/research/research-ethics/			
1	Signature of applicant:	Jslattery	Date: 30/03/2023
2	Director of Studies/Supervisor:		Date:
3	Signature:		

FOR INTERNAL USE ONLY:

Ethical approval given		
1	Signature of assessor:	Date:
2	Name:	
3	Role:	

The effects of chemical additives on the ultra violet output of MTV

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

48/100

Intro / Aim & Objectives (150 words)		
Project title.		
Identification of a specific problem to be investigated.		
Well-defined aims and SMART objectives.		
Explaining why this project is worth doing.		
Discussion of what the project needs to do in order to be a success.		
Description any deliverables that will be produced at the end of the project	20	14
Specific problem has been identified and well justified. Aims are well-defined but would be benefitted by referring back to SMART. Success criteria has been defined with some reference to end of project deliverables but this could have been better defined.		
Background to the Project / Literature Review (450 words)		
Description of how the work to be done in the project relates to the work identified in the literature review.	20	9
Discussion of any ethical issues raised by the project Identifying what has already been done within the field. Topic familiarity.		

Brief literature review using appropriate sources – 6-8 journal papers and book chapters rather than just websites. Selection of relevant models & concepts. Efforts have been made to describe previous work in the area but as only three references are used this is limited. Some evidence of topic familiarity demonstrated, including a wider range of research would have been beneficial.		
Project Design (200 words)		
Clear statement of which development methods are to be used and why they are appropriate. Clear statement of which tools are to be used and why they are appropriate. Clear description of how data collected will be analysed Some attempt made at describing the project design, however much of this section discusses the preliminary literature reviewing methods which are not necessary at this stage. Description of the actual experimental process involved is vague, it would have been better to go into more detail about this rather than the literature review as this is the key part of the research that will be performed. Discussion of data collection and analysis is much better in terms of detail.	30	13

Resources / Planning (200 words)		
List of any deliverables. Clear diagram showing both timing and resource use. Completed ethics form. Limited and relevant appendices Limited discussion of required resources, this needs to be clearly stated. Some attempts made at listing deliverables throughout but this could have been focused on slightly more. Completed ethics form included as an appendix and listed in the table of content is good, it may have helped to include in the TOC something like "Appendix A – Ethics Form" for ease of understanding for the reader as well as page numbers. A good effort has been made to show a time scale for this research, however a gantt chart may have been more helpful in this situation as it can allow for a more detailed and time accurate plan to be given.	15	6
Document Presentation		
Correct spelling. Grammar and punctuation. Flow of narrative/fluency. Coherence. Word processed. Correct use of referencing with bibliography.	15	6

Strict word limit for main text – 1000 words. Some typos, multiple grammar errors. Consider having someone proofreading work prior to submission or using something like Grammarly to help avoid this in future. Avoid the use of first person, consider terms such as “the researcher” instead of “I”, etc. IEEE referencing utilised correctly, however more references would have been expected. Kept within the wordcount +/- 10%. A title page may have given the document a more professional feeling.		
TOTAL	100	48

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