Energy-Efficient and Multi-modal Body Area Sensing System for Remote Diabetes Management

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Introduction

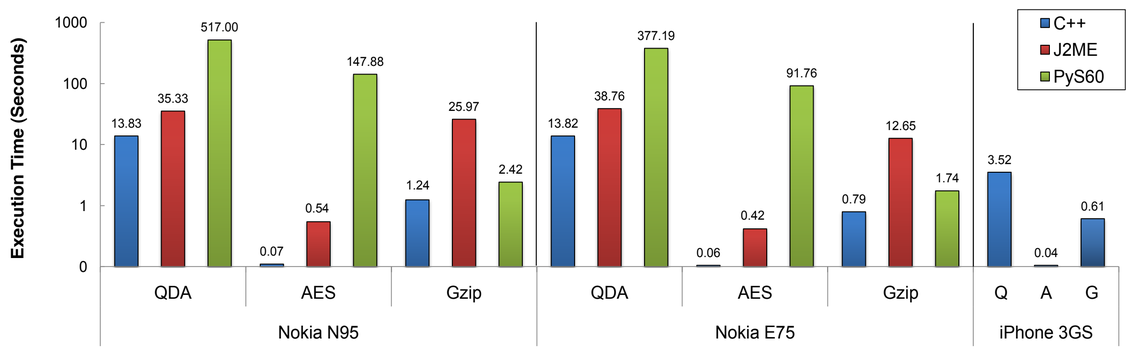
•The alarming rise in diabetes rates requires thorough understanding in biological reasons, social and environment impact.

•A real time multi-modal body area sensing system can provide a powerful database for medical research, as well as remote diabetes management.

•Battery life in mobile device is critical in continuously sensing system, therefore an energy-efficient framework is essential.

Related Work

- Energy comparison between 3 WBAN functions, 3 languages and 3 models

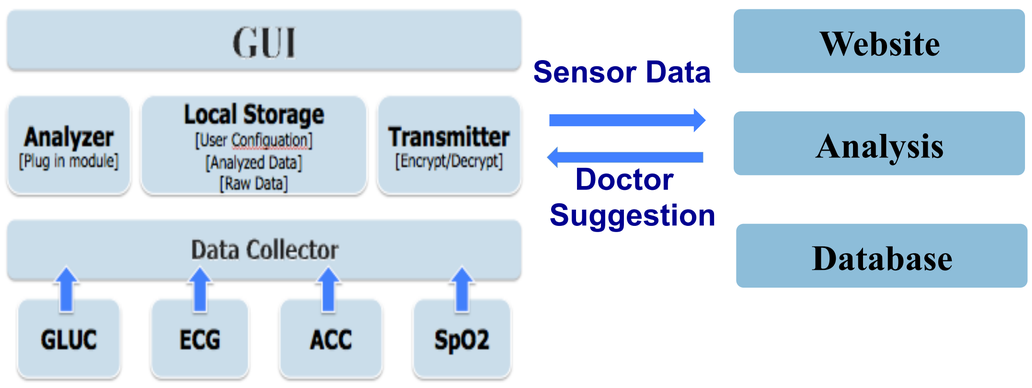


QDA: QRS Detection, AES: Encryption, ZIP: 10 min data (180KB)

- PyS60 Energy >> J2ME > C++

  This difference is due to runtime environment overheads and memory management.

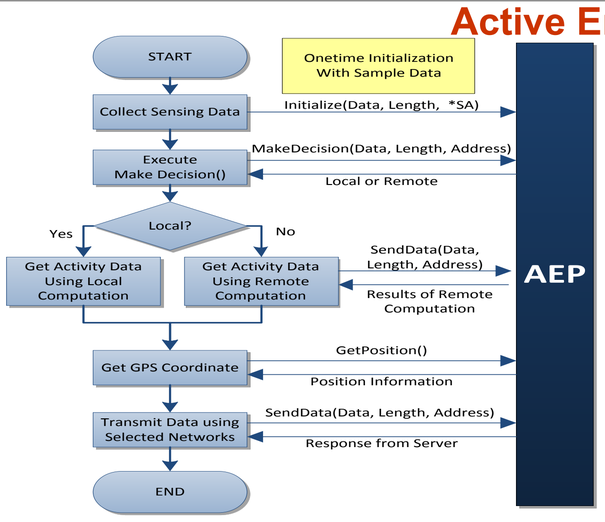
System Architecture



•Data collector aggregates different types of data into a single record. Local storage stores user configuration, analyzed data and raw data in the external storage.

• Some analysis are done on phone while some analysis are sent to the remote server to save battery life. After the analysis is done on server side, online doctor suggestion are sent back to the mobile client.

Active Energy API



- Provide a set of API for designers to obtain system services at the lowest energy cost, such as GPS, data transmission
- API automatically selects the best implementation
- Implementation relies on Active Energy Profiling framework

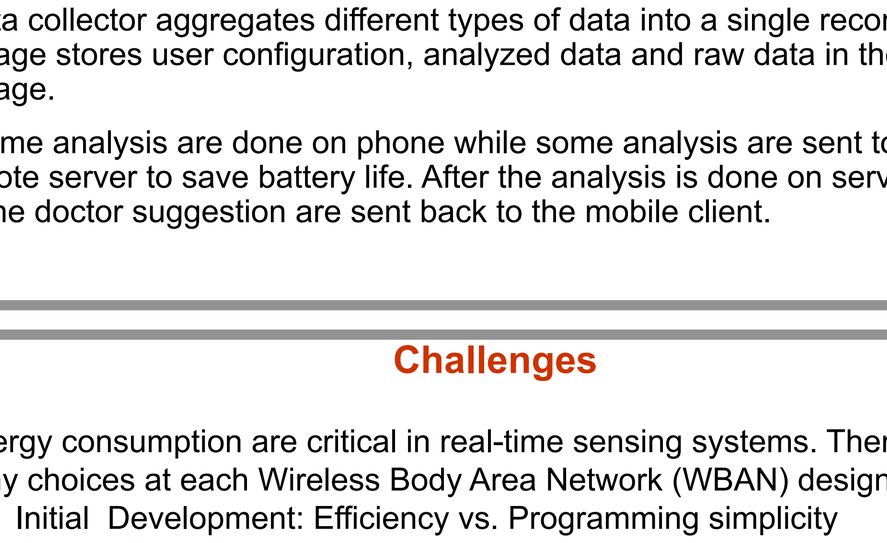
Challenges

•Energy consumption are critical in real-time sensing systems. There are many choices at each Wireless Body Area Network (WBAN) design stage.

- Initial Development: Efficiency vs. Programming simplicity
- Sense: Sampling rate vs. accuracy
- Transmit: Signal quality vs. decoding complexity & encryption
- Local computation vs. remote computation.

•Each choice has dramatic impact on power consumption, however designer has little knowledge of the energy impact of their choice.

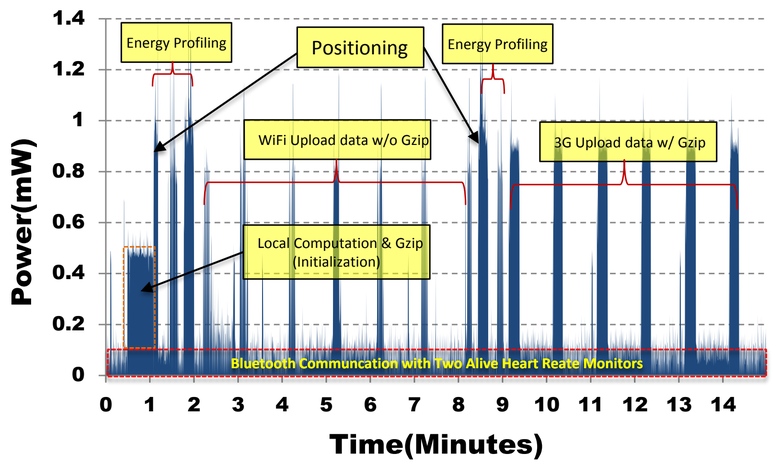
- Energy impact varies dynamically
  - Signal quality for data transmissioin, Indoor / Outdoor GPS, Compression factors.



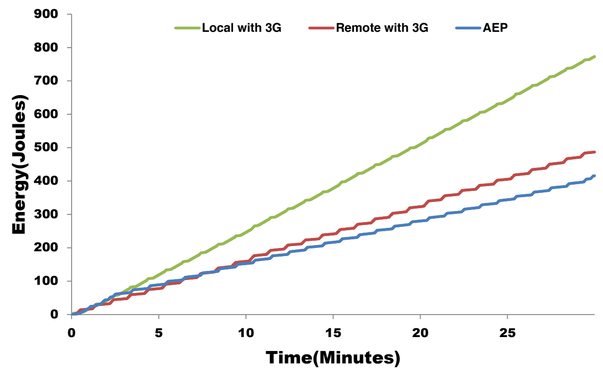
- Dramatic battery drain reduces 200 hours standby to 5 hours. Even without external sensors the in-built sensors also drain battery.

Experiments

- Runtime energy profiling using active energy API



- Results from Active Energy API (AEP)
- AEP has a shallow slope
  - Energy savings increase with time.
- After 30 minutes
  - Local: 773 Joules
  - Remote: 487
  - AEP: 416 Joules



Conclusion

- Energy efficiency must be dealt with in all aspects of the WBAN design, selecting from programming language to sensor sampling rate. Energy efficiency also plays major role in robustness.
- An Active Energy API is developed to automatically select the optimized implementation. Experiment shows that around 2X battery improvement is obtained.

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