Control Logic Design of Sensor Transport System for DCSS inspection

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The spent nuclear fuel is currently stored and managed in the spent fuel storage pool in Korea. Near future, the spent fuel may be stored in a facility containing air or an inert gas (dry storage) or under water or other liquid (wet storage) depending on the composition of the fuel. We are considering the Dry Cask Storage System (DCSS) as a short term solution for expanding capacity of spent fuel, optionally. The spent fuel is extremely radioactive and generates a large amount of heat and must be carefully managed. DCSS has high radiation, high temperature and the structure that is difficult to access and confined space, so it can't be directly inspected and monitored the integrity of DCCS by workers. The small size of sensor transfer system should be considered and made of material which has radiation resistance, and it should be able to be driven in the vertical plane and the horizontal plane. In particular, it is important that the transport system mounts on the wall in order to pass through a stepped-narrow path.

In general, conventional vertical transfer robots are classified into legged type, wheeled type and tracked type according to the shape of the wheel and can be classified into magnetic type and vacuum type according to the attachment method. The legged type is advantageous for overcoming obstacles, but the movement speed is slow and the algorithm is difficult [1] [2]. The wheel type is high speed, but the complex shape movement is low. [3] [4]. In addition, the magnet attachment method has a very strong adhesive force but is not suitable for attaching to the wall made of concrete made of DCSS. Therefore, we selected the sensor transfer system using the vacuum adsorption method by the impeller and developed the algorithm for driving.

In this paper, the configuration and control logic of sensor transport system is presented.

2. Configuration of Sensor Transport System (SETS)

For the Design of Sensor Transport System (SETS), aluminum which is known to be excellent in radiation resistance and heat resistance was selected as the frame material. In addition, the size can consider less than 30 cm x 30 cm, and the main board components should be constructed as shown in Fig.1 to operate the nondestructive sensor, drive motor, and suction motor. First, if a voltage of 12 ~ 24V is applied to the main board, the SMPS convert the voltage of each motor and sensor to 24V, 12V and 5V. The voltage is supplied to the drive motor and the drive sensor for driving the sensor transfer system.

In addition, when it reaches the canister, the nondestructive inspection can be performed by supplying an additional voltage to the suction motor which can attach to wall, the nondestructive sensor, and the sensor jig. If a defect is detected, defect's information and defect's location information can be sent through the wireless communication module of the main board.

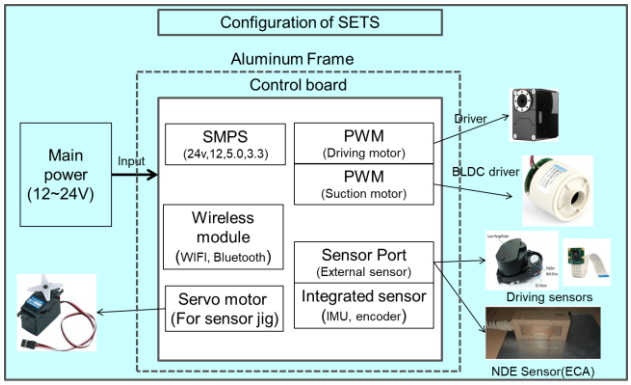

Fig.1 Configuration of SETS

3. Transfer control logic of SETS

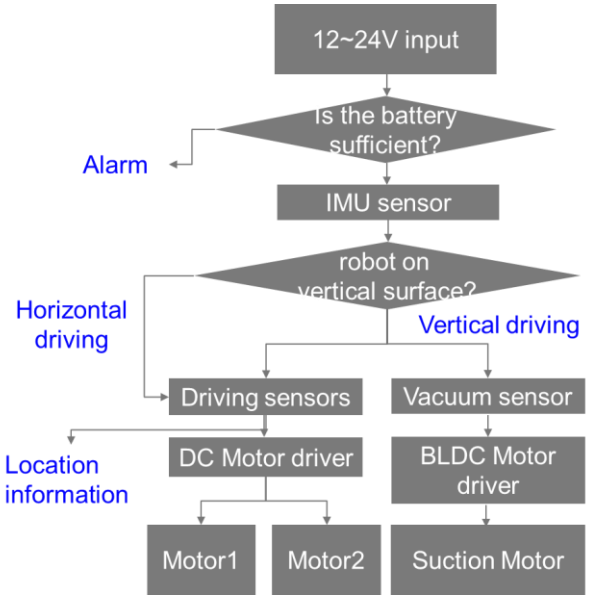

Fig.2 Control logic of SETS

sensor is used to sense the tilt of SETS. In the horizontal plane, only the driving motor is operated to run horizontally, but when reaching the vertical plane, the suction motor is operated at the same time as the driving motor, so that it can be attached and run on the wall surface which makes it possible to run the stepped path of the DCSS.

Using the above algorithm, there is a problem that the transfer system's the adhesion force is drastically reduced as the seal's adsorption rate at the corners is decreased. In order to solve the hardware problem for driving, it is possible to connect several sensor transfer systems using the joints and can be drive the STEP shape structure. It is called for STEP shape driving algorithm (Fig.3).

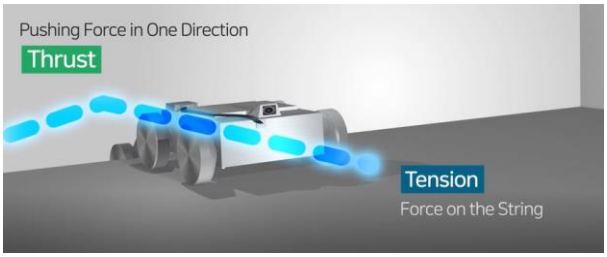

Fig.3 Control logic of SETS

3. Conclusion

In this paper, we establish the requirements of the sensor transport system for DCSS inspection. Also, STEP shape driving algorithm of SETS was developed for DCSS inspection. As a result of our development, it is expected that DCSS non-destructive inspection will be possible by further developing driving hardware design and algorithm in stepwise curve.

ACKNOWLEDGEMENTS

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