

Figure 5: Maximum, minimum, and median values of precision and recall

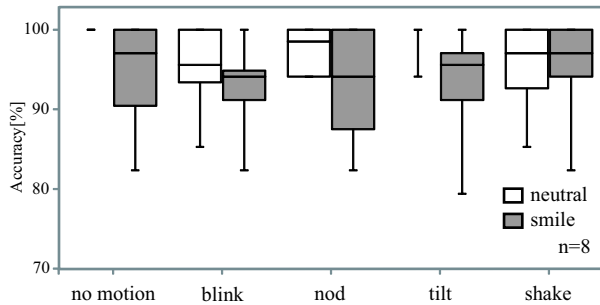


Figure 6: Maximum, minimum, and median values of robustness

(roll, pitch, and yaw); therefore, a positive result means that the system is likely to be robust against any combination of head motions. We asked the eight subjects to perform this experiment while wearing the headband. Each subject performed each motion for about 5 s while smiling or having a neutral face. *Blink* represents 10 blinks, and *Nod* and *Tilt* were done twice each. *Shake* represents random head shaking along the yaw axis. Figure 6 shows the maximum, minimum, and median values of the classification accuracy for each motion in the experiment. The results showed that the system classified neutral expression with no motion with a probability of 100%. The system was able to classify the neutral expression of most subjects with an accuracy of more than 95% even when there were some disturbances. In the case of smiles, there were some cases where the smile was occasionally not detected properly. In the most prominent case, subjects reported that it was difficult to smile and blink at the same time, which probably contributed to the classification accuracy for blinking being lower than others. However, the interface was capable of classifying smiles by the majority of the subjects with an accuracy of more than 90%.

5. DISCUSSION AND CONCLUSIONS

In this study, we considered the scenario of daily communication between children and their parents and focused on facial expressions, which are non-verbal information that is important to facilitating communication. We proposed wearable interfaces to classify facial expressions based on facial muscle activities and share them through light and vibration. We evaluated the classification accuracy and robustness of the system through experiments and verified that

the acquired signals from the sides of the head and forehead can be used for facial expression classification. Through several experiments, we verified the classification accuracy of the developed system. The results demonstrated that the interface can be used in real environments with some disturbances to classify facial expressions with high accuracy and to present smiles in real-time. Further investigation will include the implementation of adaptive filtering to remove motion artifacts.

So far, we have presented the concept of a novel interaction design between children and their parents and developed interfaces that enable the realization of such interaction. We have already conducted a feasibility study with children having ASD during robot-assisted activities and confirmed that the proposed device is acceptable [7]. In the future, we plan to conduct a user study with children and families to verify that the interfaces can support the sharing and perception of facial expressions in the given scenario.

6. REFERENCES

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