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DEVELOPMENT OF POWER, CONTROL, COMMUNICATION, AND MONITORING (PCCM) SUBSYSTEM FOR MOVING-ACTUATOR TYPE TOTAL ARTIFICIAL HEART

Department of Biomedical Engineering, Seoul National University
H.C. Kim, W.W. Choi, J.M. Ahn, D.W. Kang, E.J. Kim and B.G. Min

During the past year as the second year of a two-year project for the development of KORTAH, the human model of the moving-actuator type TAH, PCCM subsystem has been developed. It consists of four subunits of internal and external control unit, teanscutaneous energy transmission (TET) system, and transcutaneous information transmission (TIT) system. A prototype system for each subunit has been developed and tested through *in vitro* and *in vivo* applications.

(1) Internal controller : A new upgraded microcontroller (INTEL, 87C196KD) replaced the previous version and provided faster operation as well as powerful functions. Even though it has now an external UVEPROM (ultra violet erasable programmable read only memory) and a decoding logic circuitry, it will be ultimately disappeared by utilizing one time programmable on-chip PROM. New power MOSFET (International Rectifier, IRFP054, R_{on} = 0.014Ω) was used in motor drive circuit in order to reduce the heat generation. Framework of the software system has been completed. The feature of the developed software system is that it is based only on the waveforms of Hall effect sensors required for a 3Φ brushless DC motor commutation and motor's input current. It is expected to simplfy the circuitry as well as to enhance the reliability of the internal controller system. A unique automatic control algorithm without a compliance chamber has been developed and explained elsewhere. It is now being coded to be included in the internal controller's software system.

(2) External controller : Since a IBM-PC compatible computer system is used as hardware, software development is the only work for the external controller development. A real-time graphic representation of the current operating status and an interactive way of changing operational parameters are implemented in C language.

(3) TET system : In TET system based on magnetic induction, the external primary and implanted secondary coils have the shape of a truncated cone, 5.8 and 5.2 cm in diameter, and 10 and 10 turns of Litz wire, respectively. The external coil is driven by a 400 kHz tuned class E amplifier that has a minimum switching loss of power transistor. In vitro test results using a 0.8 cm thick skin-compatible silicone patch showed almost flat total efficiency (DC to DC) of 78% for 20 to 60W of delivered mean power for a regulated 13 V output.

(4) TIT system : Unmodulated optical signal is used to achieve bidirectional data communication between implanted and external control systems. A small circuit board containing four light emitting diodes(LED) and a photodiode was incorporated in each TET coil facing each other across the skin. The protocol for transmitted digital data is RS-232 with 9600 baud rate.

The developed PCCM subsystem is currently being tested on the mock circulation set up while preliminary *in vivo* experiments were performed for the evaluation of TET and TIT system performance. It is expected to be ready for animal implantation as a total set by the end of this year. The remaining works include hermetically sealed enclosure, connector and wiring and miniaturization of the implanted electronics.