**Track check in Helicopter using**

**Image processing**

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# List of Abbreviations

**RTB** Rotor Track and Balance

**WTS** Weights

**PCR** pitch control rods

**TBR** tailing edge ends

**PHPT** Progressive ProbabilisticHough Transform

**RPM** revolution per minute

# Introduction

## 1.1 Background

Nowadays, machines hold a significant position in our everyday existence. Our dependency on machines extends to various aspects of life, from enabling travel and air transportation to facilitating construction activities such as building houses, roads, and infrastructure. Machines offer the dual advantage of expediting tasks while enhancing overall productivity. Thus, maximizing uptime, optimizing resource utilization, and ensuring the reliability of critical machinery have become the fundamental goals for any organization. Predictive Maintenance has emerged as a groundbreaking approach to achieve these objectives by harnessing the power of data-driven insights and cutting-edge technology.

Initially, Predictive Maintenance was only used in the Oil and Gas industry, but with the advent of AI and IoT, a data-driven approach for Predictive Maintenance is taking a new flight towards smart manufacturing in several new domains. It uses data analysis to identify operational anomalies and potential equipment defects, enabling timely repairs before failures occur. It aims to minimize maintenance frequency, avoiding unplanned outages and unnecessary preventive maintenance costs.

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   Fig 1. In-track and out of track blades

Blade tracking is a critical process used to manage vertical vibrations. It involves calculating and adjusting the vertical position of each blade’s tip based on its position in the air. Typically, one blade is selected as a reference, and the position of the other blades’ tips is measured relative to this reference blade. If the difference in blade tip position falls within a certain threshold (usually around 20 mm), the blades are considered to be in track; otherwise, they are deemed out of track or misaligned. This threshold may vary for different helicopter models. Blade tracking can be performed both in-flight and on the ground. Various methods have been employed in the past for blade tracking. The oldest method is known as flag tracking, where each blade is painted with a different coloured wet paint, and an operator holds a flag near the rotating blade tips. When the blades touch the flag, marks are left on it, and the out-of-track values are determined from these marks.

Diagram of a helicopter and a diagram

Description automatically generatedFig 2. Track Balancing in Helicopters – Evolution in equipment 

# Objectives

The objectives of this technique include:

1. Reducing vertical vibrations.

2. Designing a system suitable for indoor/outdoor use and in-flight/on-ground operation.

3. Developing a system that requires no modifications to the blades like attaching sensors to blade tips.

4. Creating an affordable system.

This approach utilizes image processing techniques and is divided into several steps, including image filtering, image thresholding, precise determination of each blade’s position, and conversion of pixel distances into real-world measurements. This method aims to provide accurate results while overcoming the drawbacks associated with previous techniques.

# Literature Review

# Rotor Track and Balance (RTB) Techniques (Bechhoefer1 et al [1])

# The study introduced the idea of rotor blade adjustments using weights (WTS), pitch control rods (PCR), and trailing edge tabs (TAB) to balance out inherent blade non-uniformities. Additionally, Ferrer (2001) laid the groundwork for later algorithmic developments in RTB by highlighting the linearity of adjustment coefficients. Multiple equivalent solutions are produced when the Fourier transform is applied to the time domain, necessitating the development of a method to determine actual blade adjustments. Initially, all efforts to reduce blade non-uniformity began with a desire to reduce track split errors. Since rotor track and balance's main objective is to reduce vibration, finding an effective solution to the issue is a driving force.

# Use if Hough Transfor

# A novel

# Shi Tomasi corner detection

# Camera calibration

# Parameters

# Mathematical formulation

The literature review should provide a good review all the relevant papers, case studies etc. related to your work. The following text is for illustration. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elitsit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a,

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## Section Heading

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# Work plan and Gantt Chart

The work plan must be stated in this section along with a Gantt chart of the activities planned in the remaining duration of the project.

# Progress so far

# Blade Tracking

# Blade Tip detection

# Edge detection

# Corner detection

# Finding blade tip positions

# Camera calibration

Any preliminary results, computational study, etc. that has been accomplished so far can be mentioned as a part of this section. Some discussion and future work for the remaining of this semester should also be presented .

# References

1. D. Sarunyagate, Ed., *Lasers*. New York: McGraw-Hill, 1996.
2. G. Liu, K. Y. Lee, and H. F. Jordan, "TDM and TWDM de Bruijn networks and shufflenets for optical communications," *IEEE Trans. Comp.*, vol. 46, pp. 695-701, June 1997.