Adversarial Domain Adaptation for dyspnea monitoring using facial infrared thermal imaging

Internship Context

In hospital environment, vital signals monitoring is key to ensure both physical and psychological comfort for patients. However, the feeling of struggle while breathing (dyspnea in medical terms), which is known to be a source of fear/panic, goes undetected by usual captors. As a matter of fact, prior work have demonstrated that the oxygen saturation rate (main indicator of how well the breathing process is doing) does not drop at dyspnea early stages, meaning that breathing is painful but successful. In addition, hospitalized patients that are prone to suffer from dyspnea are often unable to call for help because of invasive medical support devices. Hence the need for a dyspnea detection system that could automatically alert the medical staff in case of respiratory distress. This internship proposal is part of the DYS-FIRTI project, which is a collaboration between ISIR and La Pitié Salpétrière in order to develop a dyspnea monitoring system that detect respiratory struggle from facial infrared images. More precisely, the main purpose of the internship will be to develop a deep learning based action units detection system for facial infrared images. Action units (AU) being unitary facial movements [1], which are known to display dependencies with dyspnea.
The underlying motivations behind the use of infrared images are mainly two fold. First, it favors robustness to nightly conditions. Second, infrared images are ideal to track other useful respiratory signals such as breathing frequency. Therefore, training a dyspnea detector on infrared images will reduce the system requirements to a single thermic camera.

Intership Objectives

One of the main challenges of using infrared images is that very little annotated data is available. In particular the AU-annotated infrared images dataset provided by La Pitié Salpétrière is too small and do not provide a variety of subjects that is wide enough to be able to learn generalizable knowledge from scratch. To solve that challenge, the intern will dispose of large datasets of RGB AU-annotated images and will have to explore the transfer learning [3] and more precisely the domain adaptation litterature. The idea is to come up with a way of exploiting statistical similarities between RGB and infrared images that enables the transfer of AU-related discriminative knowledge from RGB to infrared domains. We are particularly interested in adversarial domain

adaptation [4], [2], and a good (but not imposed) starting point could be [4] in which a generator learns to project data from both distributions into a space in which they are similar in the eye of a discriminator while keeping task-related discriminative information.

Required Profile

- Masters Students in statistical learning/computer vision.
- Strong Background in maths and computer science (python mostly).
- Motivation to explore/innovate in the machine learning field.
- Prior experience in one of the basic deep learning library (pytorch, tensorflow/keras) is not mandatory but will be appreciated.
- Excellent communication skills (French and English)

Practical Details

The internship will take place in Sorbonne's Pierre et Marie Curie campus and more precisely in ISIR. It would ideally start between January and April. If you want to apply, please send an email with both CV and transcripts enclosed to one of the following address :
kevin.bailly@sorbonne-universite.fr,
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References

[1] Rosenberg Ekman. *What the face reveals: Basic and applied studies of spontaneous expression using the Facial Action Coding System (FACS)*. Oxford University Press, USA, 1997.

[2] Judy Hoffman et al. "Cycada: Cycle-consistent adversarial domain adaptation". In: *arXiv preprint arXiv:1711.03213* (2017).

[3] Sinno Jialin Pan and Qiang Yang. "A survey on transfer learning". In: *IEEE Transactions on knowledge and data engineering* 22.10 (2009), pp. 1345–1359.

[4] Eric Tzeng et al. "Adversarial discriminative domain adaptation". In: *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*. 2017, pp. 7167–7176.