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|  <b>Queensland<br/>University<br/>of Technology</b> | <b>QUT Systems Engineering</b><br><br><b>WT18G4</b> | Doc No: WT18G4-VV-01<br>Issue: 1<br>Page: 1 of 12<br>Date: 28 October 2018 |
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# WildTracker

## Verification and Validation Report

|                       |   |      |                  |
|-----------------------|---|------|------------------|
| Prepared by           | <br><hr/> Delenn Palmer, WT18G4 - PM       | Date | <hr/> 28/10/2018 |
| Checked by            | <br><hr/> Christian Neilsen, WT18G4 - OD | Date | <hr/> 28/10/2018 |
| Approved by           | <br><hr/> Delenn Palmer, WT18G4 - PM     | Date | <hr/> 28/10/2018 |
| Authorised for use by | <hr/> Felipe Gonzalez, Supervisor   | Date | <hr/> 28/10/2018 |


Queensland University of Technology  
Gardens Point Campus  
Brisbane, Australia, 4001.

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### Revision Record

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### Definitions

|        |   |
|--------|---|
| WT     | WildTracker - Software implementation of an autonomous detection and tracking tool for wildlife |
| QUT    | Queensland University of Technology   |
| HLO    | High Level Objectives   |
| PMP    | Project Management Plan   |
| GUI    | Graphical User Interface  |
| TF     | TensorFlow  |
| CNN    | Convolutional Neural Network  |
| OpenCV | Open Source Computer Vision   |
| OD     | Objective Detection   |
| DL     | Deep Learning   |
| ML     | Machine Learning  |

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## **1 Introduction**

As the final phase of the systems engineering approach, the verification and validation is a document that ensures that all system requirements and by extension the high-level objectives are satisfied. This is to ensure that the final delivered solution meets all of the requirements that the customer wanted.

There are 2 sections to this document. The verification matrix, which checks the system requirements against the performance of the final design. This is checked at the final testing stage of the final integration of the project. The validation matrix is completed when the customer confirms that they are satisfied with the overall project.


The results for both of these tests are recorded in the sections below.

### **1.1 Scope**

A summary of how the requirement was tested and if it passed or failed was determined. The results are recorded in the verification and validation matrices. There are different methods of verification and validation, and these are listed alongside the requirements. There is also reference to the test article where more information can be seen. Finally, there is an additional comments section included within the matrices.

### **1.2 Background**

The QUT Airborne Systems Lab (ASL) has commissioned students of EGH455 in collaboration with WWF and Wildlife Australia to design and build an autonomous detection and tracking tool for wildlife. Group 4 was tasked with designing an Unmanned Aerial System (UAS) application that must have the ability to identify and report the number of and the size of wildlife present in footage retrieved by the drones. In addition to the data being acquired, the video must be processed and accessible for both real-time use of the application and after the video has been exported. All details for the verification and validation of the program is detailed further below. For more detailed client requirements, they can be viewed in RD/1 and RD/2.

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## 2 Reference Documents

### 2.1 QUT Systems Engineering Documents

|      |                           |   |
|------|---------------------------|---|
| RD/1 | WT18G4-SUP-Customer Needs | Autonomous detection and tracking tool for wildlife                     |
| RD/2 | WT18G4-SR-01              | WildTracker Project: System Requirements Document 2018                  |
| RD/3 | WT18G4-PMP-03             | WildTracker Project: Project Management Plan 2018                       |
| RD/4 | WT18G4-FD-01              | WildTracker Project: Final System Design 2018                           |
| RD/5 | WT18G4-GUI-TR-01          | WildTracker Project: Graphical User Interface (GUI) Testing Report 2018 |
| RD/6 | WT18G4-OD-TR-01           | WildTracker Project: Object Detection Testing Report (2018)             |
| RD/7 | WT18G4-GUI-OD-TR-01       | WildTracker Project: GUI & Object Detection Testing Report (2018)       |

### 2.2 Numbering Scheme

For ease of identification, a numbering system has been developed.

For the requirement REQ-M-01:


REQ – This is a requirement derived from the client's brief and the associated HLOs

M – Denotes a *mandatory* requirement, whereas D denotes the *desired* requirement.

### 3 Verification Matrix

| REQUIREMENTS             | VERIFICATION                              | TRACEABILITY |         |         |         |         |         |               | SUBSYSTEM |     |    |    |
|--------------------------|---|--------------|---------|---------|---------|---------|---------|---------------|-----------|-----|----|----|
|                          |   | HLO-M-1      | HLO-M-2 | HLO-M-3 | HLO-M-4 | HLO-M-5 | HLO-M-6 | CLIENTS BRIEF | PM        | GUI | ML | DL |
| FUNCTIONAL REQUIREMENTS  |   |              |         |         |         |         |         |               |           |     |    |    |
| REQ-M-01                 | Demonstation /<br>Simulation /<br>Testing | X            |         |         |         |         |         | X             | X         | X   | X  | X  |
| REQ-M-02                 | Demonstation /<br>Simulation /<br>Testing | X            |         |         |         |         |         | X             | X         | X   | X  | X  |
| PERFORMANCE REQUIREMENTS |   |              |         |         |         |         |         |               |           |     |    |    |
| REQ-M-03                 | Demonstation /<br>Simulation /<br>Testing |              | X       |         |         |         |         |               |           |     | X  | X  |
| REQ-M-04                 | Demonstation /<br>Simulation /<br>Testing |              | X       |         |         |         |         |               |           |     | X  | X  |
| USER REQUIREMENTS        |   |              |         |         |         |         |         |               |           |     |    |    |
| REQ-M-05                 | Demonstation /<br>Simulation /<br>Testing |              | X       | X       |         |         |         |               |           | X   | X  | X  |
| REQ-M-06                 | Demonstation /<br>Simulation /<br>Testing |              | X       | X       |         |         |         |               |           | X   | X  | X  |
| REQ-M-07                 | Demonstration                             |              |         | X       |         |         |         |               |           | X   | X  | X  |
| REQ-M-08                 | Demonstration                             |              |         |         | X       |         |         |               |           | X   | X  | X  |
| DELIVERY REQUIREMENTS    |   |              |         |         |         |         |         |               |           |     |    |    |
| REQ-M-09                 | Deliverable /<br>Submission               |              |         |         |         | X       |         |               | X         |     |    |    |
| REQ-M-10                 | Deliverable /<br>Submission               |              |         |         |         |         | X       |               | X         |     |    |    |

Table 1: Verification Matrix

|  |   |  |
|--|---|--|
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## 4 Validation Matrix

### 4.1 Functional Requirements

| REQUIREMENT | DESCRIPTION  | VERIFICATION METHOD                  | STATUS | REFERENCE DOCUMENT                 | ADDITIONAL INFORMATION  |
|-------------|--|--------------------------------------|--------|------------------------------------|---|
| REQ-M-01    | The WildTracker system will be capable of detecting and tracking 2 types of wildlife present       | Demonstration / Simulation / Testing | Pass   | WT18G4-GUI-TR-01 & WT18G4-OD-TR-01 | The system is capable of detecting both Elephants and Horses in a variety of footage.                                   |
| REQ-M-02    | The WildTracker system will be capable of processing a top down view and/or oblique angle footage. | Demonstration / Simulation / Testing | Pass   | WT18G4-GUI-TR-01 & WT18G4-OD-TR-01 | The system is capable of making accurate detections of animals from top down or oblique angles from various elevations. |

Table 2: Functional Requirements - Validation Matrix




|  |   |  |
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## 4.2 Performance Requirements

| REQUIREMENT | DESCRIPTION   | VERIFICATION METHOD                     | STATUS | REFERENCE DOCUMENT | ADDITIONAL INFORMATION  |
|-------------|---|---|--------|--------------------|---|
| REQ-M-03    | The WildTracker system shall be capable of achieving 95% accuracy     | Demonstration /<br>Simulation / Testing | Pass   | WT18G4-OD-TR-01    | When used to detect animals in relatively familiar environments the system is capable of detecting with over 95% accuracy (can be lower on images that are largely different from training material). |
| REQ-M-04    | The WildTracker system shall have less than 8% error in animal counts | Demonstration /<br>Simulation / Testing | Pass   | WT18G4-OD-TR-01    | When used to detect in relatively familiar environments (as above) the system was found to be capable of accurately counting the number and type of animals in a frame.                               |


Table 3: Performance Requirements - Validation Matrix

|  |   |   |
|--|---|---|
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### 4.3 User Requirements

| REQUIREMENT | DESCRIPTION  | VERIFICATION METHOD                  | STATUS | REFERENCE DOCUMENT                 | ADDITIONAL INFORMATION   |
|-------------|--|--------------------------------------|--------|------------------------------------|--|
| REQ-M-05    | The WildTracker system shall be capable of distinguishing between wildlife species and displaying necessary labels on the GUI  | Demonstration / Simulation / Testing | Pass   | WT18G4-GUI-TR-01 & WT18G4-OD-TR-01 | The system stores all frame data (including animal types, counts and sizes) into a .JSON object during the processing stage, and this file is then accessed with all of this information being displayed in the GUI on the leftside panel. |
| REQ-M-06    | The WildTracker system shall be capable of detecting the number of an animal species and displaying the appropriate label on the GUI   | Demonstration / Simulation / Testing | Pass   | WT18G4-GUI-TR-01 & WT18G4-OD-TR-01 |  |
| REQ-M-07    | The system will have an easy to use interface that allows for the opening of footage, the ability to play the raw video and for the wildlife to be detected after a button is pressed to process the footage. Pausing the footage and reviewing the processed footage will also be a feature | Demonstration                        | Pass   | WT18G4-GUI-TR-01 & WT18G4-OD-TR-01 | The GUI closely followed the example GUI provided by the client, and clearly labelled buttons and intuitive actions allow easy navigation of the GUI and its functionality.  |
| REQ-M-08    | The system shall be packaged into a simple and user-friendly installer with an installer being provided for both the Linux and Windows platforms   | Demonstration                        | Pass   | WT18G4-GUI-TR-01 & WT18G4-OD-TR-01 | The system is packaged into a simple extractable folder which contains all of the necessary files, and provided that external dependencies are installed along with Darkflow then the system runs without issue on both Linux and Windows. |


Table 4: User Requirements - Validation Matrix

|  |   |   |
|--|---|---|
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#### 4.4 Delivery Requirements

| REQUIREMENT     | DESCRIPTION  | VERIFICATION METHOD      | STATUS | REFERENCE DOCUMENT | ADDITIONAL INFORMATION  |
|-----------------|--|--------------------------|--------|--------------------|---|
| <b>REQ-M-09</b> | The system will show significant progress towards the first five requirements by week 8 of the project | Deliverable / Submission | Pass   | WT18G4-PMP-04      | Preliminary Design documents were submitted during week 7 of the project.   |
| <b>REQ-M-10</b> | The developed solution shall conform to the systems engineering approach                               | Deliverable / Submission | Pass   | WT18G4-PMP-04      | All necessary design and testing documentation has been appropriately named and submitted with the final documentation package. |

Table 5: Delivery Requirements - Validation Matrix

|  |   |   |
|--|---|---|
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## 5 Conclusion and Recommendations

As shown in the verification and validation matrices, all system requirements were passed by the developed system. As noted in the additional comments for 'Requirements 08', even though the system is easily extractable from a folder that contains the necessary files for the program, certain external dependencies would need to be installed to ensure that the machine learning aspect of the program would run without any issue.

Therefore, we would consider this project a complete success as it satisfies all system requirements and in turn verifies the project high level objectives.