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Technical Writing:
The Introduction

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What is the Introduction for?

The Introduction should:

- Provide context for your work by outlining the relevant technical field with references to previous key contributions.
- Identify the motivation for your work by indicating a gap or scope for improvement in the field – the PROBLEM.
- Outline the aim of your work and what you intend to accomplish in order to solve this PROBLEM.
- State the objectives/activities required to achieve your aim and link this to an outline of the structure of the thesis with sufficient detail to provide a handle for the reader to remember as they read the work

The Introduction should not:

- state any results or conclusions
- be written FIRST, it should be written after the main content of your work.
- Just say “in this work I am going to do this … and this… and this…”

“Setting the scene”

A piece of technical writing requires justification i.e. WHY did you do the work that you are presenting? This motivation is central to your work and should be presented carefully.

The relevant field of work should be outlined by selecting key references from your background material. These references should be the most important and/or informative ones. Summarise this information in a clear way with logical progression, either:

- Chronologically (usually)
- From broad scope down to the specific

The natural progression in this section is towards your work.

The flow of the narrative should therefore end with that relevant to the aim.

The “Problem” and the Aim

Following on from the information about the field in which your work is carried out, you then expand and discuss what is missing or lacking.

This is the problem that you are solving with your work. The problem may be a gap in the field or a lack of ability in a current technology etc.

This is connected with the presentation of the aim of your work. Write a short passage of text on this, discussing what you are going to present, what its value is and why it is important. This should be justified with key facts from reference material.

Ensure that the reader can “get” what your work is about from reading the context and can see what your work is going to do if successful.

Outline the objectives and the report

This greatly depends on the specifics of your work. The key requirement is that it covers the main structural aspects of the report as a quick guide for what to expect. It should provide a narrative both for the work that you undertook and the presentation of the work.

Here are a couple of suggested content methods:

- Lay out the objectives of the work, the specific activities and then discuss where in the report this can be found.
- Lay out the structure and the key discussion points in the report. Loosely align this discussion with the objectives of the work.

DO NOT state any results or conclusions.

Example

1. Introduction

Forearm crutches are used routinely following many operations to the lower limb (including the repair of fractures and the fixation of implants) in order to reduce weight-bearing through the affected limb and optimize the healing conditions for bone and soft tissues. It is widely recognized that excessive loading of the lower limb following certain types of surgery can disrupt the operated tissues and put the healing bones at risk of mal-union, while mobilization soon after surgery increases the bone turnover metabolism and stimulates bone growth [1]. It has also been recognized that prolonged unloading of the articular cartilage causes the cartilage to become less stiff and less able to tolerate high loads [2]. Therefore, a programme of protective partial weight bearing (PWB) usually

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begins immediately after certain types of surgery and continues until full weight bearing is achieved at a time when there is sufficient healing in the limb. The level of PWB prescribed by the clinician (ranging from non weight-bearing to full weight-bearing) is dependent upon the severity and nature of the injury, the method of surgical intervention and stage in the healing process [3]. It is critical that the patient follows this programme in order to expedite the rehabilitation period and avoid further and long-term damage to the affected limb.

To ensure that the patient loads their affected limb at the prescribed level, they receive PWB training from a clinician before they are discharged from hospital [4]. As a patient's perception of the loading on their lower limb is usually prone to considerable error, a range of training techniques exist. These include the use of bathroom scales [1, 3, 5–8], visual examination by a clinician [4, 8, 9], subjective measurement by a clinician whose hand is placed under the patient's foot [7, 8], video instruction [10], full-length mirrors [5], force platforms [8] and in-shoe pressure monitors [4, 8]. In practice, visual examination is widely used, which introduces considerable error in the loading of the affected limb.

The effectiveness of 'static' training tools (such as bathroom scales) is disputed, as the ability to correctly perform PWB in a static posture may not necessarily transfer to dynamic gait [7, 10]. During gait, the force through the lower limb can range between zero and five times body weight, vibrating cane handle and to the clinician via two LEDS on the handle. Bergmann *et al* [14] used a similar 'mechanical' sensing system to monitor the force exerted through a forearm crutch, but added a mercury tilt switch to infer the phase of the gait cycle. Neither of these systems offered telemetry or were able to perform signal analysis on the sensed data and, arguably, the presence of a spring affected the patient's usage of the crutch. Clearly, in this application domain, untethered operation is essential, and recent advances in wireless sensing and sensing networks clearly lend themselves to providing this functionality and improving the usability of devices. Wu *et al* [15] developed a 'smart cane' for geriatrics to monitor the usage of the cane and infer further information about the patient's well being. Raw data from various sensors on the cane are wirelessly streamed to a PDA via Bluetooth to provide analysis and feedback, for example detecting incorrect usage or if the patient has fallen. The requirements for an instrumented crutch are largely distinct from this as, unlike a walking cane which is used to assist full-weight-bearing gait only, the forearm crutch is used for PWB to reduce and control the loading on the lower limb following an injury. Šantić *et al* [16] produced a system that monitored the forces through the crutches (using an infrared transducer) and feet (using capacitive force sensors strapped to the shoes). The system used infrared telemetry to communicate data from the sensors requiring multiple receivers to be present in the environment,

Example

dependent on the speed and stride length [8, 11]. It is reported that tools that monitor the patient during gait and provide biofeedback allow more accurate, objective and reliable data [8]. However, even with the use of these objective training tools, the patient's ability to remember how to correctly use the crutches is limited [10]. Therefore, the effectiveness of PWB is questionable, with patients usually and regularly overloading the affected limb once they return to a home environment [1, 4, 9]. As an example, one study found that patients were putting, on average, 36% of their body weight through their affected limb when they had been prescribed a target PWB of 10% [3]. This study also found that patients are better at maintaining a PWB of 50% of their body weight through their affected limb, as opposed to the extremes of 10% and 90%. Aside from simply forgetting how to correctly perform PWB, a patient may apply too little weight when they are in pain, or too much when pain has subsided (possibly caused by a high dose of analgesia) [6]. It has also been reported that the absence of a clinician, the home environment, the time since surgery and the many routine distractions of daily life can all influence the ability of the patient to comply with their recommended PWB programme [4].

A number of biofeedback devices have been developed in the past that monitor the weight being exerted through the patient's shoes [8, 12]; these are generally invasive as they require the patient to wear special footwear or attach devices to their own shoes. The concept of an instrumented walking aid has been previously investigated; Engel *et al* [13] modified a walking cane to monitor PWB using a compressible spring inside the tube of the cane which activated (adjustable) micro switches when too much or too little force was applied. Biofeedback was provided to the patient by means of a hence rendering it unsuitable for use in a patient's natural environment. While earlier research has also developed instrumented crutches for analysing kinematics and gait within a laboratory environment [17], our proposed device is designed for biofeedback in assistive healthcare (i.e. to be used for the patient's benefit throughout the entirety of their rehabilitation programme).

In this paper, we present the research, design and development of a pair of forearm crutches augmented with low-cost wireless sensors for use in both in-hospital training and patient monitoring over the full period of recovery (including its potential use in the home environment). The crutches monitor the force being applied through their axis, enabling an indicative and objective estimation of the weight being exerted through the affected limb to be obtained. To assist in teaching patients the correct usage of forearm crutches, the tilt of the crutch and position of the hand on the grip are also measured. Two crutches are required for PWB, and both must be instrumented in order to account for patients which may unevenly distribute their weight through the crutches (although not ideal, this is quite likely to occur due to pain and an instinctive protection of the affected leg). The developed crutch was designed as a research tool for physiotherapists at Southampton General Hospital, and the specification and design of the crutch was undertaken with considerable input from them. The physiotherapist can observe data from the crutch in real time using a LabVIEW graphical user interface (GUI) on a remote computer, while the patient receives biofeedback by means of an audible notification when PWB events occur (i.e. too much or too little weight is exerted through the affected limb). The instrumented crutch provides clinicians and patients with a

Example

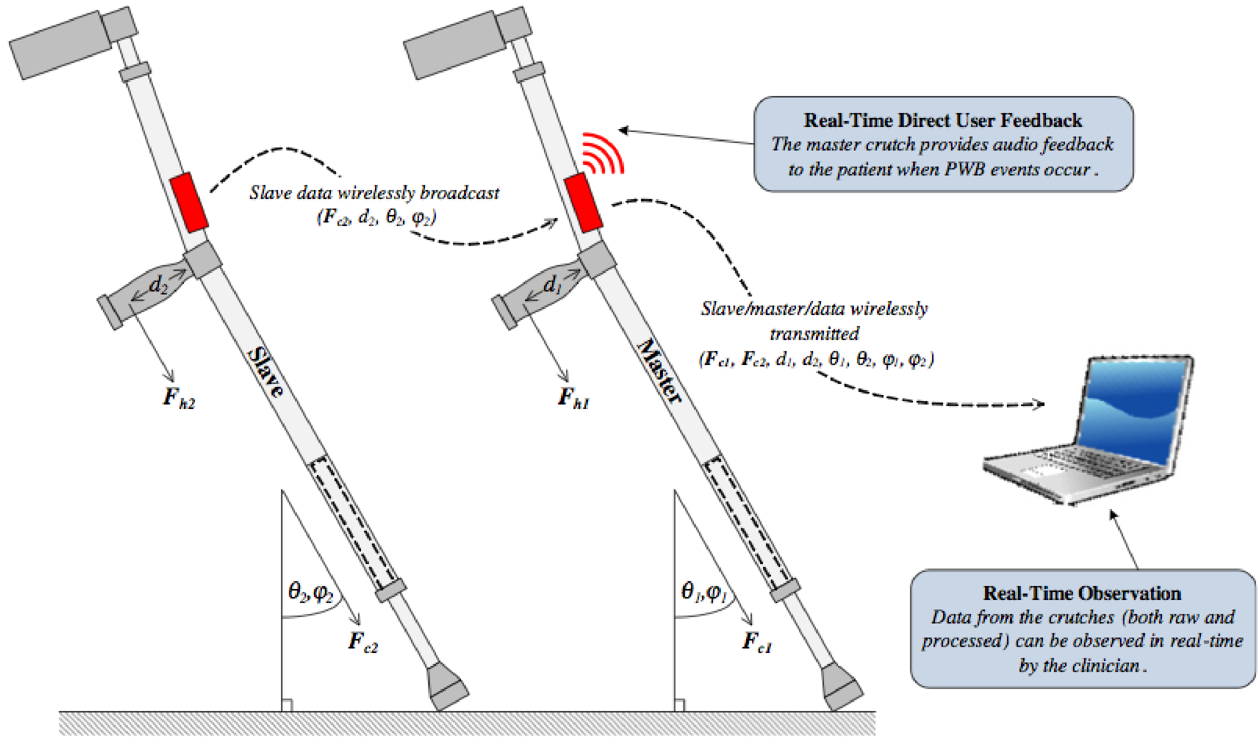

Figure 1. The instrumented crutch, showing the architecture (crutch-to-crutch or crutch-to-host), functionality (real-time observation and biofeedback), and also the forces, angles and distances measured.

means of objectively measuring and receiving feedback on the weight being exerted through their affected limb. Such an instrumented crutch differs from those previously researched and developed for PWB by being less invasive (no additional equipment is required to be attached to the patient or their footwear, as all electronics is contained within the crutch), and being used for both clinical training and long-term in-home monitoring.