Robots & Drones for Power Plant Inspection

A Group Sponsored Project

(Exploratory Phase Completed; Development Phase to Start)

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The Problem

Power plants inspection of → *A labour intensive activity.* The mere size of power plant boilers and HRSGs, burners, ducting etc. means that to visually examine and inspect various parts needs time taking and costly scaffolding and hazardous climbing. Even then not all parts are necessarily easily accessible.

A 6-month Exploratory Phase project studied:

a) What is available in the market in terms of drones and robots suitable for industrial plant visual and UT inspection.

b) New R&D being carried out in this area.

- Leading to *Project Phase 2*. Starting with a proposal for the design & development of a most suitable & economic automated device for power plant boiler inspection.

Looking at two type of devices

1) **Drones** for visual, thermal and possibly UT inspection of remote, out of view / at height components.
2) **Robots** for polishing and UT inspection (wall thickness measurement and crack sizing) of components.

- Developments of this type at any significant level need greater expertise than afforded by any one utility or service provider on its own and need accumulated resources and experience from various organisations and experts. Hence this GSP.

PART 1

Drones for more than Visual Inspection

Studied the possibility of adopting drones for carrying small polishing heads and UT probes, land at specific sites and carry out wall thickness measurement or crack detection and sizing.

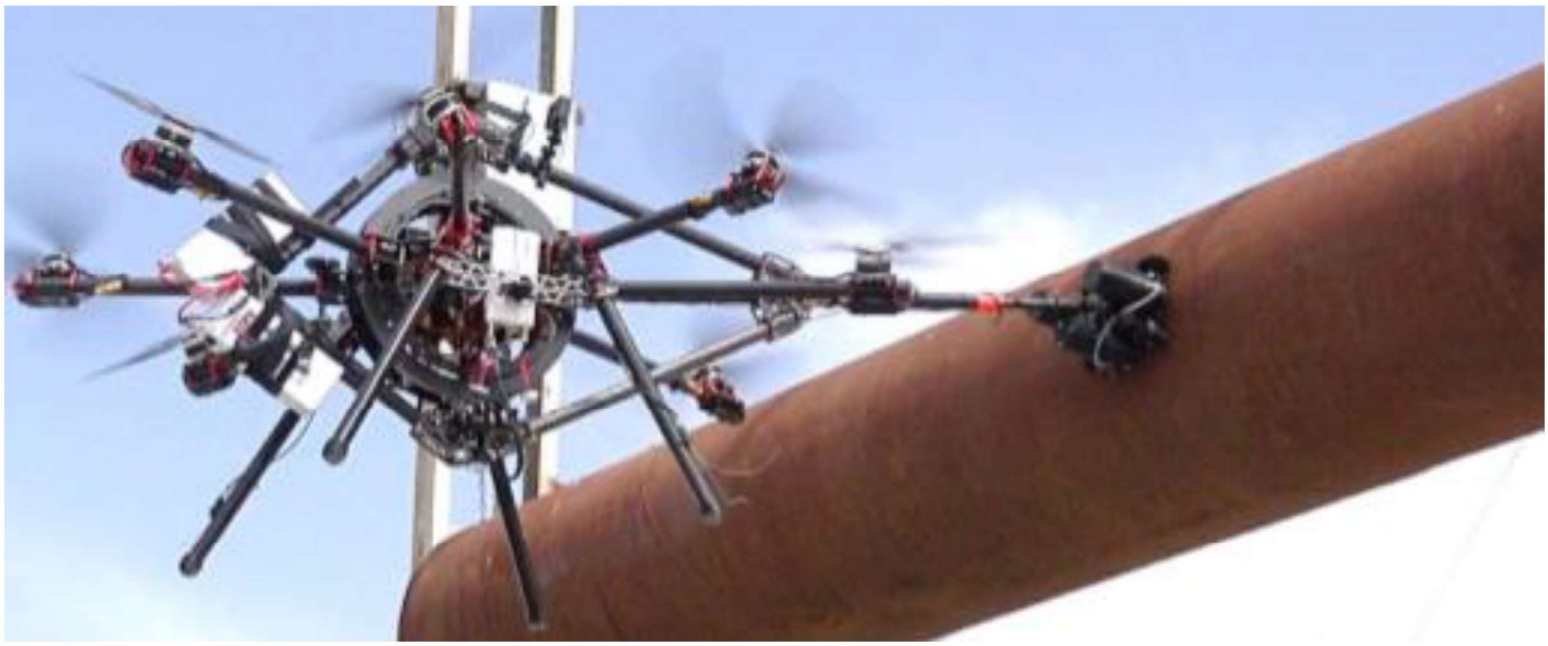
Drones – Present state of development

A few power utilities studying this in the USA, Japan, Australia, Europe and elsewhere for visual inspection.

- A few known attempts for UT inspection in the oil and gas industry – inspection of the supply pipelines but drone stability a problem!
- No known attempts in the power industry except for visual inspection by commercial drones.

Various drone designs with protective frames/ cages to limit the damage when hitting an object

UT inspection by attaching to a pipe (oil and gas industry)



Drones for boiler visual inspection

- Photographs taken by the modern commercial drones can be enlarged on a computer screen by factors **greater than 20x** before pixelation creeps in.

- In the case of power plant such detail is used to diagnose the cause of failures. For example, in the case of a burst evaporator tube a drone photograph reveals the nature of the failure – thick edged caused by impure feed/boiler water, thin edged by overheating, fireside wastage, etc.

- Importantly, this valuable information becomes available as soon as the boiler has cooled sufficiently to allow access.

Emergency Shutdowns

- A drone is a frontrunner → immediate access to failure location. (*For human inspection the erection of scaffold and use of ladders in plant demands careful planning combined with statutory inspections and labelling by qualified personnel takes time).*

- Particularly beneficial - **failures occur at high levels** and there is a need to procure materials or services for repairing the failure.

- Having advance information on the location of the failure also **avoids erecting scaffold in the wrong position** for a repair.

- Drones - of the surrounding areas for deterioration, restoration is possible before a chain of failures occurs.

Power Plant external inspections

- Benefits of drone inspections not confined to internals of plant items but external inspections at elevated levels may be carried out within the boiler house (or turbine hall) such as the condition of the boiler support systems. A drone camera survey provides a permanent record of the condition at the time of the survey.
- It may be necessary to survey the stack or cooling towers, both inside and outside. This is a task where a drone is particularly suited.

Aerial Thermal Surveys

Drones are particularly adept at carrying a thermal imaging camera for thermal surveys from positions that are not possible by other means except helicopter. These surveys can identify where lagging is inadequate, hot gases and steam are escaping and generally where improvements and rectification is necessary.

Many more cases of benefit outlined in the Exploratory phase of this project.

Powering drones for carrying out operations such as surface polishing, UT inspection etc.

- **There are two choices, either an internal combustion (IC) engine or electrical power.**

- **Electrical power became the best choice ever since lithium batteries appeared on the market. They have a high energy density, but not large enough for carrying heavy loads for long periods.**

- **On the other hand IC power is noisy, variable within a flight and less reliable.**

These aspects have been studied in this project.

Conclusion

For such work drones, even if higher performance power can be available, need a factor of stability higher than available at present.

PART 2

Robots for Power Plants

Definition

A surface crawler that carries out visual / NDE inspection and sends inspection data to a remote control unit.

Robots

a) Can be used to reach inaccessible areas or areas that otherwise will need scaffolding to reach.

b) A variety of robots, robotic machines and intelligent flexible arms some of which already carry small powerful camera eyes.

c) Further development needed for power plant component inspection and robots adopted to carry polishing heads and UT probes for wall thickness measurement.

GE's BIKE platform is a magnetic wheeled robot capable of inspecting power plant facilities and multiple applications in the oil & gas industry, such as vessel or pipe inspection.

Weight = 10Kg, Paylaod = 5Kg.

Vortex Scanner (developed by this project partner based in the UK)
Uses vacuum adhesion technology and is used for visual, eddy current and UT inspection.

Current state

Robots currently available not suitable for climbing the tubes in a power plant boiler due to the challenges posed by the deposits on the tubes.

Challenges

Following challenges are facing any proposed device for plant inspections:

- Deposits build-up on the boiler tubes.
- Long distances to travel.
- If contact between the robot and the climbing surface is lost, the robot can fall, damaging expensive equipment and can pose risk to life.

CONCLUSION

- None of the drones / robots currently available in the market suitable for power plant inspection.

- **Novel device required** that can overcome the mobility challenges faced by the currently available robots and still deliver key NDE capabilities.

Proposal for a full scale 3-years duration project
(Phase 2):

Development of a novel Drone-Robot Hybrid device

This is being proposed for the next phase of this project. It will carry out visual and thermal inspection, polishing, UT wall thickness measurement and UT crack sizing using TOFD.

All interested parties are welcome to join this GSP.
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