AUTOMATED MAINTENANCE OF LARGE COMPOSITE STRUCTURES

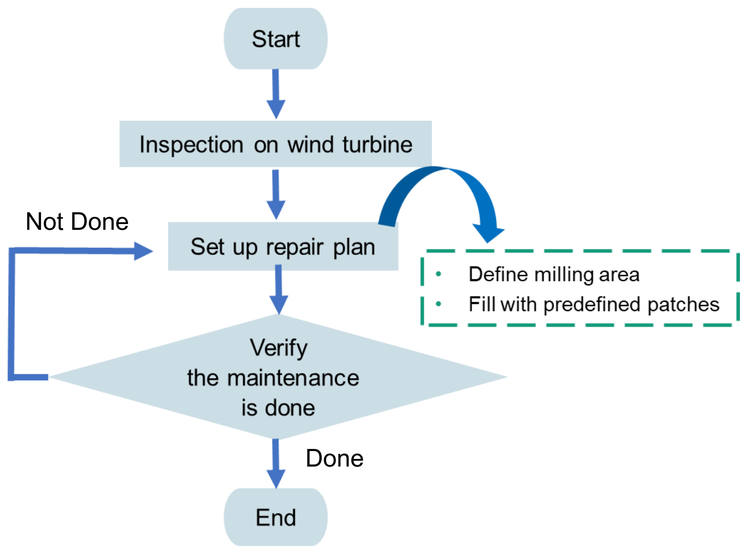
OBJECTIVE

The aim of this project is the conceptual design of an automated system to work on large composite structures such as wind turbines and other similar constructions

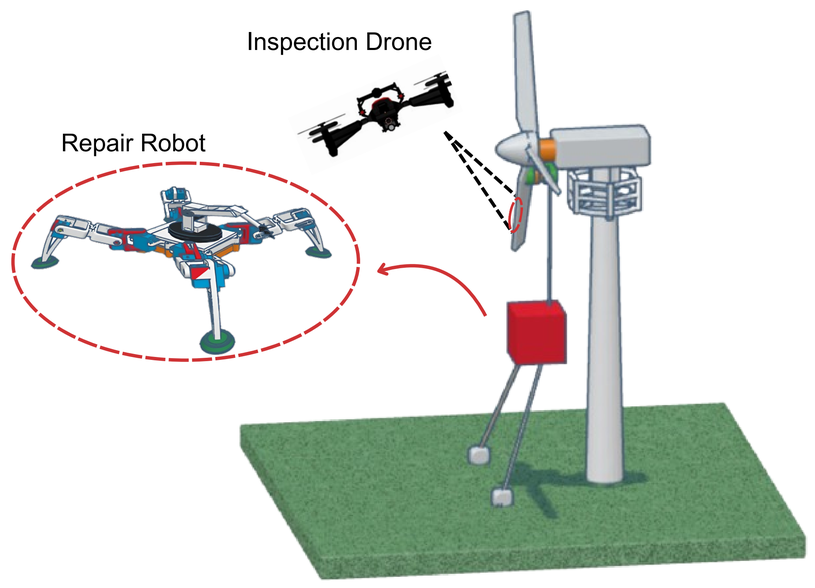
PROJECT SCOPE

- Reliability and safety while operating
- Lightweight construction
- High load capacity
- Environmentally friendly operation
- Competitive process times
- inline process control

SYSTEM PROCEDURE



SYSTEM CONCEPT DESIGN



INSPECTION AND LOCATION TRACKING SYSTEM

How does Infrared Thermography (IRT) work?

- Utilizes infrared radiation to detect temperature variations
- Converts thermal energy into visible images
- Reveals hidden defects or abnormalities in objects or structures

Why IRT?

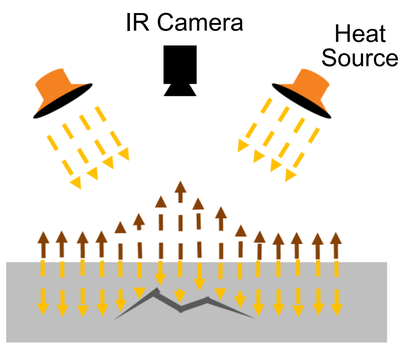
- Non-destructive, non-contact inspection
- Real-time imaging for immediate analysis
- High sensitivity to surface and subsurface defects

IMU sensor to track the location which typically consists of:

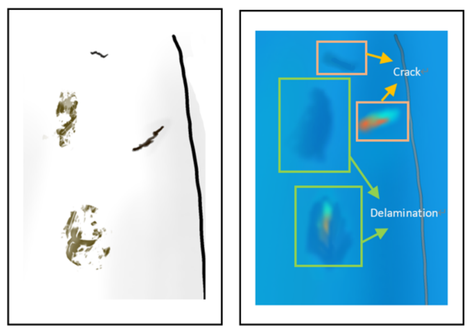
Gyroscope: Angular velocity

Accelerometer: Acceleration

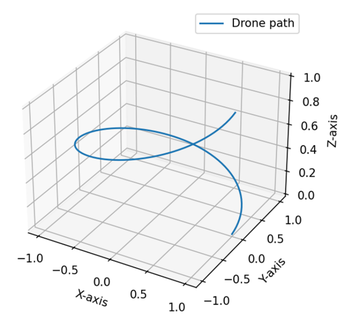
By combining these parameters over time, IMUs provide estimates of robot position, velocity and orientation



Infrared Thermography (IRT)



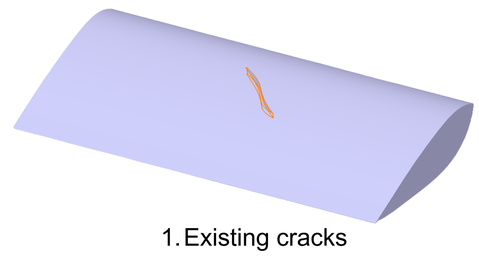
Infrared Thermography highlighting defects



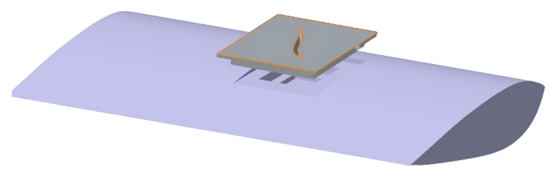
Location tracking record

REPAIR PROCESS

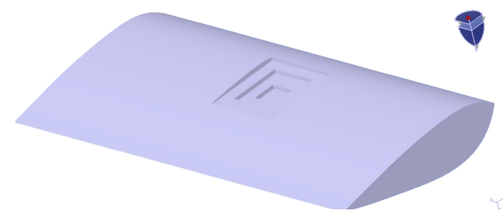
- Primary focus on addressing cracks and delaminations for turbine blade repairs
- Initial deployment of inspection systems to precisely locate defects
- Milling operation chosen for defect preparation due to its contour-shaping capabilities with adjustable feed rates
- Milling operation covers a maximum repair area of 20x20cm, ensuring extensive defect coverage
- Subsequent step involves using a suction mechanism with predefined composite patches for efficient and precise defect repair



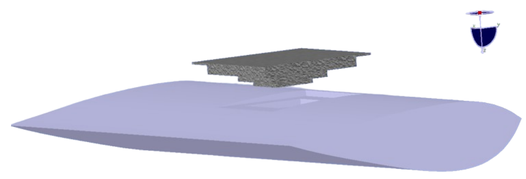
1. Existing cracks



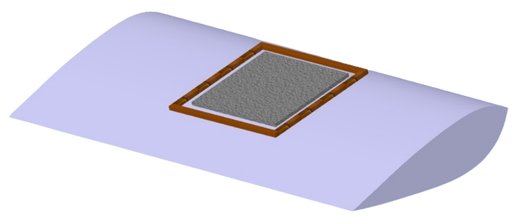
2. Surface to be removed through milling



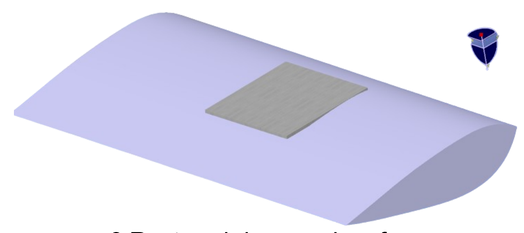
3.Removed portion and ready for repair



4.Predefined composite patches to be filled



5.Patch attached to surface through suction mechanism



6.Restored damaged surface

REPAIR ROBOT

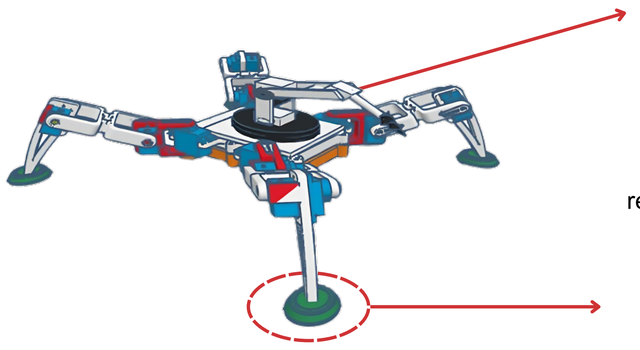
Lift Mechanism:

- After analyzing the inspection data, the drone pinpoints the exact location on the wind turbine blade
- Using a rope system, a four-legged modular robot is lifted and positioned at the identified repair spot

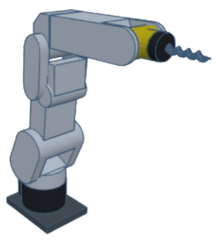
Robot components:

- Suction cup that house a small rotor turbine to increase the negative pressure
- Detachable arm end effector with magnetic tool changer
- A toolbox that contain the needed end effector for the repair process and the predefined patches

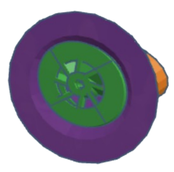
Rope system for lifting the four-legged robot



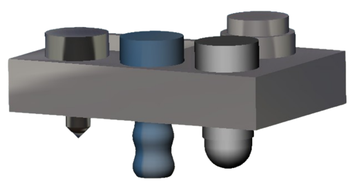
Modular four legged robot with suction cup



Robot arm with replacable end effector



Suction Cup with rotor turbine



Toolbox consisting of different end effectors

FUTURE PROSPECTS

- Looking ahead, there is potential for further refinement, making the design more compact and versatile to address different defects
- Exploring the feasibility of utilizing drones equipped with integrated robotics emerges as a promising avenue for future advancements

CONCLUSION

- The developed concept is highly autonomous and stands out for its environmental friendliness, reliability, and superior performance compared to existing procedures
- Adaptable to various composite structures

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