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Non-Invasive Blood Glucose Monitoring System

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BIOMEDICAL

Non-Invasive Blood Glucose Monitoring System

Sponsor: VCU School of Engineering Foundation Sternheimer Award

Faculty Advisor: Dr. Paul Wetzel

The Problem The Design 2013- 382 million worldwide have diabetes → expected to increase by 55% to 592 million by 2035 · 26 million Americans have diabetes → 3 million are type 1 diabetics · Hypoglycemia is a drop in the blood glucose Skin Resistance Calibration Curve · As time progresses, the diabetic cannot feel this drop and is diagnosed with 1.205+05 hypoglycemic unawareness · Hypoglycemic unawareness is a threat to diabetics, side effects of hypoglycemia include: organ damage, convulsions, coma, and especially dangerous while sleeping · Symptoms & Biological markers of hypoglycemia include: sweating, increased heart rate, cognitive dysfunction, dizziness, and other emotional marker (i.e. anger, tired, c por - pa irritability, etc.) · Current solutions fall short: · Blood glucose meters and continuous glucose monitors are invasive, cause patient Figure 6. Peak detection circuit at 60 bpm Figure 7. Peak detection circuit at 120 bpm discomfort, and require the patient to self-awaken Current non-invasive glucose detection systems are inaccurate Figure 2. Areas of Time Intervals Corresponding to Heartheat · How can we solve this problem? 12 0.5 highest sweat gland Voltage Drop (V) concentrations Figure 3. Skin resistance sensor calibration curve The Solution highlighted in yellow in comparison to heart · To design a non-invasive solution to nocturnal hypoglycemia, capable of detecting GSR Sensors . hypoglycemia in type 1 diabetics during sleep ECG Leads that will alert them to wake up. Vibe Boards · Measurements taken to detect this include: Lillypad Figure 8, R-R intervals at 60 bpm and 120 bpm Heart Rate Hardware Skin Conductance · Couple these two measurements together to The Future have a higher accuracy and sensitivity of detecting hypoglycemia during sleep Design basics include: · Improve upon the design by consolidating hardware components and increase ergonomics · Diabetic wears a compressive t-shirt that ECG signal Increased for user houses a microcontroller collection heart rate · Empirical testing to determine the accuracy of the system across multiple people of different · Attached to the microcontroller are: body types, ages, and severity of diabetes. · ECG leads (for heart rate detection) · Develop smaller size to accommodate children Skin conductance sensors (for detecting · Develop an app to accompany the shirt to track hypoglycemic episodes over time sweat) Alert user Implications: through vibration Parental and patient peace of mind → better **Acknowledgements** sleeping patterns Skin Increase in Decreased risk for hypoglycemic attack → conductance skin prevents future problems from hypoglycemia measurement conductance Other Considerations include: This project was funded by the Virginia Commonwealth University Biomedical Engineering Wearability during sleep → Human Factors Department and the Virginia Commonwealth University School of Engineering Foundation Effectiveness Sternheimer Funding. We would like to thank Dr. Paul Wetzel for mentoring us on this Figure 4. Signal collection, analysis, and user alert flowchart Potential Market Figure 6. Finalized project, as well as Dr. Thea Pepperl for her support throughout the year. Other support came Figure 1. T-shirt sensor layout and from Mr. George Weistroffer, Mr. Tyler Ferro and Mr. David Parker, graduate students in the prototype on mannequin desian VCU BME Department



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