THESIS PROJECT PORTFOLIO

SurePace Walker: A powered walker for children with cerebral palsy

(Technical Report)

The Bioethics of CRISPR-cas9 and Potential Solutions

(STS Research Paper)

An Undergraduate Thesis

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The project behind the technical thesis centers around the creation of an intelligent powered walker, called the SurePace Walker. This project was done in conjunction with Barron Associates, a research and development company based in Charlottesville, Virginia. The SurePace Walker is a walker that, through use of a camera or a sensor array, analyzes the user's gait through an onboard algorithm in a computer to provide motor power to the wheels, thus relieving the user of any excess energy expenditure. This target audience of this powered walker was children with cerebral palsy, as they suffer from poor muscle tone which results in movement disabilities. The walker allows for an increase in the speed and range that the user can move, allowing them to more proactively participate in daily activities. Additionally, the walker makes exercising more accessible to the user, which is a major component of physical therapy. The STS Research paper delves into the bioethics of CRISPR-cas9 and possible solutions. The paper evaluates various perspectives from groups ranging from academic to religious in order to come to a conclusion about how the technology should be regulated, if at all.

The primary aims of the technical project were to 1) create a commercially available mechanical walker that could serve as the base upon which to implement the necessary features of the powered components, 2) compile documents together to submit a 510(k) premarket notification to the Food and Drug Administration (FDA), and 3) optimize the design to make it more readily manufacturable for potential partners. The first and third aims of the project were achieved through using computer-aided design (CAD) via the SolidWorks suite of products. A single iteration was created for the walker, and stress testing was conducted on it through the use of finite element analysis that was available in SolidWorks. In order to complete the second project aim, contact was established with the FDA and their Division of Industry and Consumer Education to understand what documents were necessary. The most essential part of the 510(k)

application was proving substantial equivalence to a “predicate device,” with a predicate device being a device that is similar to the SurePace Walker that is already currently being legally marketed.

The topic of this STS research paper is the discussion of the bioethics surrounding CRISPR-cas9 through the lens of utilitarianism. CRISPR, which is an acronym for clustered regularly interspaced short palindromic repeats, is a family of DNA sequences which can be found in prokaryotic (i.e. nucleus-lacking, single-celled) organisms. Cas9, an acronym for CRISPR-associated protein 9, uses the sequences defined by the CRISPR sequences in order to cleave the specific strands of DNA that are complementary to it. The primary use of this complex is to cleave any DNA strand that is defined by the CRISPR sequence for the purpose of developing therapies for diseases, mainly genetic. It also has various uses in other industries, such as the agriculture industry, where it is used to develop resilient crops.

The paper focuses on the bioethics of this technology through the lens of classical utilitarianism, which simply states that the most morally correct action is the one that produces the most utility (i.e. general benefit, advantage, or pleasure). Medically speaking, it was found that CRISPR-cas9 almost exclusively provided pure utility, when used with good intentions. The therapeutic potential for CRISPR-cas9 is almost limitless, with the ability to cure almost any genetic disease since it can cleave out any faulty DNA sequences. However, with respect to society, the question becomes more difficult to answer for a variety of reasons. Due to the scarcity of the reagents needed to create CRISPR-cas9 as a functioning gene editing tool, its use as a treatment is limited to only wealthy individuals, thus locking out poorer populations from receiving potentially life-saving treatment. Additionally, CRISPR-cas9 has the potential to reinforce cultural genetic stereotypes, instead of attacking the root causes of these diseases, a

phenomenon coined as biocolonialism. Finally, in religious communities, the use of CRISPR-cas9 sparks a large internal ethical dilemma over whether modifying an individual's genetic data is considered sacrilegious or not and whether it encroaches upon the body, which some may consider sacred. However, despite these potential negative impacts, CRISPR-cas9 should still be allowed to be used with little restriction as its overall utility outweighs any potential negative outcomes that may occur.

With regards to the technical thesis, although much experience was gained from working on the project, there was still a significant amount of work that could have been done. Overall, time management and communication were major issues with this project. For those looking to take up this project in the future, please ensure that individual initiative is taken, lest no progress be made at all. However, the STS research paper was significantly more fruitful, as it taught how to analyze a specific topic from different perspectives. Although the debate behind CRISPR-cas9 will still remain, it is important to note how many different parties are in play and how they affect the ethics of this technology.