Re-Engineering Urology: Autoflow 1.0

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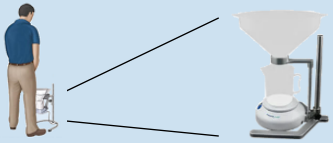
After 71 years, we're due for an upgrade. Our device, Autoflow, features a user-friendly system and automatic, wireless data transmission.

Background

Uroflowmetry is a procedure used to diagnose lower urinary tract symptoms such as an overactive bladder, enlarged prostate, and neurogenic diseases.

It was last adapted in 1953.[2] The current system is time consuming, burdening on clinicians, and compromises test results when delays occur.



The uroflowmetry system used today (uroflowmeter)

The current procedure uses a bucket, funnel, and scale system to record data. Here's the problem:

15% of uroflowmetry tests have their results compromised [1]

83% of urologists say uroflow leads to significant delays in clinic[1]

We created a novel medical device, **Autoflow**, that automates the testing process, and allows patients to void in a natural bathroom setting.

It replaces the current bucket-scale setup with a device that sits inside an in-clinic toilet, and actively records uroflow data.

Methods

There are 2 features that must be implemented for Autoflow to work:

Feature 1: A control system. This allows users to control the device.

Approach: Develop a state machine. Each 'state' executes a task. The user toggles between these states (via button clicks) to control the device.

Feature 2: A wireless connection system to connect with in-clinic computers.

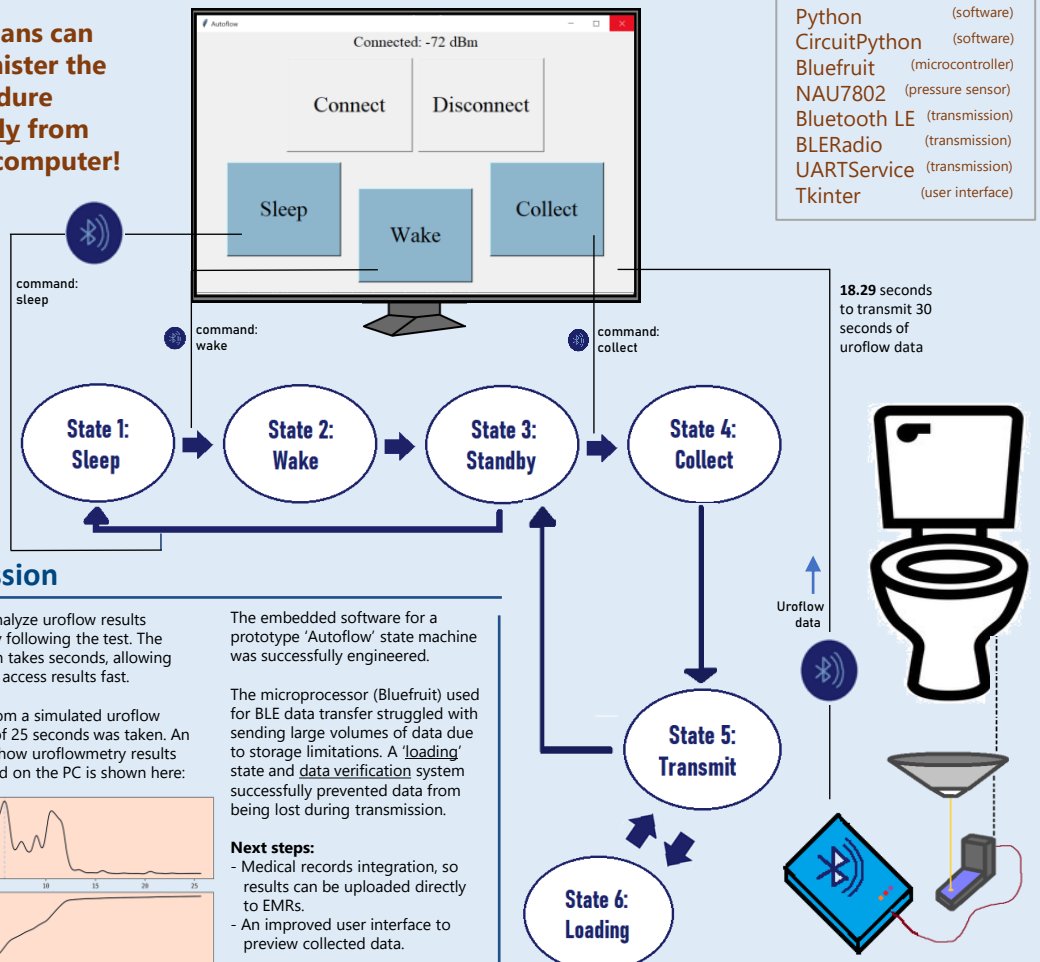
Approach: Use Bluetooth Low Energy (BLE). Research microcontrollers with a built in BLE chip. Find a software library that is compatible with it. Write the code that allows the device to send and receive data.

References

1. F. Elnakoury et al. (2023). An Observational and Survey Study of a Flow-Through Uroflowmetry device.
2. Chancellor, M. B., et al. (1998). The Invention of the Modern Uroflowmeter. In Urology (Vol. 51, Issue 4, pp. 671–674). Elsevier BV. https://doi.org/10.1016/s0090-4295(97)00203-3

Autoflow's Wireless Control System

Clinicians can administer the procedure entirely from their computer!



Technologies

Python	(software)
CircuitPython	(software)
Bluefruit	(microcontroller)
NAU7802	(pressure sensor)
Bluetooth LE	(transmission)
BLERadio	(transmission)
UARTService	(transmission)
Tkinter	(user interface)

Discussion

Clinicians analyze uroflow results immediately following the test. The transmission takes seconds, allowing clinicians to access results fast.

Test data from a simulated uroflow procedure of 25 seconds was taken. An example of how uroflowmetry results are displayed on the PC is shown here:

The embedded software for a prototype 'Autoflow' state machine was successfully engineered.

The microprocessor (Bluefruit) used for BLE data transfer struggled with sending large volumes of data due to storage limitations. A 'loading' state and data verification system successfully prevented data from being lost during transmission.

Next steps:
- Medical records integration, so results can be uploaded directly to EMRs.
- An improved user interface to preview collected data.

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