An Improved Inexpensive Closed-Loop Insulin Pump for Automatic Management of Types 1 and 2 Diabetes

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Type 1 and 2 diabetics typically require exogenous insulin to maintain normal blood glucose levels. Insulin pumps have been shown to significantly improve quality of life and diabetes management, but the cost is prohibitive for many patients in low-income communities. This project aims to improve the student-researcher's low-cost insulin pump by creating a fully offline closed-loop system that automatically doses insulin in response to changes in blood glucose levels without the need for carbohydrate-counting or other management techniques. The Raspberry-Pi-powered pump was redesigned to reduce pump size and improve durability by using a 3D-printed, stainless-steel gearbox. On the software side, the closed-loop algorithm was enhanced to improve customization for each patient and allow for the delivery of microboluses of insulin to more rapidly correct high blood sugar, which enables the algorithm to dose insulin at mealtimes without user input. To assess the accuracy of liquid delivery, the reservoir was filled with water, then liquid was dispensed and weighed using a scale accurate to the ten-thousandth of a gram. User testing was done by having diabetics use the prototype pump in parallel to their own; the reservoir was filled with water that drained into a collection device and was weighed to determine accuracy in real-life situations. This testing showed the pump's accuracy, 1.16% ± 1.16% (95% confidence), is similar to commercially available pumps, suggesting the prototype could be used to accurately deliver insulin as a part of a closed-loop system.

Awards Won:

Third Award of $1,000