to be defined

1 Context

The beginning of XXIth century sees a drastic increase of applications coming as an assistance to numerous human activities, among which medicine is one of the main domains. And the use of technology for the healthcare system is the focus today, with technologies ranging from robots to assist in surgery to gadgets that measure sugar levels and help diabetic people.

Among those areas, an important one deals with pain, which is a complex subject to master. The main objectives of the research project, which consists in being able to properly measure pain levels, is of a great importance, as it will help medical doctors to provide a precise treatment especially for patients suffering from chronic pain condition. It will also allow pharmaceutical companies to have a better feedback from their clients for the development of treatments, whether they are pharmaceutical or not.

But pain assessment is not a simple task and has been a long lasting challenge even for human evaluators. Many scales and methods have been created to tackle such a problem [1, 2, 3, 4, 5, 6] with limited efficiency. So far, it is still difficult to have an accurate assessment of pain, all the more important when it comes to deal with chronic pain.

As a matter of fact, as pain is a subjective feeling, the most used measurement is the auto evaluation of the patient, but even if it gives fairly acceptable results, it still falls short on some aspects, notably when it comes to simulated pain [7], or, most commonly, when the patient has difficulties to communicate, as is the case of infants and some elderly people [8].

And the creation of a method capable of providing a precise assessment for the level of pain felt by patients could help the present diagnosis system overcome a complicated barrier.

1.1 State of the art

Up to now, some serious research has been done to achieve a reliable pain detection via facial expressions. To reach this objective, the systems used

datasets of images labeled with FACS codes (*Facial Action Coding System*) [9].

The main work done on the subject was the research carried at the Pittsburgh University *"Automatically Detecting Pain in Video Through Facial Action Units"* [8]. This research was mainly based on the use of the FACS to detect pain on a given frame, but obtained elementary results such as *"pain or no pain"*.

Another research, done on the same subject with the same dataset, is the research carried at the university of Aalborg [10]. This more recent research did achieve more promising results by using a combination of convolutional neural networks, and recurrent neural networks. By using the combination of these two methods, it was possible to consider not uniquely the one frame and FACS, but also to analyze the previous frames of the considered sequence, and to get a better precision for the result achieving a scale between *"no pain"* , *"weak pain"* or *"strong pain"* what is significantly better. What all those approaches has in common is the fact that it uses the same data base for the training and it don't give a result with enough accuracy to to be a reliable tool. Also both researches rely solely on facial expressions and not taking in consideration the other factors like voice tone and the semantics used on the dialog to be able to analyze the emotional component what is an important factor to be able to properly assess the patient pain level [**?**].

1.2 Methodological approach

This thesis proposes a new approach to the problem by using a new dataset generated with the contribution of volunteering people who suffer from chronic pain. While a new dataset is a good start, train a deep learning model can take large amounts of data.

But on the other side we can rely on the practioners who have a long experience and knowledge of the problem, and should not be excluded from the scope. A practitioner uses more than just an image to assess pain, they take many other factors into consideration. This is why the project proposes to tap the practioners' experience to compensate the small amount of training data, what could be compared to the functioning of expert systems [11].

However it is not clear up to this day how it will be possible to reconcile deep learning and expert systems. The aim of this thesis will be to explore ways to achieve this.

2 Objectives

As the data on the subject is some how limited one of the main focus of this these will be to train *deep learning* models capable of accurate measure pain level on a video, using reduced data by importing core decision factors from experts that already have knowledge on pain assessment. And make the learning process less dependent of huge amount of data, but yet this process should not sacrifice the capabilities of generalization of the model.

2.1 Scientific and technological challenges

The scientific challenges to be explored on this theses will be:

- Propose an model capable of accurate measure pain with efficacy.
- Identify the main decision points that can be imported from experts, and that can be used to improve the models learning.

3 Organization

The these will take place on a period of 36 months and during all the duration the time will be shared between the hosting laboratory (LABRI university of Bordeaux) and the company (Lucine).

3.1 Planning

- T0 + 6m:
- T0 + 12m:
- T0 + 18m:
- T0 + 24m:
- T0 + 36m: Writing of thesis and defense

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