ARC '18

مؤتمر مؤسسة قطر
السنوي للبحوث

QATAR FOUNDATION
ANNUAL RESEARCH CONFERENCE

البحث والتطوير: التركيز على
الأولويات، وإحداث الأثر

R&D: FOCUSING ON PRIORITIES, DELIVERING IMPACT

20-19 مـــارس
19-20 MARCH



Computing & Information Technology - Poster Display

http://doi.org/10.5339/qfarc.2018.ICTPD190

# COORDINATED ROBOTIC SYSTEM FOR CIVIL STRUCTURAL HEALTH MONITORING

Muhammad Ali Akbar*, Uvais Ahmed Qidwai

Qatar University
* ali.akbar@qu.edu.qa

With the recent advances in sensors, robotics, unmanned aerial vehicles, communication, and information technologies, it is now feasible to move towards the vision of ubiquitous cities, where virtually everything throughout the city is linked to an information system through technologies such as wireless networking and radio-frequency identification (RFID) tags, to provide systematic and more efficient management of urban systems, including civil and mechanical infrastructure monitoring, to achieve the goal of resilient and sustainable societies. In the proposed system, unmanned aerial vehicle (UAVs) is used to ascertain the coarse defect signature using panoramic imaging. This involves image stitching and registration so that a complete view of the surface is seen with reference to a common reference or origin point. Thereafter, crack verification and localization has been done using the magnetic flux leakage (MFL) approach which has been performed with the help of a coordinated robotic system. In which the first modular robot (FMR) is placed at the top of the structure whereas the second modular robot (SMR) is equipped with the designed MFL sensory system. With the initial findings, the proposed system identifies and localize the crack in the given structure. Research Methodology: The proposed approach used the advantages of the visual and MFL inspection approach to improve the efficiency of the SHM. Therefore, the usage of both approaches should be done in a way that the whole inspection is carried out in an optimal time period. Thus, due to the fast processing of visual inspection, it is done first followed by an MFL based verification approach. The visual inspection has been carried out such that the drone will take-off from a fixed point and take images at different heights without changing the GPS coordinate values of start point during



Cite this article as: Akbar M and Qidwai U. (2018). COORDINATED ROBOTIC SYSTEM FOR CIVIL STRUCTURAL HEALTH MONITORING. Qatar Foundation Annual Research Conference Proceedings 2018: ICTPD190
http://doi.org/10.5339/qfarc.2018.ICTPD190.

flight. After completing the first scan, the coordinates of the GPS will be shifted and same procedure of taking images at different heights will be conducted. The process remain continue until the drone reaches to the starting GPS coordinates. The images which were taken at different heights for particular coordinates are considered as a single set. Thereafter, the image stitching (IS) is applied on individual sets. The process of IS involves a series of steps which were applied on the consecutive images of a particular set, such that one of the image is taken as a reference image (RI) whereas the other one is termed as the current image (CI). The resultant stitched image will be RI for the next consecutive image and then the whole stitching process is applied. The process remain continue for each set until a final stitched image has been obtained from them. The stitched result will be saved in the database with its corresponding GPS values. The same procedure of taking and stitching the images of the same structure will be repeated again after few months, depending upon the structural sensitivity as well as the severity of the weather condition around it. The current results will be compared with the stitched images present in the data base and if some anomaly is detected then the HP coordinates (i.e. the GPS coordinates) along with the estimated height for that particular location will be sent to the FMR to proceed the crack verification using MFL. The GPS module present in the FMR will guide the robot about its own location. As soon as Arduino Mega2560 Microcontroller receives the GPS coordinates from the system. It will translate them and compare them with its current location. The need of translation is because the FMR is present at the top of the building whereas the drone is flying at particular distance from the building. In order to obtain a correct translation the drone should remain at particular distance form in structure during the whole scanning process. The robot will take its direction based on the comparison result between its current GPS coordinates and the translated received GPS coordinates. As the robot moves it will keep checking the current GPS values and take decision accordingly. Since there might be some temporary or permanent obstacle present on the roof for decoration purpose. Therefore an ultrasonic range sensor has been used such that when the robot come close to an obstacle at defined distance the sensor will guide the robot to change its path and as soon as the obstacle is disappeared from the sensor range the robot will again start checking the GPS value to reach to its target destination. As it reaches to the target destination it will instruct the wrench motor to allow the SMR to reach to the location and obtain the current MFL reading of that place. These readings will be sent to the System. If an anomaly is detected then it is verified that the structure is having deformation at that particular location. If in vision based approach multiple anomalies have been detected then the robot will perform same procedure to determine the faults. Conclusion: With the initial findings, the proposed system appears to be a robust and inexpensive alternative to current approaches for automated inspection of civil/mechanical systems. The combination of VI and MFL approach provided the opportunity to detect, verify and localize the deformation in the structure.