Research Statement

My Master's study was about topology optimization of high-speed flexible robot arms where the study focused on the idea of obtaining a topology-optimized robot arm considering the structural/controller design integration and synergy basis. During this study, many topology optimization methods have been investigated for testing their fitness for the under-investigation optimization problem. The study has been accomplished by developing optimization algorithms operated by an interface between MATLAB and ANSYS [1-3]

The Ph.D. work focused on a distinctive and contemporary robotic topic that targeted finding a generic solution for the inspection of the vessels of the liquified gas industries despite its material type or surface roughness. This solution is represented in a climbing robot capable of climbing the interiors of the vessels for inspection and maintenance purposes [4-5]. I've fabricated two prototypes of this climbing robot in Egypt and Japan respectively. In which the later one was designed in the form of the commercial product to be tested in the real industrial fields. This second prototype has been funded $4000 from Prof. Shuji Hashimoto's lab budget at Waseda University. The URL below shows both EJBot prototypes: https://www.youtube.com/watch?v=xXKKpNN5MZE

Amongst many other activities during the Ph.D. research work, the EJBot robot has been investigated in terms of mathematical modeling, control, finite element analysis, and dynamic simulation by MATLAB/Simulink, ANSYS and ADAMS, respectively, as well as, experimental tests in the lab and outdoors in a simulated environment [6-8].

My current work as a post-doctorate researcher (Research Associate) at Surrey Space Centre, University of Surrey, UK is concerning with planetary drilling and sampling system in which many drill bits inspired by the wood-wasp ovipositor morphological design have been developed and experimentally tested into Martian regolith simulants to fit with different planetary surface locations [9]. I've proposed a new drilling mechanism inspired by both the wood-wasp ovipositor reciprocation technique and the

fish-caudal-fin undulatory gait. The new drill has an integrated reciprocation and oscillation motion that helps in improving the penetration rate into the soil. This novel drilling concept has been proved by the aid of simulation tools such as ADAMS (as multi-body dynamic simulation tool) and EDEM (as a discrete element method tool for particle simulation). With various sensors, like linear potentiometer and current sensor, the drill can measure easily its position, penetration rate, and consumed power. This design is considered a low-cost and low-energy system which is practical for both terrestrial and extraterrestrial surfaces [10]. The drill design aims at obtaining an integrated and easily-launched/deployed system to be attached to the exploration rovers for space missions. This drill design has been filled as a patent at UK intellectual property office (UKIPO) which application no. 2005716.2.

Other research points including the topology optimization of the internal combustion engine's connecting-rod for getting a revolutionary layout of the connecting-rod design are ongoing by personal effort in my free-time during the formal roles.

Therefore, my research work can be concluded in the following topics:

1. Structural topology optimization
2. Mobile and propeller-type climbing robots
3. Intelligent drilling and sampling systems

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Kind regards,

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