Using Contextual Data to Enhance Machine Learning in Traumatic Brain Injury: Progress from the MIND Workgroup

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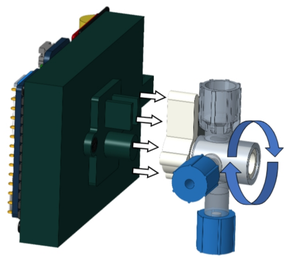
INTRODUCTION

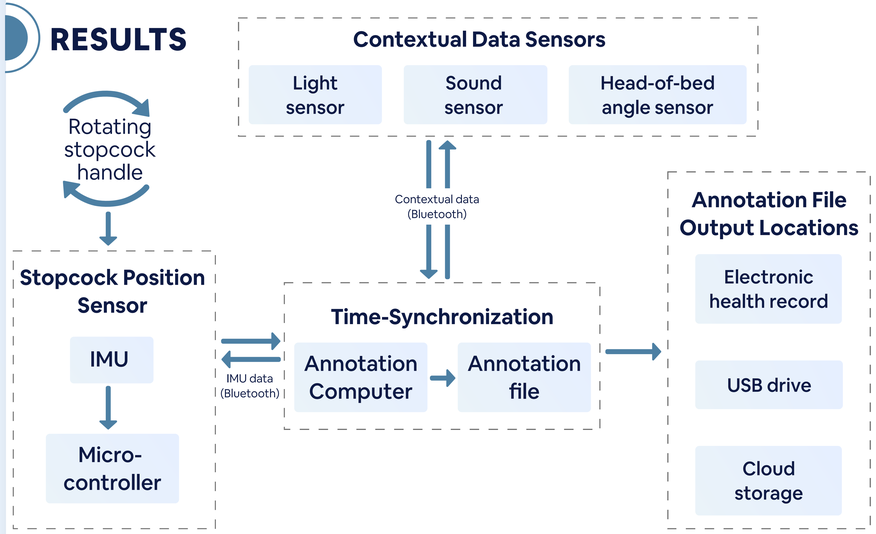
- Contextual data is rarely factored into analytic methods used in physiological data event detection or prediction.
- It is difficult to obtain contextual metadata time-synchronized to other real-time monitored data sources.
- Many traumatic brain injury (TBI) patients experience elevated intracranial pressure (ICP).
- An external ventricular drain (EVD) is placed in the ventricles of the brain as a way to control the pressure.
- ICP values are recorded continuously, but are only valid when the stopcock is in the correct position.
- We report here a method to record the EVD stopcock position to provide critical information about the reliability of ICP measurements.

METHODS

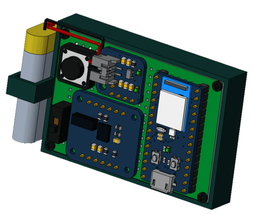


- The stopcock position sensor attaches to and rotates with the stopcock handle (shown above).
- An inertial measurement unit (IMU) acquires the position data.
- The position data is transmitted via Bluetooth to the Annotation Computer.
- The Annotation Computer creates the time-synchronous stopcock position annotations
- Device dimensions and functionality were deemed acceptable by clinical reviewers.
- 4 hours of continuous data was collected with a 90 degree stopcock rotation each hour.

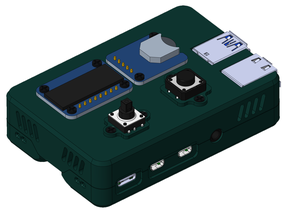
RESULTS

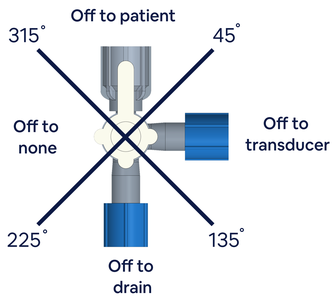


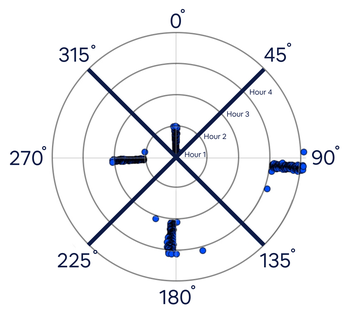
Stopcock Position Sensor



Annotation Computer







Time	Stopcock Position	Ideal Angle (°)	Measured Angle (°)
Hour 1	Off to patient	0	1.84±2.72
Hour 2	Off to none	270	265.30±2.72
Hour 3	Off to drain	180	176.64±2.47
Hour 4	Off to transducer	90	92.33±1.36

CONCLUSION

- We successfully synchronized stopcock position annotations with the physiology.
- We demonstrated the Stopcock Position Sensor and Annotation Computer are a high-fidelity data pathway for contextual metadata.
- Stopock position annotations may improve machine learning decoding accuracies in identifying valid/invalid segments of ICP data.

FUTURE WORK

- A protocol to evaluate stopcock position sensor efficacy at UT Southwestern pending IRB approval.
- Inclusion of additional intensive care unit contextual data sources.
- Integration of a microphone in the Annotation Computer to enable vocal annotations using natural language processing.

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