Development of a wireless sensing unit to measure tibial-translation

Degree programme: BSc in Micro- and Medical Technology | Specialisation: Medical technology
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Tibial translation is a parameter used to examine the mechanical stability of the knee and eventual injuries of the anterior cruciate ligament (ACL). However, today's manual tests and equipment only allow testing in static conditions. In this project a wireless and battery-powered unit for data acquisition and transmission is implemented on an existing prototype, in order to enable dynamic measurements.

Introduction

The present study is a follow-up of a project launched by the School of Health Professions & Bern Movement Lab in which the goal was to measure the tibitranslation in order to examine kneestability. While the current system works well for static measurements, the aim of this work is to develop the system in a way that allows wireless and thus dynamic measurements.

Goals

The goal is to add wireless functionality to the existing device including energy supply, analog to digital conversion and signal transmission to the acquisition side.

Methods

Design is made by met some initial consideration in terms of space, positioning on the patient and with an attempt to preserve and integrate some of the material already in use. Previously used analogue distance sensors are retained as they have a high resolution in measurement. A microcontroller is therefore introduced to handle the input data, the ADC conversion and to manage the output transmission. Bluetooth technology was chosen for wireless transmission, as it allows data to be transmitted in sufficient space for use (approximately 30 m with BT v2.0) and uses low energy for its power supply. Power consumption is a fundamental parameter in the design of embedded systems, as it is used to size the correct capacity of the power source while trying to conserve space.
In this case, the choice of battery is constrained by the 24V voltage required by the distance sensors. To improve dynamic measurement, an accelerometer is introduced into the system for the purpose of measuring foot contact to synchronize it with the measurement of tibial translation during the gait cycle.

Results

Acquisition of data sensors works via STM32Cube IDE with C programming language. Wireless visualization of measured data is achieved with Matlab software, although it presents a slight delay in real time display. A Bluetooth DAQ card (BTH-1208LS) that allows wireless transmission and enables a return to the wired acquisition system with the existing GUI has been found, but due to delivery time, it cannot be implemented at the moment.

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Fig 1: Current prototype tested in a static measurement to simulate an external shock force with an apposite apparatus

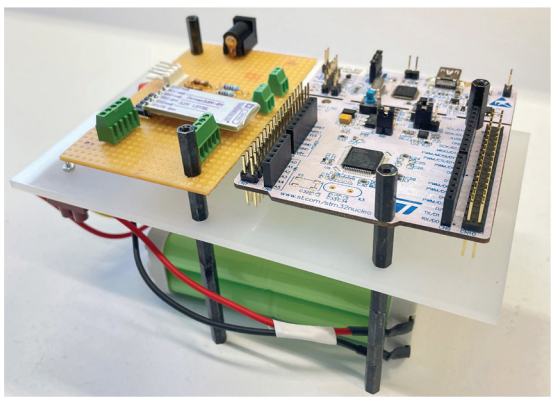

Fig 2: Wireless sensing unit prototype