AquaMAN: Aquafarming Management Analysis Network

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Introduction

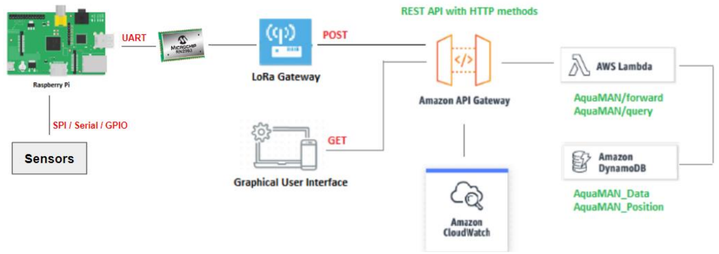
Global harvest of aquatic species through aquafarming has shown increased popularity. The key to maintain high production rate and efficient use of resource is to provide an controlled and optimal environment. AquaMAN is an automated IoT solution for aquafarming using Long Range (LoRa) technology.

Data Acquisition

All the sensors are interfaced with Raspberry Pi 3. Communication protocols include SPI, Serial, and direct GPIO.

- **Temperature** - DS18B20 temperature sensor (GPIO)
- **pH level** - PH0-14 value detect sensor module and pH electrode probe BNC (SPI)
- **Total dissolved solid** - TDS meter probe (SPI)
- **Video -** 5MP OV5647 Sensor (CSI-2)

System Overview



Data Processing

RN2903 module is a Class A LoRa device and have strict data rate limitation. It has maximum data rate of 4 which corresponds to Spreading Factor 8, 12.5k bps, and maximum payload size of 242 bytes. The captured frames are reduced to several coordinates prior transmitting to LoRa gateway.

- **RGB to HSV**

$$H = \begin{cases} 0^\circ & \Delta = 0 \\ 60^\circ \times \left(\frac{G'-B'}{\Delta} mod 6\right) & , C_{max} = R' \\ 60^\circ \times \left(\frac{B'-R'}{\Delta} + 2\right) & , C_{max} = G' \\ 60^\circ \times \left(\frac{R'-G'}{\Delta} + 4\right) & , C_{max} = B' \end{cases}$$

$$S = \begin{cases} 0 & , C_{max} = 0 \\ \frac{\Delta}{C_{max}} & , C_{max} \neq 0 \end{cases}$$

$$V = Cmax$$

- **Masking –**

$$Lower\ bound\ HSV \leq Image \leq Higher\ bound\ HSV$$

- **K-Means –**

$$S_i^{(t)} = \{x_p : \left\| x_p - m_i^{(t)} \right\|^2 \leq \left\| x_p - m_j^{(t)} \right\|^2 \ \forall j, 1 \leq j \leq k$$

$$m_i^{(i+1)} = \frac{1}{|S_i^{(t)}|} \sum_{x_j \in S_i^{(t)}} x_j$$

The centroids from the k-means algorithm can be used to represent the observed targets position.

- **Frames Concatenation –**

Positions	TDS	Temp	pH
(2 * # of targets * # of frames) Bits	12	8 (Bits)	12

The rate of transmission can be reduce by concatenating several frames along with all other sensor data into a single payload.

Random port (63-71) is selected for each transmission.

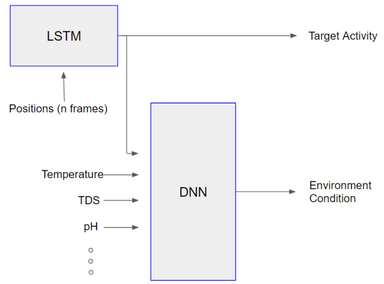
Data Storage and Retrieval

Data forwarded from LoRa gateway to AWS Dynamodb and queries are handled by AWS API Gateway. A RESTful API with HTTP method is utilized and logics are stored in AWS Lambda.

ttl	Position	TDS	Temperature	pH
1605661081	02001F04007E0270A202401F03E07F03...	214	70	7.36
1605661069	01A013087008070A101100F090008051...	214	70	6.77
1605661044	09E00D01E01809C026062018018015091...	215	70	7.7
1605661019	05805F0130180330 0E05305501601905...	215	70	7.19
1605661032	04C03D024027056018033026022017070...	214	70	6.91
1605661007	06309B00B00D02101D06409B01E01A0...	215	70	7.16
1605660982	0670960110 1A0210 2E0690950160 1B02...	215	70	6.74
1605660994	06809701D01D024004068098023047020...	215	70	7.25
1605661056	07301502302000A707108201A026026098...	215	70	7.53

Data Analysis

- **Target Activity** – use LSTM RNN to predict target behavior as a classification problem
- **Environment Condition** – use DNN to estimate the environment condition as a regression problem.



Real Time Monitoring GUI