Abstract

In this thesis work, we present the development of a Six Degrees of Freedom (6DOF) magnetic tracking system based on a low computational complexity algorithm and a low-cost, wireless and wearable hardware for biomedical applications.

We start by studying the role of the different types of tracking systems presented in the literature on the biomedical field, with a special interest in upper limb motion tracking, hand fingers motion tracking and medical instrumentation tracking. Based on this study, we choose to work with magnetic tracking techniques and set our system general characteristics.

Then, we present a literature review of magnetic tracking systems from which we extract our thesis goals, design constraints and research contribution to the field which consists of designing a wearable wireless magnetic tracking system based on the use of a lightweight algorithm onboard a small-sized low-cost MCU that can acquire and process the magnetic field signals perceived by movable sensors and transmit the estimated sensor position and orientation to an end-user device via wireless communication, projecting to the substitution of gold standard high-cost systems for the development of medical device of its use as an assessment tool in the research field.

Following the presented research methodology consisting of short experimentally driven step development cycles, we expose our system development from exposing our proposed tracking methodology and system hardware architecture to a functional prototype of a 6DOF magnetic tracking system with 2.6 mm static spatial accuracy, 5.4 mm dynamical spatial accuracy and 1.78 ° orientation accuracy within a 21 cm radius, BLE communication with a maximum measured latency of 150 ms, processing unit current consumption of 51.1 mA and a 0.54 cm^3 marker size.

A Figure Of Merit (FOM) was developed to compare the state-of-the-art magnetic tracking systems with our prototype. On this analysis, our system ranks only second w.r.t. only wireless magnetic tracking systems to the industry gold standard Polhemus G4 using deeply engineered micro-sensors.

This allows believing that with further system optimization our tracking methodology could replace the use of industry gold standard instruments for the development of low-cost medical instrumentation and research assessment tools with off-the-shelf components.