Development of the Robust System Design Process for Unmanned Rotorcraft

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Unmanned Aerial Vehicle can be divided into a fixed-wing aircraft and a rotorcraft according to the function and the configuration. In particular, growing attention has been paid to the rotorcraft because of the VTOL(Vertical Take-Off and Landing) and hovering of the rotorcraft, which is not possible in the fixed-wing aircraft. However, an appropriate requirement selection and definition is essential issues because the rotorcraft performs various missions during the forward and hovering flights. Additionally, the environment of operation is not fixed and that changes could effect on the performance of rotorcraft. So, in this study, user requirements are defined to fulfill the reconnaissance and the search missions, by analyzing the system characteristics and operation environment. Furthermore, robust rotorcraft system design and optimization process is developed to identify the best configuration concept that satisfies the design requirements and to derive robust design solution.

User requirements are analyzed and quantified to select alternative concepts that satisfy the user requirements. Then an affinity diagram is prepared to classify the factors indicated in the performance and design requirements. The design requirements are selected on the basis of customer and engineer viewpoints. Based on the initial customer requirements, the subcategories under the voice of customers formed the fundamentals of Nested Column Diagram and Quality Function Deployment(QFD). Also, the classifications under the voice of engineers determine the subcategories in Nested Column Diagram and Quality Function Deployment. As a result of the absolute importance of Second QFD, a morphological matrix is prepared using the design requirements with high scores. In Pugh concept selection matrix, the alternative design configuration concepts are evaluated by scoring the design requirement satisfaction level of each configuration.

Analysis tool is developed to analysis baseline and alternative configurations. The analysis tool is sizing code which based on empirical equations. Design of experiment method is applied to input variables of the analysis code and different design cases are derived in this way and a design space model is derived that would show interpretations of each case in order to understand the sensitivity of design variables and to identify the feasible design region. Using the results of each design case from the design space model, prediction profile and contour plot are prepared. The design feasible region within which the conditions that satisfy each design variable are extracted to establish the design requirements.

Robust design method is applied to derive the robust solution of selected alternative configuration. At first, a variance of object function is calculated, and a mean value and a variance of target value

are determined by the tentative design results of alternative configuration to apply the robust design method. Then robust optimum design formulation is prepared to derive the robust solution that minimizing the variance of the response and bringing the mean to the target caused by variations of design variables from the noise effect.

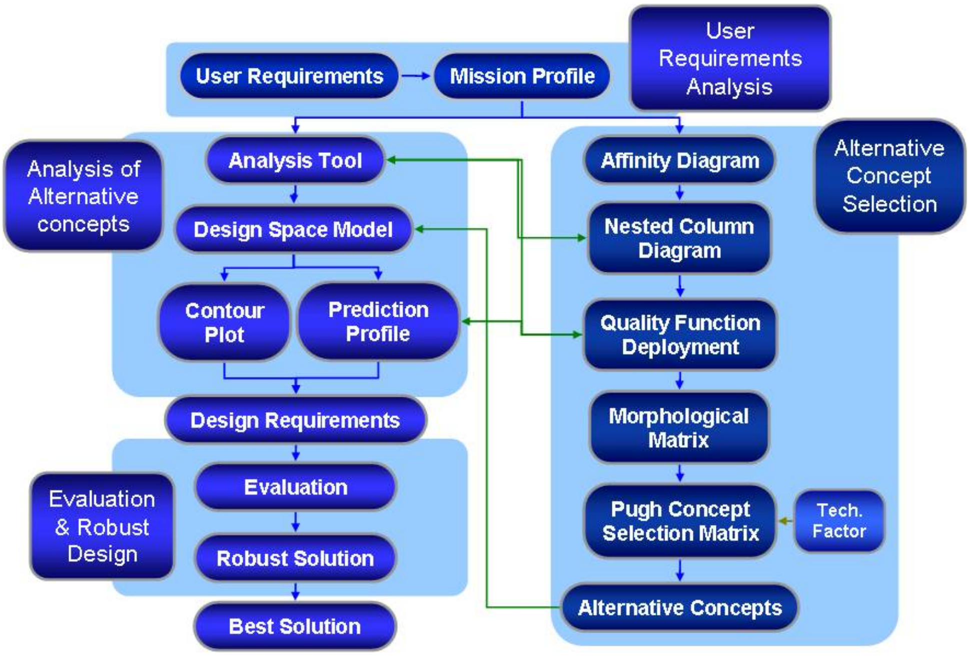

Figure 1. Flow chart of whole process