**Project Proposal Form**

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| SECTION 1: TITLE AND OBJECTIVES | **Project type** *(tick as appropriate):* | | | |
| Dissertation | Investigation ✓ | Performance | Artifact |
| **Title: Is Behavioural Cloning more appropriate to use in autonomous vehicles than a Model Predictive Control?**  Research question (dissertations), hypothesis (investigations), performance title or design brief (artefact) | | | |
| 1. Is Behavioural Cloning more appropriate to use in autonomous vehicles than a Model Predictive Control? 2. Build software written with both methods to compare the ease of development and real life/simulation performance. 3. Build a model car using a Raspberry PI and passive light sensors. s | | | |
| **Objectives:**  Divide your title into a handful of smaller questions or objectives that you would need to answer/meet in order to conclude on your main question. | | | |
| 1. Research the theory behind MPC and CNN by searching through the internet and reading papers written by universities and companies. 2. Spend time learning about the specific details in Python, machine learning cars, and self-driving car development by reading books and online courses. Gain a basic understanding of the mathematics involved (differential calculus, statistical analysis etc.) Try contacting experts on the subject. 3. With the help of libraries from Python, Google’s Tensorflow, and tools from Udacity, build a working version of a self-driving car using CNN in simulation. Do the same using MPC. Compare the results including the accuracy, average speed, safety, and ease of development. 4. Build working versions of a self-driving car using a Raspberry Pi with both CNN and MPC. Collect the same data as mentioned above. 5. Compare the data collected and reach a conclusion as whether MPC or CNN would be the way to develop the self-driving cars of the future. | | | |
| **Responsibilities:**  If this is a group project, outline your main responsibilities below. | | | |
| This is an individual project. | | | |

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| SECTION 2: RATIONALE | **Personal rationale:**  Why do you want to do this project, from a personal perspective? Why does it interest you? What do you want to get out of it? |
| I have always been fascinated with topics in computer science, I love the idea of exploring new technology, and I lave a long-lasting habit of building projects that I think will be useful in real life. Self-driving car development is one of the new and uprising subjects in computer science both interested by both enterprise and academia, I would love the opportunity to explore the subject before university.  I want to get out of this experience the ability to set long-term and short-term goals, to adjust the goals when they are inappropriate, and to stick to them when they are reasonable. Doing an EPQ will prepare me for both the university work ahead, and the work in the society later. Machine Learning is always a subject that interested me but I haven’t had an opportunity to explore it, I want to use this experience to further my understanding of the subject. |
| **Links:**  How does this project relate to your AS Level subjects and/or your intended university course? |
| I am studying double maths, physics and chemistry at the moment and plan on applying for computer science in university. This project will help with my time management skills for studying the subjects mentioned above. More specifically, it will improve my maths skills as this project is heavily mathematics based, and it would improve my understanding of some physics concepts and I would need to apply them in the development of the Raspberry PI powered self-driving car. |
| **Wider application:**  Why do we (the human race) need to know the answer to your question? What are the direct and indirect applications of your project to wider society? |
| 1.3 million people die in road death each year and over 95% of these deaths are caused by human error. If we could create an algorithm that eliminates the human factor in driving, the world would be a lot safer, and the stresses caused by driving would virtually disappear.    Model Predictive Control and Convolutional Neural Network are the two most popular ways of achieving self-driving cars right now. With MPC used more by automotive companies and CNN used more in research. My research may help with deciding the future of how to develop a safe and efficient autonomous vehicle control system. |
| **Justification:**  What evidence is there that this is an important topic (e.g. media coverage, government funding etc.)? Who else is interested in this field? |
| Google and Tesla are the two main players in the industry with google focused more on the research side and Tesla focusing on the more practical side. Other players in the field incudes Nvidia, Uber, and traditional automotive giants such as Volkswagen and Mercedes-Benz. All the organizations mentioned above have invested a lot of money and human resources into the technology as they believe it would change the world as we know it. Media coverage of the subject is overwhelming since google announced its involvement in 2009. Government funding includes the DARPA challenge set up by the US government with a 1-million-dollar prize, the UK government have a similar challenge for a prize up to 51 million pounds, and the Chinese government have also supported the progress of the industry. |

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| SECTION 3: ACTIVITIES AND TIMESCALES | **Time period and tasks:** | **How long will this take?** |
| Spring Term 2017  **Mon 27th Feb** – Research/Literature Review deadline (1st draft)  Research the theory behind MPC and CNN by searching through the internet and reading papers written by universities and companies.  Spend time learning about the specific details in Python, machine learning cars, and self-driving car development by reading books and online courses. Gain a basic understanding of the mathematics involved (differential calculus, statistical analysis etc.) Try contacting experts on the subject. | 5-10 hours  30 hours |
| Easter Holiday 2017  With the help of libraries from Python, Google’s Tensorflow, and tools from Udacity, build a working version of a self-driving car using CNN in simulation. Do the same using MPC. Compare the results including the accuracy, average speed, safety, and ease of development. | 40 hours starting from the end of spring term |
| Summer Term 2017  **Mon 15th May** – External examinations begin  Finish the simulation if not finished and make a start of the real-life demonstration.  **Thurs 22nd June** - Discussion/Analysis deadline (1st draft) |  |
| Summer Holiday 2017  Build working versions of a self-driving car using a Raspberry Pi with both CNN and MPC. Collect the same data as mentioned above. | 20 hours |
| Autumn Term 2017  **Fri 13th Oct –** Poster Day  Compare the data collected and reach a conclusion as whether MPC or CNN would be the way to develop the self-driving cars of the future. Finish the writeup.  **Mon 23rd Oct** – Deadline for full draft of whole project  **Weds 6th Dec** – Deadline for final draft of whole project | 20 hours |

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| SECTION 4: RESOURCES | **People:**  Who are the big names in the field of your project?  Who has published a lot of books or articles about your project area? |
| Sebastian Thrun is a well-known name in the field who helped both Google and Udacity with their efforts and lead the first team in history to complete the DARPA Grand Challenge. |
| **Organizations:**  Identify the universities which are leading the research in your field  Are there any private companies who are investigating / have been investigating your project area? |
| Google and Tesla are the two main players in the industry with google focused more on the research side and Tesla focusing on the more practical side. Other players in the field incudes Nvidia, Uber, and traditional automotive giants such as Volkswagen and Mercedes-Benz.    Universities such as Stanford, MIT, Oxford, and Warwick are also interested in the subject. |
| **Resources:**  What are the titles of the main journals that publish research in your area?  What physical materials are you going to need for the project (e.g. equipment, technology, funding). |
| International Journal of Computer Vision  IEEE Transactions on Pattern Analysis and Machine Intelligence  IEEE Transactions on Neural Networks and Learning Systems  IEEE Transactions on Automatic Control  Raspberry PI  3D printer may be needed  Motors, servos  Portable Camera for Raspberry PI  Access to research  Access to books, online courses |
| **Research areas:**  What different areas will your research cover? Think of this as the main library categories that are relevant to your project – don’t just include the main academic field, but any other areas that might be relevant to only a small part of your project. |
| Statistics  Differential Calculus  Deep learning  Computer vision  Decision cloning  Convolutional neural networks  Automotive path planning  Sensor fusion  Localisation  Model predictive control  Semantic segmentation network |