Mimicking acute stroke findings with a digital avatar

Maryam Pourebadi, M.S.[1], Jamie Nicole LaBuzetta, M.D.[2], Cynthia Gonzalez Gonzalez, M.D.[2], Preetham Suresh, M.D.[4,5], and Laurel D. Riek, Ph.D.[1,3]

[1] UC San Diego Department of Computer Science and Engineering
[2] UC San Diego Department of Neuroscience
[3] UC San Diego Department of Emergency Medicine
[4] UC San Diego Department of Anesthesiology
[5] UC San Diego Simulation Training Center

Introduction

It is now well-accepted that simulation-based learning (SBL) is an important component of medical education [1]. At our institution, we have a state-of-the-art simulation center, and SBL is already incorporated into many medical subspecialties. However, commercially available patient simulators have static faces and lack the realistic depiction of non-verbal facial cues important for rapid diagnosis of neurological emergencies such as stroke [2, 3]. This multidisciplinary project addresses the urgent need for expressive patient simulators by developing acute stroke avatars for use in simulated healthcare training.

Methods

Using a previously published and validated method [2, 4]., we developed techniques to display stroke pathologies on a virtual patient simulator (VPS) [2,5]. After obtaining patient or surrogate consent, we obtained source videos from patients admitted to an academic medical center who had experienced acute ischemic stroke resulting in neurological findings such as facial droop, eyelid apraxia, dysarthria, and coma. We then extracted facial features using shape-based modeling techniques, leaving anonymous feature points. Next, we applied a novel algorithm to use these feature points to build accurate computational models (masks) representing the facial characteristics of stroke. We then overlaid these prebuilt masks onto a live facial video stream to generate asymmetric expressions on a virtual avatar. This project was IRB approved.

Results

More than 21 videos of stroke patients were made. Once the feature points were extracted from these videos, we were able to develop VPSs capable of expressing realistic asymmetric facial expressions. These avatars were then validated amongst neurologists with clinical experience in diagnosing acute ischemic stroke.

Conclusion

This multidisciplinary effort using patient-inspired facial expressions resulted in a tool that aids the stroke education community by making virtual and robotic simulators of acute stroke more varied, interactive, and realistic.

References:

1. Riek, L.D. (2019) "Healthcare Robotics". Communications of the ACM, Vol. 60, No. 11. pp. 68-78

2. Moosaei, M., Pourebadi, M., and Riek, L.D. (2019). "Modeling and Synthesizing Idiopathic Facial Paralysis". In Proceedings of the IEEE International Conference on Automatic Face and Gesture Recognition (FG).

3. Pourdebadi, M. and Riek, L.D. (2018). "Expressive Robotic Patient Simulators for Clinical Education". In Proc. of R4L Workshop on Robots for Learning - Inclusive Learning, Workshop at the 13th Annual ACM/IEEE International Conference on Human-Robot Interaction (HRI).

4. Moosaei, M., Gonzales, M.J., and Riek, L.D. (2014). "Naturalistic Pain Synthesis for Virtual Patients". In Proc. of the 14th International Conference on Intelligent Virtual Agents (IVA). Lecture Notes in Artificial Intelligence (LNAI). pp. 295 - 309

5. Moosaei, M., Das, M., Popa, D., and Riek, L.D. (2017) "Using Facially Expressive Robots to Calibrate Clinical Pain Perception". In Proc. of the 12th ACM/IEEE International Conference on Human-Robot Interaction (HRI).