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STUDENT SUMMER INTERNSHIP TECHNICAL REPORT

Artificial Intelligence Implementation for Object Detection in Route Operable Unmanned Navigation of Drones (ROUNDS)

DOE-FIU SCIENCE & TECHNOLOGY
WORKFORCE DEVELOPMENT PROGRAM

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ABSTRACT

Route Operable Unmanned Navigation of Drones (ROUNDS) is a cost-effective method for drones to navigate a course inside a building or other structures where strong GPS signals are absent. Self-navigation is achieved by determining the drone's location from the visual angle of QR codes placed along the desired course, then dynamically adjusting trajectory accordingly. Artificial intelligence was implemented for object detection and to assist the ROUNDS project. Details of the research and implementation are omitted from this report because they are part of a patent application.

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1. INTRODUCTION

The manual and expensive nature of data collection activities in nuclear power plants often involve a person attending to the area where the data is to be collected (Al Rashdan et al. 2019a). A significant part of the data collection by operators is performed during operator rounds. Surveillances are another form of data collection that usually involve activities beyond visual data collection. As the nuclear power industry is seeking means to automate surveillance activities, sensors are installed to replace the manual measurement collection process (e.g. in Al Rashdan 2019b).

Visual data collection as part of operator rounds, however, covers a high number of instruments per round. It is therefore not economically feasible to replace all of these instruments with digital equivalents because the cost to replace each far exceeds the hardware cost, and the regulatory compliance burden associated with a new design modification package might deem this process unfeasible. Therefore, the industry sometimes resorts to retrofitting the equipment with digital technologies as a separate layer of instrumentation on top of the analog instrumentation in the plant (Bolick et al 2016).

Instead of retrofitting each instrument with one device and having to qualify that process, a drone can collect multiple measurements in one round if the necessary means are developed for it to fly indoors where there is no GPS signal. To achieve self-location awareness, visual features, represented by Quick Response codes (QR codes) were used. The drone would have an autonomous charging nest, fly from it through a preconfigured route using QR codes, capture the video stream of the needed measurements, send them back to a server for processing, and return to its nest. A technology named Route Operable Unmanned Navigation of Drones (ROUNDS) was developed as part of the light water reactor sustainability (LWRS) program in fiscal year 2019 to achieve this objective using commercial drones.

In this effort, ROUNDS was overhauled to improve its performance and enable an efficient process of module integration and testing. ROUNDS was augmented with an Artificial Intelligence (A.I.) implementation for fast object detection to reduce latency and increase accuracy. Details of the research and implementation are omitted from this report because they are part of a patent application.

2. EXECUTIVE SUMMARY

This research work has been supported by the DOE-FIU Science & Technology Workforce Development Initiative, an innovative program developed by the U.S. Department of Energy's Office of Environmental Management (DOE-EM) and Florida International University's Applied Research Center (FIU ARC). During the summer of 2020, a DOE Fellow intern, Roger Boza, spent 10 weeks doing a virtual summer internship with Idaho National Laboratory (INL) under the supervision and guidance of Mike Griffel. The intern's project was initiated on June 15, 2020, and continued through August 21, 2020 with the objective of using an artificial intelligence implementation for object detection to assist the ROUNDS project.

3. RESEARCH DESCRIPTION

Object detection is not a trivial task and can be computationally expensive. In the case of QR codes, the object can be located randomly in the image and is not known a priori. The object can be skewed horizontally and/or vertically depending on the perspective of the camera. It can be rotated at different angles relative to the rotation of the image and camera. The size of the object can also vary due to its distance from the camera. To complicate the detection even further, a single image can contain multiple instances of the object, which would also have to be detected. It is also common for a combination of these factors to occur simultaneously as they are not mutually exclusive.

An A.I. approach was used for object detection with the purpose of locating QR codes and assisting the navigation task of ROUNDS. Details of the research and implementation are omitted from this report because they are part of a patent application.

4. CONCLUSION

The A.I. implementation for QR code object detection was successful. The approach taken was able to increase the performance and accuracy of the ROUNDS project significantly.

5. REFERENCES

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