Digitalization of Water Desalination System

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Introduction

Water is one of life's essential necessities. As such, not all sources of water are viable for consumption and require treatment to remove impurities. In California, the drought has become an important issue due to declines in surface water sources.. [1] Therefore, use of recycled water is necessary. The DROWT project aims to develop a new approach for wastewater treatment using reverse osmosis to physically remove impurities from the water with no carbon footprint.

Figure 1: Version 1 and Version 2 side-by-side size comparison

Objective

The main objective of this project is to digitize a control system of all the sensors used in a water decentralized system which is called DROWT. All of the sensors are controlled through a device such as a tablet or an Ipad which is connected to a server via wifi and at the same instant the data acquisition system (MyRio) which is attached to the system is connected to the server. This allows the user to be able to track the behaviour of water treatment system from any place.

Specification

- Processor speed……...667 MHz Core (2)
- Nonvolatile memory……. 512 MB
- Outdoor range…….Up to 150 m (line of sight)
- Analog Input/Output Resolution 12 bits
- How to connect both systems to server:

Arduino + WiFi Shield → Blynk Server → Blynk app

System Configuration

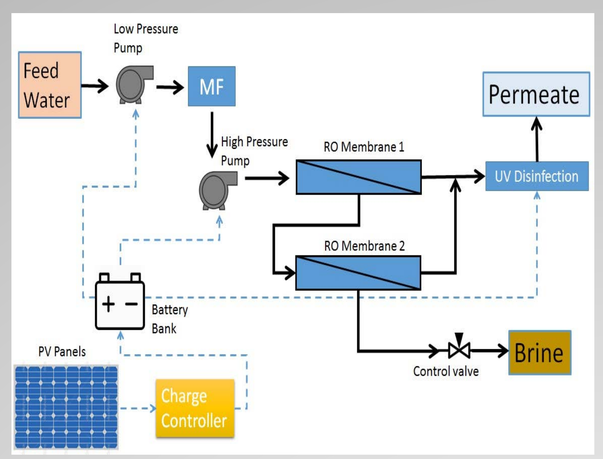

Figure 2: Version 1 Schematic

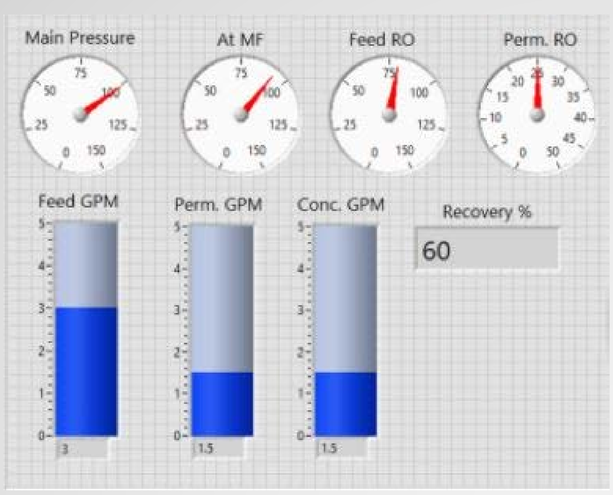

Figure 3: LabVIEW control system screen

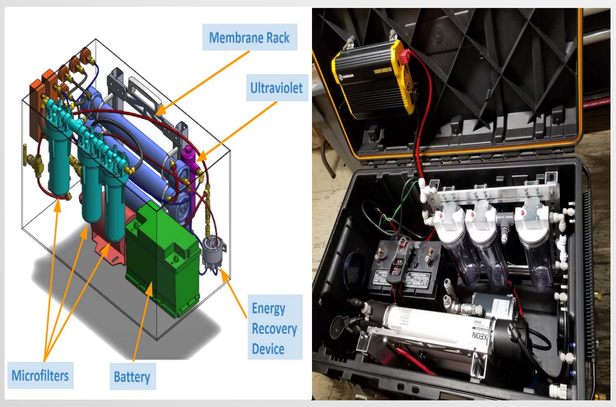

Figure 4: Version 2 Design and Build

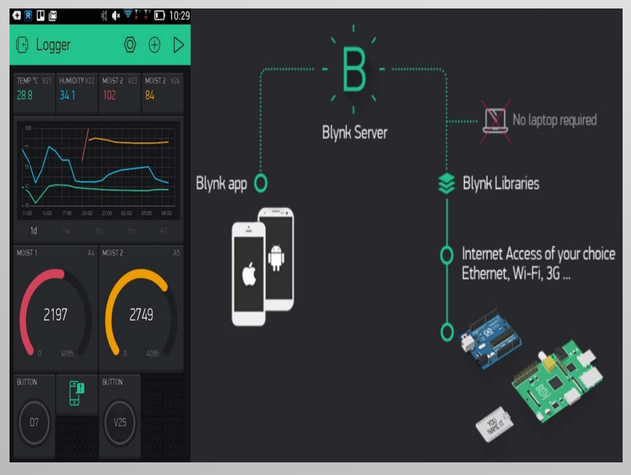

Figure 5: Processes of connecting to server

Results

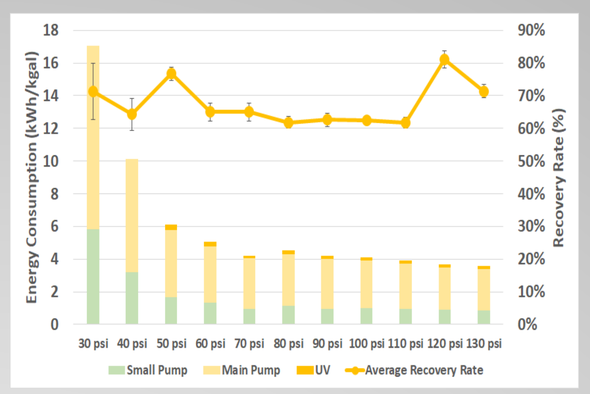

Figure 6: Version 1 - Energy Consumption and Recovery Rate

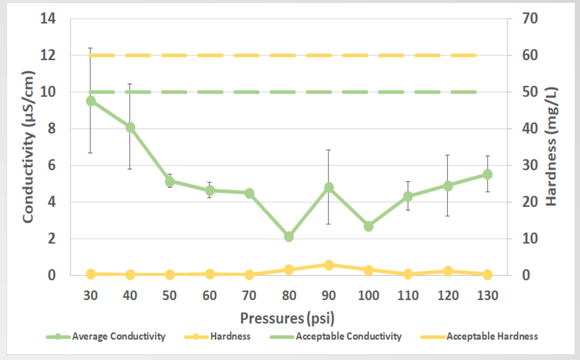

Figure 7: Conductivity and Hardness of Version 1 Permeate

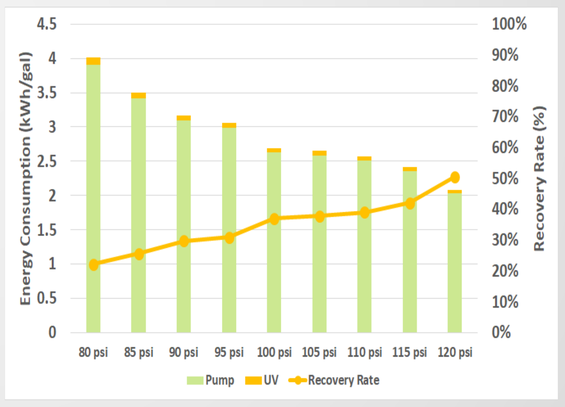

Figure 8: Version 2 - Energy Consumption and Recovery Rate

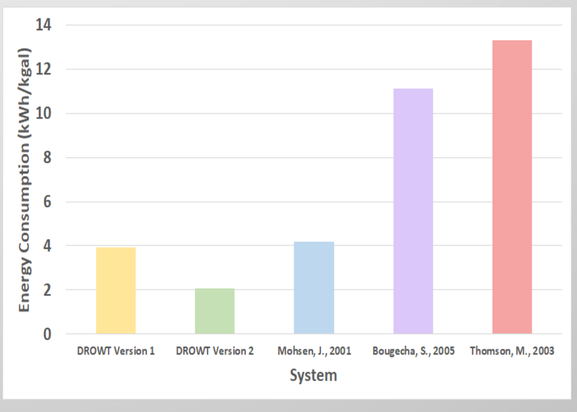

Figure 9: Energy Consumption Comparison With Other Existing Projects [5][6]

Challenges

- There were a lot of synchronization between the various sensors such as pressure transducers, flowmeters, and current sensor which were sort of obstacles at the beginning of the project but it came out as it was expected after a while.
- In addition, setting up the control system on LabVIEW required a lot of research to pick a proper data acquisition system that can elaborate data with the current sensors within the given bites.
- Accomodating a system that can be connected to a server and allow a user to not only observe the behaviour but also be able to control it was a challenge.

Conclusion

The most critical part of this functioning system was to add a digitalized system to illustrate the instantaneous progress of the system and detect any malfunctioning by using various sensors such as pressure sensor, flowmeter, current sensor, and water leak detector. This control system can open the doors for DROWT to be marketed to everyone's house to save more water in California and produce 90 gallons per day.

Acknowledgments

I would also like to show my gratitude to my mentor, who clarified a lot of ambiguous obstacles that I encountered during the project, Dr. Lakeh is one of the most helpful professors that I had during my college education. I want to appreciate his support for helping me to build a decent control system.

References

1.Moran, T., et al. "Understanding California's Groundwater." Water in the West, waterinthewest.stanford.edu/groundwater/overdraft/.
2.Thomson, M., Miranda, M. S., & Infield, D. (2003). A small-scale seawater reverse-osmosis system with excellent energy efficiency over a wide operating range. Desalination, 153(1–3), 229–236.
3.Voutchkov, N. (2013). Desalination engineering: Planning and design. Maidenhead: McGraw-Hill.
4.Hourlier, F., et al. (2010). Formulation of synthetic greywater as an evaluation tool for wastewater recycling technologies. Environmental Technology, 31(2), 215–223.
5.Mohsen, M. S., & Jaber, J. O. (2001). A photovoltaic-powered system for water desalination. Desalination, 138(1–3), 129–136.
6.Bouguecha, S., et al. (2005). Small scale desalination pilots powered by renewable energy sources: Case studies. Desalination, 183(1–3), 151–165.