Section: **Mechatronik**

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Abstract-Title:
EVALUATION OF AN INTUITIVE CONTROL SYSTEM FOR AN INTERACTIVE ROBOTIC SYSTEMEVALUIERUNG EINES INTUITIVEN STEUERUNGSSYSTEMS FÜR EIN INTERAKTIVES ROBOTERSYSTEM

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Abstract-Text:
Purpose
The MicroAssistant (figure 1) is in preclinical evaluation but addresses clinical applications in the field of micro surgery. The motivation is derived from middle ear surgery were the surgeon is often confronted with very small and sensitive structures like the ossicles (hammer, anvil and stirrup) or nerves and vessels. For evaluation the first focus is the milling process which is necessary for widening the operation field as well as for cleaning otosclerotic regions out of the middle ear. In this context there are some general problems due to small structures and tremble free positioning tasks in contrast to force intensive milling [1]. These problems could lead into complications (injury of sensitive structures like nerves or vessels) or cost-intensive following surgeries. Slipping off during milling is one example described in [2] which can lead into complications. For preventing slipping off during milling the interactive robotic system MicroAssistant was designed and first evaluated as an automated system [3]. Higher stiffness is obtained through a parallel kinematic structure, which is a new approach and detailed described in [4]. The interactive component of the MicroAssistant is evaluated in the following experiment. Our new approaches for the design of the human machine interface as a joystick is derived from the aim to disturb the surgeon actual habits as less as possible. For this a kind of joystick is developed which can be used by the heel of the hand. This makes it possible to still hold a surgical instrument while giving control signals. The position measurement system MicronTracker (Claron Technology, Toronto, Kanada) measures a distance between markers attached at a base panel and a hand panel (figure 2). The base panel is rigidly attached at the MicroAssistant and connected with springs to the hand panel. At the hand panel the user can apply force through his heel. These forces result in a dislocation of hand panel to base panel. The resulting difference vector is measured with the position measurement system and interpreted as target direction for the kinematic. Method
For testing the control abilities of the joystick a predefined trajectory is applied on a plaster model (figure 3 a). This trajectory should be milled inside the plaster model by using the joystick (figure 4). The predefined trajectory is scanned previous to the milling process and after milling again. The scanned images are compared and the difference is measured at 17 points along the trajectory (figure b and c). For the guidance in which direction the user has to mill only visual feedback of the applied trajectory is provided. To get a statement if the joystick is suitable different persons where taken to carry out the experiment.

Results

A total of 68 measurement points are taken to get a mean error of 0.43 mm with a standard deviation of 0.25 mm for the difference between predefined and milled path. The maximum deviation of the milling was 1.07 mm.

Conclusion

The mean value shows the high capability of the introduced control mechanism. Further development steps should be concentrated to reduce the relatively high maximum error. For this development following influence will be separately analysed: - inexactnesses through the position measurement system - errors due to the analyzing method of the path comparison, like pixel resolution and scan resolution - influences through the human system because of the visual feedback for the guidance along the trajectory The use of this human machine interface for a zero-force control scheme is already discussed in [4] but for positioning task e.g. placing of prosthesis without a previously planned trajectory the human machine interface shows high capability.

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Figure 1: Setup of the MicroAssistant at the OR table. a) 6 d.o.f. positioning measurement system MicronTracker (Claron Technology, Toronto, Kanada), b) Milling Instrument (Aesculap, Tuttlingen, Germany), c) kinematic system, d) patient, e) displays for the visualization of medical image data and the position of the tool f) mounting arms. Figure 2: Scheme of functional principle of the human machine interface. a) hand panel, b) base panel, c) springs, d) markers for the position measurement system, e) 6 d.o.f. positioning measurement system MicronTracker (Claron Technology, Toronto, Kanada) Figure 3: Analysis of the plaster model. a) predefined trajectory, b) measurement points, c) overlay of scanned images with milled trajectory and predefined trajectory Figure 4: Experimental setup for milling in a plaster model

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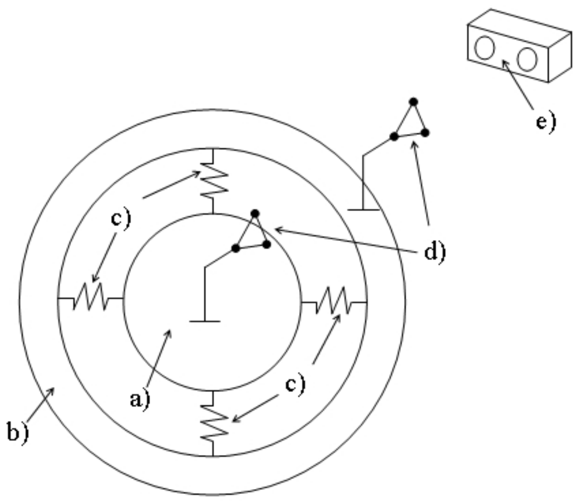

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