The Development and Commercialisation of Wearable Electrical Stimulation Devices for Gait Guidance with Freezing of Gait in Parkinson’s disease

Keywords:
Parkinson’s disease (PD); Freezing of Gait (FOG); gait guidance, wearable electronics; neuromuscular electrical stimulation (NMES); smartphone; electronic medical device

Project Summary:
As part of CÚRAM Research Platform Device Design which aims to deliver new medical device options for economical, faster and more efficient patient care, NUI Galway are engaged in a research programme centred on the development of wearable electronic devices to address the debilitating motor symptom of Parkinson’s disease (PD) referred to as Freezing of Gait (FOG) using neuromuscular electrical stimulation (NMES). We want to develop the next generation of this technology, collect clinical evidence of its effectiveness and develop an investor pack for the technology to facilitate the commercialisation of the work.

We are looking for a special candidate who will work with the NUI Galway team to enhance the CueStim technology, clinically evaluate the enhanced technology and develop an investor pack for the system. There will be opportunity for equity in a campus start-up company which will be formed to facilitate the commercialisation of the system.

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Freezing of Gait
FOG is commonly described by a person with Parkinson’s disease (PwP) as feeling as if their feet are stuck or glued to the floor preventing them from moving forward. FOG can be triggered by cognitive factors like distraction, anxiety or being in a hurry and by performing certain actions, such as initiating gait, turning, and passing through doorways or tight spaces.

FOG has a very severe impact on the quality of life of PwP, affecting their ability to walk for extended periods of time and over extended distances. FOG increases a PwP’s incidence of falls, their fear of falling and can subsequently lead to reduced independence and increased social isolation. NUI Galway have a research programme for the development of a family of smartphone-enabled, electrical stimulation cueing devices designed for the prevention and relief of Freezing of Gait (FOG).

Prior Work
The Gait Guidance System to be developed will be based on NUI Galway’s waist-worn CueStim stimulator (Figure 1) designed under the FP7 project REMPARK specifically for electrical stimulation cueing applications in Parkinson’s disease and its Bluetooth interface allows the stimulator to be setup using a smartphone and an associated Android App (Figure 2). This CueStim device features a
patented surface electrical stimulation methodology designed to enhance comfort. This work will be based on NUI Galway considerable experience, over 20 years, of research on the design and application of NMES devices for orthotic and venous return assist benefit [1-26].

**Project Rationale: Cueing in Parkinson’s disease**

Cueing is a technique used by people with Parkinson’s disease (PwP) to ameliorate gait problems including the relief or prevention of FOG. The appropriate cue provides a temporal (timing) or spatial (change in environment) stimulus that facilitates the progression of locomotion (gait). Cueing has the capacity to trigger either an exit from FOG (FOG relief) or to prevent a FOG event occurring (FOG prevention). Cueing techniques include visual cues, auditory cues, proprioceptive cues and other attentional strategies.

![Figure 1: NUI Galway's CueStim electrical stimulation technology](image)

**Figure 1: NUI Galway’s CueStim electrical stimulation technology**

![Figure 2: CueStim Android smartphone App screen shots](image)

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**Attentional Strategies**

Attentional strategies are very often the first choice when adopting a cueing approach and these involve the person thinking about the movement, such as thinking about placing the heel down first.
when walking, or thinking about lifting the knees high (marching) when turning. Understandably, these techniques can be mentally exhausting, and patients struggle to use these when tired, distracted, or in a busy environment.

**Visual Strategies**

Visual cues are often the second option, and involve taping lines on the floor at known trigger points for FOG onset, for example doorways in the home. However, these techniques cannot be used outside the patient's own home environment. Laser sticks are also used as another form of visual cue, but require the patient to look at the floor with each step, which can increase falls risk, and contribute to secondary complications such as poor posture.

**Auditory Strategies**

Auditory cues are generally the third option, and involve the use of a physical or smartphone App based metronome, typically set at a specific beat rate and the patient is instructed to step in time to the beat. Auditory cueing can be irritating for the user and users are often unwilling to use it in public places. Earpieces can be used, but hearing difficulties often make this impossible.

**Unmet Need**

We believe that there is an unmet need for a more person-friendly device for the prevention and relief of Freezing of Gait and that we have the skillset to lead a team to develop a system to meet this unmet need based on our extensive experience over 20 years on the design and application of NMES devices for orthotic and venous return assist benefit [1-26].

We believe that this is an exciting opportunity for the right individual and we are looking for a special candidate who will work with the NUI Galway team to enhance the CueStim technology, clinically evaluate the enhanced technology and develop an investor pack for the system to facilitate its commercialisation. There will be opportunity for equity in a campus startup company, which will be formed to enable the commercialisation of the system.

**References:**

(Gearóid ÓLaighin published as Gerard M. Lyons prior to 2007)


