EXECUTIVE SUMMARY

DEVELOPMENT OF TUNABLE MULTI-COLOR LASER FOR SENSING: CASE STUDY FOR HYPERSPECTRAL DETECTION OF WATER CONTAMINANTS

Access to pollution free water is essential for humans and animals alike. It is from this point of view that photonic spectroscopic technologies have gained increased attention for water quality and environmental monitoring applications. The photonic technologies have the capability of detecting dissolved contaminants in clear water samples by way of inspecting optical water clarity. However, most of the well-established spectroscopic techniques such spectrophotometry used in ongoing research at University of Eldoret require expensive instrumentation and are un-affordable. Therefore, the key motivating factor of this proposal lies in the ultrafast, sensitive optical detection of low levels of pollutants in clear water samples using a simple and cost-effective all-optical approach . Our long-term goal is to develop a multi-wavelength visible laser source generated through wavelength conversion for varied applications in water quality assessment, environmental monitoring and basic research. However, development of a tunable, multi-wavelength visible laser source remain unexplored and this proposal is an attempt to bridge the existing gap. We firmly believe that such a visible laser, once integrated in an optical communication system can find wide range of applications among them, water quality assessment. For instance, it is well known that the presence of contaminants in clear water sample causes optical absorption and/or fluoresces at certain wavelengths since most known substances have specific absorption spectra. Therefore, it is possible to tell the type of contaminant through their spectral 'fingerprints' because they can show strong absorption at particular wavelengths when a laser light interacts with the contaminated sample. Notably, some of the pollutants can be toxic even a low concentration and often difficult to detect.

The specific objectives are designed to provide a detailed design, fabrication and deployment of the multi-wavelength visible laser source for sensing applications. The specific objectives are to:

1. Design a step-chirped PPLN waveguide for tunable wavelength conversion in to the visible spectral range.
2. Investigate the tunability and wavelength broadening of the waveguide device.
3. Fabricate and characterize the compact monolithic multi-wavelength device.
4. Apply the generated wavelengths for detecting water contaminants in a laboratory set up.

Implementing this proposal will strengthen and broaden the applications of multiwavelength visible lasers to solve societal challenges such as in health and environmental monitoring just to name a few. For instance, an all-optical sensing system when used for water quality assessment can contribute to mitigation measures against water pollution, decrease waterborne illnesses and improve the quality of life. It is also expected that, upon completion of the project, the future career prospects of the participants will be enhanced. The project is expected to train two (2) MSc and one (1) PhD students. The research team will participate in scientific conferences, symposia and publish research findings in peer reviewed journals.