Development of a wall–climbing drone

CAROS (Climbing Aerial RObot System) is a drone–type wall–climbing robot that can be used to inspect the surfaces of buildings and superstructures by changing its configuration and attaching itself to all types of surfaces. It is an efficient means of cleaning and conducting maintenance on buildings. CAROS has been extended to FAROS (Fireproof Aerial RObot System) that has been designed to enter large buildings and quickly gather information in the event of a fire. Such data will assist firefighters in their rescue efforts.

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● A drone–type wall–climbing robot system can access any surface of a structure by flying and attaching to the target area using a configuration–change and perching mechanism. The robot is also equipped with a mechanism that allows it to climb vertical surfaces, like other wall–climbing robots. It is expected to be used for up–close inspections and maintenance of structures of various shapes.

● The structural stability of large structures, such as bridges, high–rise buildings, wind turbines, and large aircraft, is a major factor of social security. Nowadays, due to the aging of large structures and public concern regarding the potential of their collapse, interest in structural health monitoring has been increasing around the world. Though much research has been done on means of inspecting inaccessible parts of large structures using mobile robots, the fact that most existing robots require the installation of additional infrastructure or use magnetic–based technology or vacuum adhesion has made it difficult to use them on structures with diverse surface shapes and materials.

● We have proposed the first drone–type wall–climbing robot system that doesn't require the installation of additional infrastructure, thereby maximizing stability and mobility. Called CAROS (Climbing Aerial RObot System), this robot features greater mobility than existing wall–climbing robots. In particular, it has the advantage of being able to recover from falls caused by unexpected disturbances. Since the robot can attach to surfaces, it is capable of performing up–close inspections of and maintenance on structures of various types.

– Wall–climbing drone design and analysis: The structure and mechanism of the drone were designed and analyzed to maximize flight stability and grip force.

– Development of flying/climbing mode transformation and wall–climbing control algorithm: In order to allow the robot to attach to a wall while flying, a flying/climbing mode transformation and wall–climbing control algorithm was developed. Forward and backward kinematics were derived and applied to the algorithm.

– Development of three–dimensional autonomous navigation technology: The autonomous navigation algorithm was developed using sensor information that allows the robot to sense a three–dimensional environment.
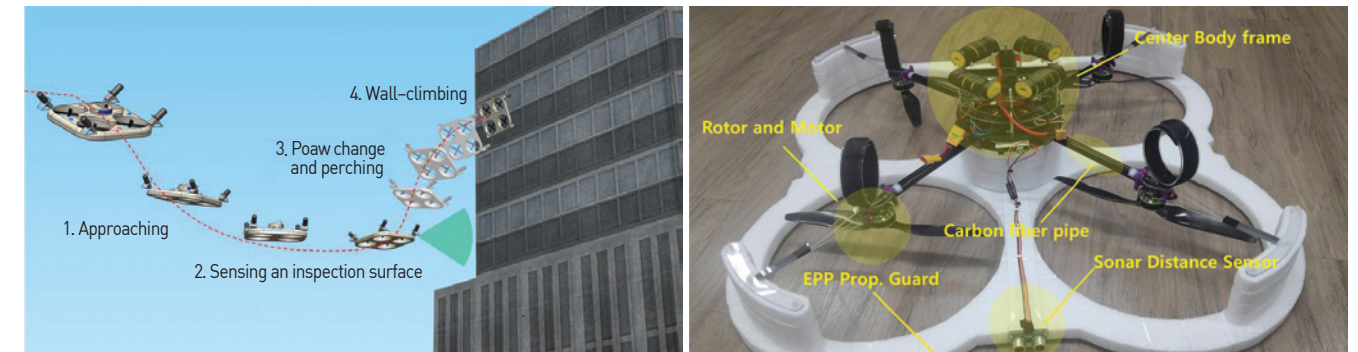

Figure 1.
Concept of wall–climbing drone

Figure 2.
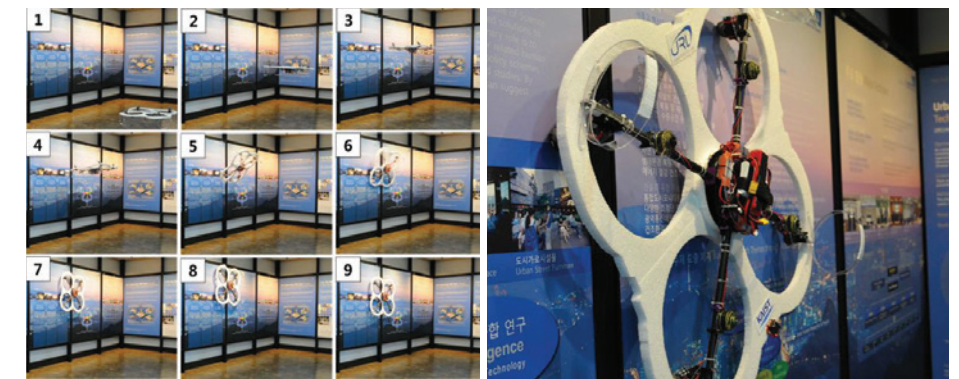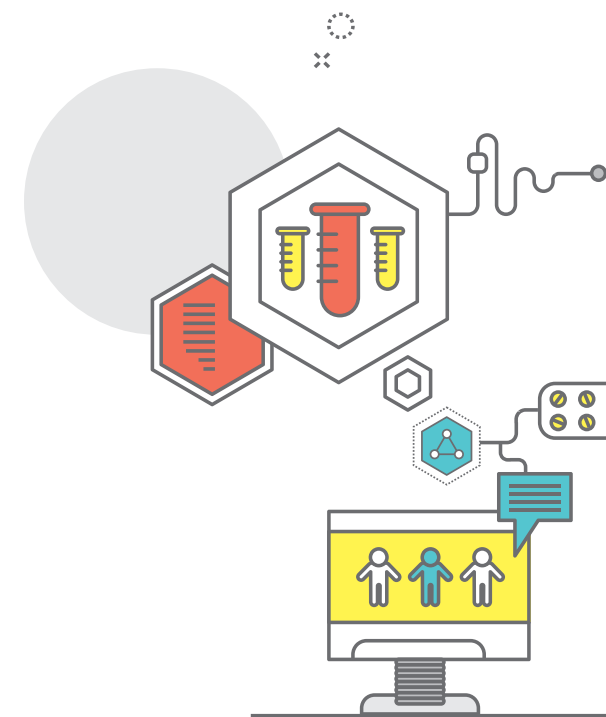Prototype of wall–climbing drone

Figure3.
Scene of flying → Attaching → Wall–climbing

Figure 4.
The CAROS, a drone–type wall–climbing robot system

● These technologies are expected to be used for the inspection or maintenance of surfaces that are not easily accessible. They may also be used to perform various types of maintenance on urban structures, such as inspections of wind turbine blades and the cleaning of high–rise buildings and solar panels