Abstract prepared for the 34th European Rotorcraft Forum

Liverpool, September 2008.

A New Pilot Model for the Assessment of Rotorcraft Handling Qualities

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This paper describes the development of a new pilot model capable of producing authentic control activity for pre-defined manoeuvres [1] and consequently assigning a Cooper-Harper rating in the same manner as a piloted test flight. The two pilot modelling methods which provide the underlying structure as well as additional elements used for creating features observed in flight tests are described. The three main methods of calculating handling qualities ratings for the project pilot configuration are described. Two of these, decision tree [2] and statistical [3] methods have been used in previous work at GCU with the third, a neural network method being a new contribution to the task. The authenticity of these ratings is then discussed with a comparison to piloted flight tests.

The pursuit of authentic pilot activity is the ultimate aim of pilot modelling. The two methods used to build the underlying structure (SYCOS[4] and two-timescale (TTS) method [5]) have not been shown to produce all the features that are observed in typical pilot activity. This study uses the characteristics of the SYCOS model as a corrective method and the TTS as an anticipative method to produce a basic control profile, with additional elements used to capture specific human characteristics. The components of the pilot model are created from linear representations of the project helicopter, requiring the combination of the individual linear helicopter systems, including full and limited authority versions of the flight control system.

It is demonstrated that assessing control activity is a valid method to gauge pilot workload [6]. A wavelet approach may be used to use pilot activity to isolate individual movements that have different aims, such as guidance and stabilisation. These movements are presented in an 'attack chart', used to assign each action into the appropriate activity region. Two methods use these metrics, firstly a decision tree format where the workload rating is found by following the decision tree depending on the number and type of events produced by the test pilot/pilot model.

Secondly, neural networks are used as a black box method, requiring the same inputs as the decision tree model. Several networks may be produced to create the same process of calculating an average workload rating from several pilots. Additionally, a frequency spectrum of control response is used in a statistical method; using the mean and standard deviation of control displacements and rate of controls to extract a workload rating. The general assumption is that an increase in control frequency results in a higher workload rating.

The interest to simulation engineers is that a rotorcraft may be simulated so any handling difficulties may be detected at an early stage in the design process or the effect of an enhancement (e.g. inclusion of an advanced flight controls system) may be observed before any piloted test flight is undertaken.

The research described was conducted through the Defence and Aerospace Research Partnership: 'Towards Robust and Cost Effective Approaches to Rotorcraft Design' sponsored by AgustaWestland, QinetiQ, UK MoD, EPSRC and DTI.

The figures below illustrate some of the issues discussed.

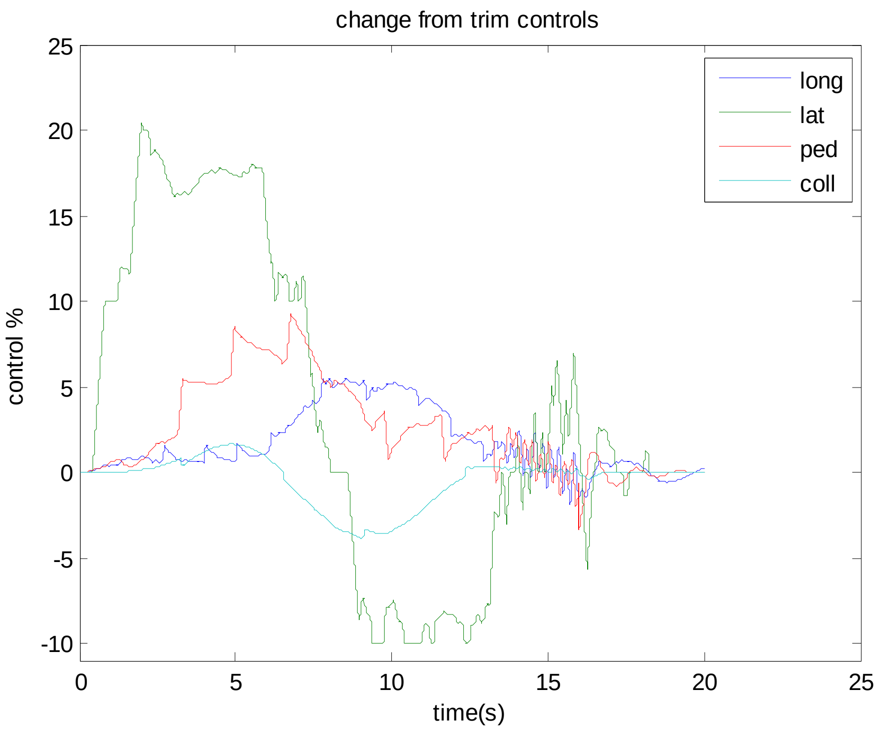

Figure 1 - Control Activity for sidestep manoeuvre produced though pilot model

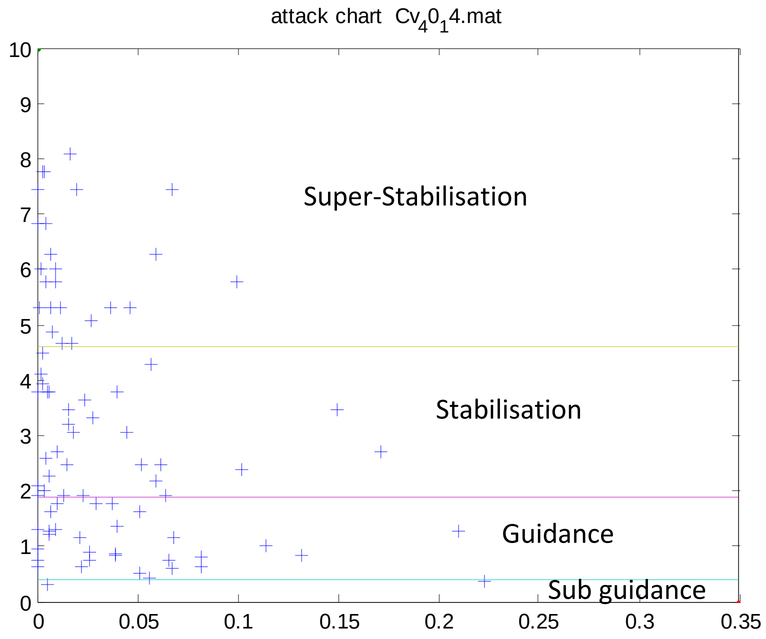

Figure 2 – attack chart for CONDVAL 40/14 test flight

Sub –Guidance	**Low values of attack, representing phantom like features –a low resolution capture of clusters of guidance and stabilisation features.**
Guidance	**Features which are of the correct timescale to influence the vehicle attitude with the aim of achieving the correct track for the MTE.**
Stabilisation	**Features that have a small enough timescale to be outside the MTE definition but still influence the attitude of the vehicle**
Super-stabilisation	**Features that are of such a high frequency that they have no effect on the vehicle attitude but still form a significant part of workload**

Table 1 – description of attack chart regions and boundaries

References

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