ABSTRACT

The present thesis work comprises of design and development of devices based on Fiber Bragg Grating (FBG) sensors for novel biomedical applications. Here, novel packaging methodologies have been utilized for transduction of the measurand parameter into a secondary parameter that can be sensed by the FBG sensor.

Chapter 2 of the thesis deals with the theory of FBGs along with photosensitive property of fibers, theory and fabrication techniques of FBGs, etc. Among the FBG fabrication techniques, the phase mask method of inscription is emphasized, as the FBG sensors utilized for the research work undertaken in the present thesis have been fabricated using this method.

Chapter 3 deals with the study on the usage of a FBG sensor as a communication assistance device. The development of a noninvasive, real-time, communication assistance device employing a FBG sensor, for the assistance of those with restricted communication ability has been presented in this chapter. The communication assistance device comprises of a breath pattern analyzer developed using a FBG sensor, which acquires the exhalation force in the form of strain variations on a cantilever. The present approach is intended to be an alternative to the common approach via brain–computer interface in which an electrode is utilized for learning of brain responses.

Chapter 4 deals with the application of a FBG sensor in the field of dentistry, in which a Bite Force Measurement Device (BFMD) has been demonstrated for the measurement of the individual maximum bite force along the dental occlusion. The developed BFMD facilitates the ability to alter the distance between the biting platform according to the tooth position. Further, clinically relevant bite forces are measured and analyzed.

Chapter 5 provides an insight to another novel application of FBG sensor in the measurement of the Range of Motion (ROM) of joints in human body, which is of prime importance in monitoring the progress of therapeutic procedures. A Fiber Bragg Grating Goniometer (FBGG) has been developed which can be employed to dynamically measure the angular movement of joints. The maximum flexion angles at the elbow along with the plantar and dorsi-flexion angles are evaluated using the FBGG for illustration.

Chapter 6 reports the application of FBG sensor in the field of cardiology, wherein a Fiber Bragg Grating Pulse Probe (FBGPP) developed is described, which comprises the

ability to dynamically acquire the arterial pulse pressure waveform. This chapter also deals with the measurement of the Carotid Arterial Pulse Pressure Waveform (CAPPW) of individual subjects, which consists of beat-to-beat carotid pulse pressure, using the proposed FBGPP.

In addition, the pulse wave analysis of the recorded CAPPW is presented, which has been undertaken to evaluate vital cardiovascular parameters and the relationships between them. Lastly, in this chapter, the deployment of the developed FBGPP for radial arterial pulse pressure waveform acquisition in children, has been presented. This study validates the fact of variation of heart rate of children with age. It has been observed that the diastolic time component varies in good accordance with children's age and in addition it is found to be major contributor to heart rate variation. Furthermore, various cardiovascular parameters are evaluated and compared along with the variation in children's age.

Finally, chapter 7 gives a summary of the thesis and future directions of the presented research work that are yet to be explored.