

INTRODUCTION

Chronic pain is a prevalent, debilitating, and increasing problem. According to a CDC report in 2021, an estimated 20.9% of U.S. adults (51.6 million individuals) experienced chronic pain, with 6.9% (17.1 million individuals) experiencing high-impact chronic pain [1].

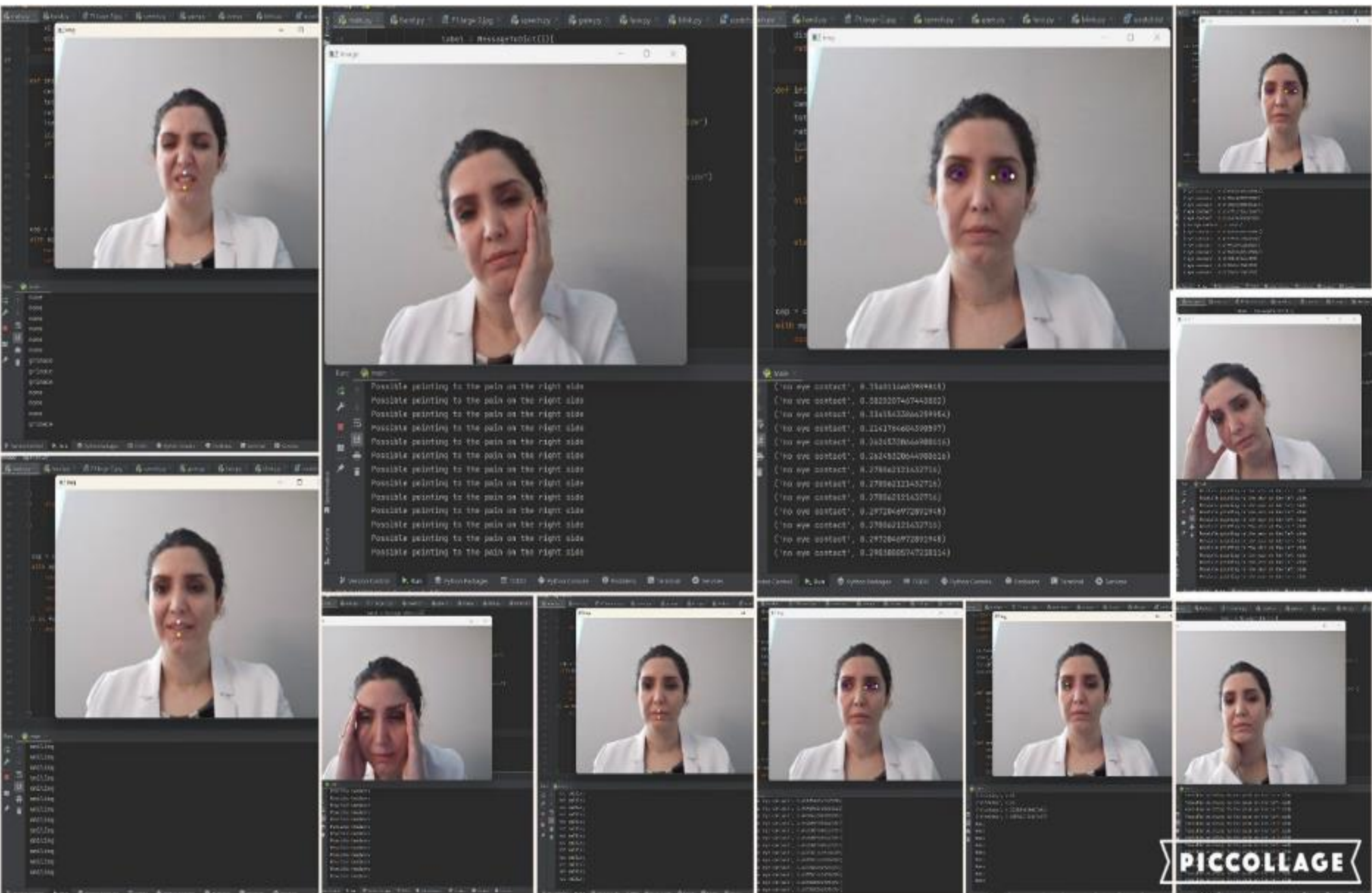
Patients with verbal communication barriers, such as dementia, brain injuries, stroke, and autism, are at high risk for underdiagnosis of chronic pain, which results in behavioral changes, unnecessary hospital admissions, overuse or underuse of pain medications, and an increase in morbidity and mortality [2,3]. An automated technology with facial expression analysis can help with pain and distress evaluation in these patient populations.

METHOD

By developing this technology, we aimed to detect facial expressions and movement cues to detect pain automatically without verbal communication. Python version 3.11.3, NumPy, OpenCV, and media pipe were employed for facial point detection, and mathematical models were used to detect grimacing, smiling, blinking, eye contact, and hand positioning as indicators of pain and distress (Table 1).

Figure 1

Result	Data points
Grimace	lips corner distance ratio to the chin combined with the upper and lower eyelid distance ratio
Smiling	Upper and lower lips distance ratio to the chin
blinking	Upper and lower eyelids and iris distance ratio
Eye contact	Detection of right and left gaze based on the iris and eye corner distance ratio
Possible left or right side craniofacial/cervical pain	Hand detection in relation to the side of the face



RESULTS

To test the feasibility of this technology, we developed a program to detect facial expressions, such as grimacing, as an indicator of moderate to severe pain. Lack of smiling, number of eye blinks, and duration of eye contact were also date points for potential predictive variables for distress. Additionally, the detection of hand positioning may correlate with simultaneous facial expressions as a cue for the possible location of the pain (Figure 1).

CONCLUSION

This prototype technology suggests that automated facial expression analysis can be valuable in assessing and detecting pain in patients with communication barriers. The potential future areas of this technology include pain detection in pediatrics, patients with limited English proficiency, video monitoring in virtual ICUs, and patients at risk of pain-related medical emergencies such as myocardial infarction following stroke with aphasia. Further clinical studies are necessary to validate the accuracy and effectiveness of this software in clinical settings.

REFERENCES

- <https://www.cdc.gov/mmwr/volumes/72/wr/pdfs/mm7215a1-H.pdf>
- Pain in Dementia: Prevalence and Association With Neuropsychiatric Behaviors, Mustafa Atee, et al. Journal of Pain and Symptom Management, Volume 61, Issue 6, 2021, Pages 1215-1226.
- Under-detection of pain in elderly nursing home residents with moderate to severe dementia, D.K.Y. Miu, et al, Journal of Clinical Gerontology and Geriatrics, Volume 5, Issue 1, 2014, Pages 23-27.

Affiliations

- Department of Neurology, State University of New York, Upstate, Syracuse, New York, USA.
- Department of Anesthesiology, Duke University Medical Center, Durham, North Carolina, USA.
- Department of Anesthesiology, Weill Cornell Medical College, New York, USA.

Contact

Mohamed Hesham El Refaey
SUNY Upstate Medical University Hospital
Email: Elrefaem@Upstate.edu