Mobile-Enabled Diabetic Foot Analyzer

A portable screening device for diabetic neuropathy

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Problem/Motivation: Diabetic Neuropathy in India

- India has the largest diabetic population in the world. 25% of diabetics develop a foot ulcer due to neuropathy [1]. Ulcers precede 85% of amputations [2]
- At least **half of these ulcers can be prevented by appropriate treatment and patient education** [3]
- Current diagnostic equipment is expensive, bulky, and requires trained operators. As a result, **rural patients are not being tested for neuropathy**

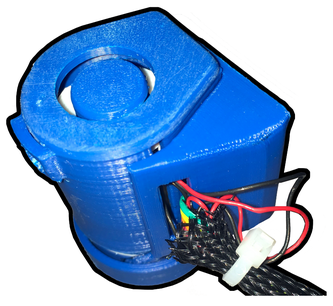
Existing Diagnostic Tests

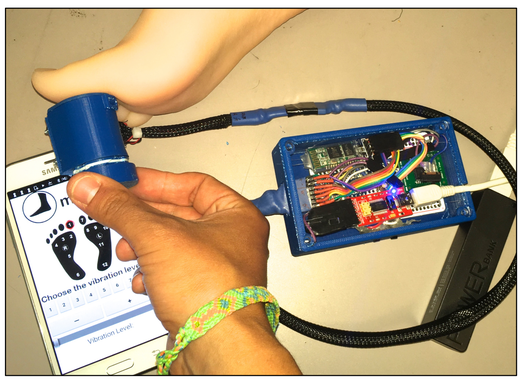
- Gold standard is the nerve conduction study
- Tuning forks and monofilaments are effective but binary
- Middle ground is vibration perception threshold (VPT) measured with a biothesiometer.
- However, **existing biothesiometers are large and heavy, mechanically and electrically inefficient, and inadequately characterized**.

	Reliable	Quantitative	Cost	Portable
Nerve conduction	✔✔✔	✔✔	$$$$	✗
Tuning fork / monofilament	✔	✗	$	✔
Biothesiometry	✔	✔	$$$	✗
m-DFA	✔✔	✔	$$	✔

Our Solution: MobileEnabled Diabetic Foot Analyzer

The Mobile-Enabled Diabetic Foot Analyzer (m-DFA) is designed for operation by community health workers with minimal technical background as part of the Rural NonCommunicable Disease Prevention Program (R-NCDPP) in Tamil Nadu, India.





Portable

Battery powered

Quantitative

Simple to operate

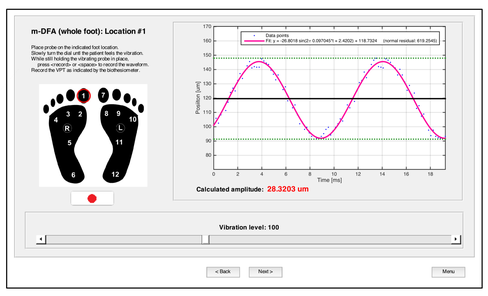
Mobile connected

Inexpensive

Initial Prototype

A probe vibrating at 100 Hz is applied to the sole of the foot with a predetermined force. The vibration amplitude is slowly increased until the patient feels the stimulus. The amplitude (in µm) at this point is the VPT.

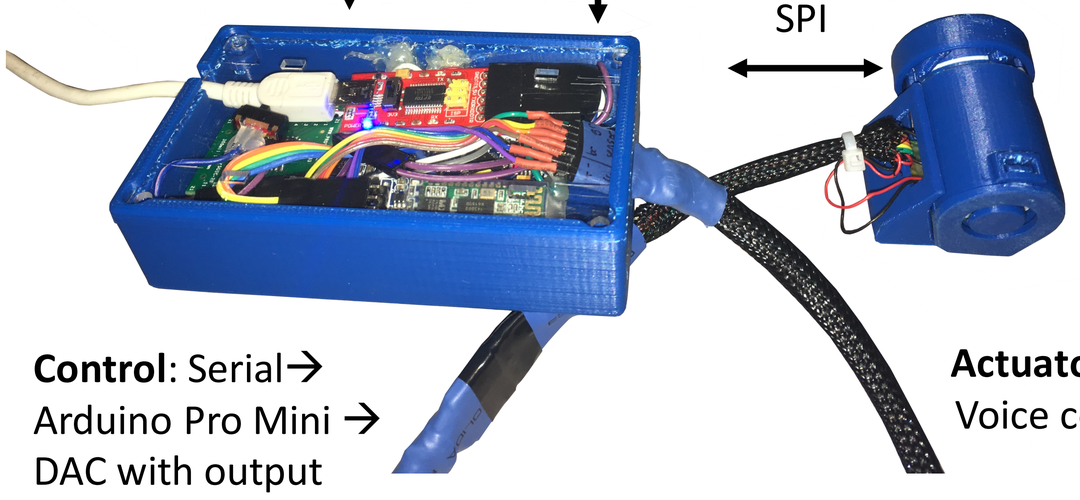
Computer application OR **Android application** + Power bank battery



USB serial

BT

SPI



Control: Serial→ Arduino Pro Mini → DAC with output amp → digital pot → power op amp → voice coil

Actuator: Voice coil

Sensor: AS5311 magnetic encoder (5µm resolution)

Next Steps and Future Work

- Incorporate feedback gathered from field workers during summer visit to India
- Validate against existing biothesiometers and nerve conduction studies, and determine relationship between VPT amplitude and degree of neuropathy
- Engineering characterization of device
- Test in other healthcare settings and locations
- Design for manufacturing

References

[1] K. Shankhdhar, L. K. Shankhdhar, U. Shankhdhar, and S. Shankhdhar, "Diabetic foot problems in India: An overview and potential simple approaches in a developing country," *Curr Diab Rep Current Diabetes Reports*, vol. 8, no. 6, pp. 452–457, 2008.

[2] R. Pradeepa, M. Rema, J. Vignesh, M. Deepa, R. Deepa, and V. Mohan, "Prevalence and risk factors for diabetic neuropathy in an urban south Indian population: the Chennai Urban Rural Epidemiology Study (CURES-55)," *Diabetic Medicine Diabetic Med*, vol. 25, no. 4, pp. 407–412, 2008.

[3] "Assessing diabetic peripheral neuropathy in primary care," - *BPJ 61 June 2014*. [Online]. Available at: http://www.bpac.org.nz/bpj/2014/june/diabetic-peripheral-neuropathy.aspx.

Acknowledgments

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