THE SOFTWARE DESIGN FOR A MEDICAL ROBOT FOR UROLOGICAL APPLICATIONS

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Abstract: The safety and reliability are the crucial requirements of the software for medical robot which is a safety-critical system. Based on the verification & validation of a commercial prototype medical robot, surgeon programmable electrical TURP, a software design method for medical robot was put forwards and was proved that it can help improve the quality of the software. The concepts of software levels, surgeon robot interfaces and error processing were also considered. These methods are being adopted in the development of a new robot, which could provide the common platform for interstitial laser coagulation and radiation seed implantation of the prostate.

Keywords: medical robot, software engineering, verification & validation, graphical user interface

I. INTRODUCTION

Medical robot is a new and challenging application[1,2]. It can offer great assistance to the surgeon in many ways, such as high accuracy and repeatability, saving time and cost, providing minimal invasive surgery and tele-surgery. The safety and reliability are the essential issue in medical robot. The software plays a crucial role in medical robot since it accepts surgeon's command, controls the motion of the robot, monitors and manages the whole system. This paper discussed the issue on software verification & validation (V&V), design method and safety consideration.

II. METHOD & MATERIAL

A. The V&V and the design method of the software

The medical robot was a commercial prototype medical robot: surgeon programmable electrical TURP(Transurethral resection of the prostate). The V&V is the process of review, analysis and testing of the software. It is a methodology that helps ensure the safety, reliability and quality of the software. The V&V and design method of the software was put forwards. The essentials of the method are top-down design, safety check and V&V in a close loop in each subsystem and the 8 developing phases. The V&V proved that the method can improve the safety and reliability of the software.

B. Software consideration of the robot being developed

The robot being developed is for urological applications, especially for the treatment of the benign prostatic hyperplasia(BPH), prostate cancer and bladder disorders. It provides a common platform for interstitial laser coagulation (ILC) and radiation seeds implantation (RSI) of the prostate. The system is based on industrial PC, the operation system is Linux, the controller is programmable multi-axis controller (PMAC), and the developing language is ANSI C++.

The safety of software is critical. The method previously discussed was adopted. The requirements are clearly defined by both the programmers and the surgeons together. The formal methods and code standards are adopted to prove the correctness and reduce the risk of errors. The idea of software levels was introduced. The graphical user interface(GUI) /surgeon-robot interfaces(SRI), robot controller interface (RCI) and the PMAC driver are different levels which are responsible for different tasks. The encapsulation of data and the access privilege help provide the security and reliability of the software. Robot controlling software regularly checks the status of the peripherals: PMAC, motors, amplifiers and mechanical switch to assure the safety. GUI is highlighted as an important area to provide simple, effective and correct interfaces for surgeon. Errors processing function improves the safety. The customer errors and system errors, such as homing fail, no image signal, PAMC off line, motor following error, amplifier fault, etc. can be detected, identified and resolved.

III. RESULTS & DISCUSSION

The V&V of the surgeon programmable electrical TURP and the potato trial were conducted. The software design method and safety considerations are being adopted when the new robot is developed.

IV. CONCLUSION

The safety and reliability of the software is crucial in medical robot. The V&V proved that the software design method presented in the paper could help improve the quality of the software. The concepts of software levels, surgeon robot interfaces and error processing, which is being adopted in the development of the new robot for urological applications, can also improve the quality of the software for medical robot.

V. REFERENCES

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