A Low Cost, Closed Loop Insulin Pump for Better Management of Types 1 and 2 Diabetes Mellitus

Quinlan, Anna (School: Menlo-Atherton High School)

Though insulin pumps do allow better blood glucose control for diabetics, they are extremely expensive, ranging from more than $6,000 to $10,000 for the pump itself, and are not covered by insurance for type 2 diabetics, who constitute the majority of those with the disease in Native American populations. The purpose of this project is to create more accessible, lower cost insulin pump with greater functionality. A Raspberry Pi was used as the controller for a stepper motor, with a self-designed 3D-printed gearbox to add additional control of infusion rate and various force sensitive resistors to detect occlusions/malfunctioning parts. The software has all the features of commercially available insulin pumps, in addition to a novel self-designed “closed-loop” (modeled off of the OpenAPS framework) that can automatically adjust insulin rates in response to blood sugar, with predictive text notifications to alert the user of blood sugar changes requiring intervention. To test the accuracy of the mechanics, the reservoir was filled with water and various amounts of liquid were dispensed and weighted using a calibrated scale accurate to the ten-thousandth of a gram. Human testing was done by having type 1 diabetics currently on insulin pump therapy use the prototype pump in parallel to their own. The prototype was loaded with water, which was dispensed into a container and weighed at regular intervals to measure performance in real-life situations. This testing indicates the pump is accurate ± 6% (95% confidence), indicating potential applications for the management of diabetes.

Awards Won:

Second Award of $2,000

Samvid Education Foundation: Honorable Mention