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Editorial

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Automated Image Analysis Software: Valuable Tools for the Future?

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Blindness causes significant disability and is associated with tremendous financial and social burden. Recent studies have shown an increase in the common causes of preventable blindness including irreversible diseases such as diabetic retinopathy and glaucoma. A study published in Lancet in 2012, highlighted the rise in Disability Affected Life Years (DALYs) between 1990 and 2010 by 160% for age related macular degeneration and 119% for glaucoma. In parallel, there has been a relative reduction in the ophthalmologist to population ratio as published in a recent article in the Canadian Journal of Ophthalmology in 2007. Developing countries face a worse situation, where the Ophthalmologist to population ratio is a dismal 1: several million depending. The situation is further compounded by the fact that in developing countries, nearly 70% of the population lives in rural areas while 70% of the ophthalmologists are based in urban areas. Providing accessible eye care is therefore a challenging task.

The goal of vision 2020 is to eliminate preventable blindness by the year 2020 and this mammoth endeavor is only possible with appropriate use of manpower and establishing eye care facilities in the peripheral and rural areas through vision centers or primary health care centers. Unlike the ophthalmologist to population ratio, which is rather dismal, the optometrist to population ratio in developing countries is slightly better being in the order of 1:600,000, though much worse than developed countries having a 1:10,000 ratio. This entails that, to achieve the goal of eliminating blindness, the optometrists and ophthalmic technicians would have to play a very significant role in disease screening and directing patients to the appropriate eye care facility.

It is at this step of screening that technology needs to be brought in to aid in disease detection and diagnosis. To take an example, we can examine a disease like glaucoma which has an estimated prevalence of 2.65% in people above 40 years of age and affects 60 million people worldwide, likely to increase to 80 million by 2020. Knowing that blindness due to glaucoma is irreversible and prevention is the sole option, and that the disease is asymptomatic and silent, the appropriate method of eliminating blindness due to it would be to perform preventive screening in the high risk age groups. For diagnosing the disease during population based screening, a relatively trained manpower is required, which is probably the biggest limiting factor to this kind of a screening exercise (particularly in developing countries). Thus, it is here that image analysis software [RIA-G (Kalpah innovations) or image recognition software (Watson, IBM Inc.) or many others in the research stage] would play a role, by highlighting suspect cases of glaucoma after processing fundus images. Many equipment have been devised to analyze retinal nerve fiber layer thickness for diagnosis of glaucoma but these are typically bulky and too expensive to put to use in a screening scenario. With the advent of highly portable fundus cameras at low costs, this problem is resolved and addition of automated disc analysis software to the cameras would enable a quick and effective screening process. Suspect patients could then be referred to an ophthalmic clinic where further testing to confirm the diagnosis and treatment can be done. The same process can also be conducted remotely over telemedicine but that would require an ophthalmologist to be viewing all the images for diagnosing. An automated software eliminates this need. Likewise, other automated image analysis software has been devised to detect diabetic retinopathy, retinopathy of prematurity, cataract, etc.

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Automated image analysis software has been in the making for the last two decades. Initial attempts at developing these programs did not achieve much success due to varied reasons. Prominent among these were limitations of infrastructure such as poor resolution of fundus cameras, high costs of equipment, slow processing power of computers, absence of optical connectivity, etc. Most of these are not hurdles in development anymore. Other reasons for poor performance of these software included factors such as individual-to-individual variability of biological systems, association of glaucoma with other ocular diseases (myopia, diabetic changes and cataract) which act as confounding factors in analysis and the broad grey zone in establishing a clinical diagnosis of glaucoma. While these are difficult to overcome, some newer innovations are likely to help the next generation of image analysis software succeed more than their previous versions. The first of these is cloud computing. This concept entails installing the software on a cloud server and uploading fundus images onto that for analysis. The images and the results of the analysis are then available for the ophthalmologist to view from any location and also the patient can have an access to his data even if he wants multiple opinions or changes clinics. Sequential images can be compared for establishing a diagnosis or modulating therapy. For purposes of screening, a field technician can upload images onto the cloud, which can screen images and automatically seek opinion from an expert at a specialist centre for suspect cases to decide there and then whether a patient needs to be brought in for treatment. This is particularly important in large screening and outreach camps where a patient once missed may be very difficult to trace later. The other innovation is the ability of the software to learn from its own errors. This is sort of an artificial intelligence whereby when an ophthalmologist manually corrects a wrong analysis report, the software attempts to learn where it went wrong and avoid making the error a second time. This holds even more meaning when the software is on a cloud system and multiple users are analyzing thousands of images. As each user makes a correction, the software learns and corrects itself for all other users. Over a period of time, it would start to give near perfect results. This innovation is now finding way into the next gen software.

The future of imaging and image analysis looks exciting. The priority for developers is to provide low cost solutions, portable devices and multifunction equipment in line with the needs of the healthcare industry. While a lot has been done in the last decade and technology has advanced by leaps and bounds there is a lot, which is waiting to be done. A good example in this context is the incorporation of spectral imaging cameras in fundus imaging devices that can capture and show a great deal more than we can currently visualize. Standard stereoscopic imaging is likely to be a part of newer cameras and with the growing availability of three-dimensional viewing systems, this may not be too far in the future. Both these innovations of imaging would require software for analyzing what the human eye may not be able to see.

Ophthalmology is a highly technology dependent field. Next generation image analysis software are getting ready to help tackle blindness and change making ophthalmic diagnosis as we know it today. There is a lot happening out there in the world of medical technology, we have to embrace the new to move ahead.