OptikosPrime: Estimating refraction and astigmatism with mobile devices

OptikosPrime develops a system for estimating the refractive error of the human eye, using just a mobile phone. The system allows users to measure their refractive error without having to purchase spectacles online. Furthermore, more than 1 billion people in global south haven't got access to Opticians. Thus, have no way of getting corrective measures.

OptikosPrime has customers across the globe; both purely commercial, but also NGOs working in global south. We have a working product in the market and access to large quantities of data (pictures of eyes).

This project allows you to work hands on with applied machine-learning and the problems that arrive when exposed to a real-world environment where the resulting algorithm will have to remain robust to noisy and unseen samples. Furthermore, it allows you to work with and experience the challenges that machine learning algorithms face when deployed in the real world.

This project raises several interesting research problems such as:

- **Comparing existing analytical models and deep neural network:**
  Investigate how robust both models are to noise, whether they perform differently with different settings, and what are the limits of their performance.
- **Investigate a wide array of machine learning models:**
  OptikosPrime is currently using specific implementations of deep neural networks. However, they would like to explore different architectures as well as other methods, e.g. SVMs
- **Synthetic data to improve performance of existing systems:**
  While examples of this have been shown to work in the literature it has not been tested for this specific use case and OptikosPrime has only conducted superficial tests thus far. They would like to develop a model for constructing such synthetic data as well as an empirical investigation into how the system's performance is affected by the amount and types on synthetic data
- **Impact of out-of-distribution samples:**
  Investigate the performance impact images of eyes from different cultures and ethnic groups can have and estimate the certain the system is regarding a specific sample and highlighting uncertain samples to conduct further training.
- **Segmentation of the image prior to refraction and astigmatism estimation:**
  Ideally the only necessary part is the light refracted from pupil, most deep-learning based methods accept square images, inadvertently including a lot of irrelevant information which can confuse the algorithm. Thus, different methods of cropping, segmentation or post-processing could drastically impact the performance of the system.

Contact:
Anders Skaarup Johansen | Asjo@create.aau.dk