WIRELESS MONITORING AND ARIMA STREAM ANALYTICS SYSTEM FOR FRESHWATER LOBSTER FARM

NUR SYAHIRAH BINTI MOHD SABLI

MASTER OF SCIENCE

UNIVERSITI MALAYSIA PAHANG

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.

(Supervisor's Signature)

Full Name : PROF IR DR MOHD FAIZAL B JAMLOS

Position : PROFESSOR

Date : 7/12/2021

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

(Student's Signature)

Full Name : NUR SYAHIRAH BINTI MOHD SABLI

ID Number : MMH 19003

Date : 7/12/2021

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NUR SYAHIRAH BINTI MOHD SABLI

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ABSTRAK

Majoriti penduduk bergantung secara langsung atau tidak langsung kepada akuakultur. Perkembangan teknologi terkini memberi kesan besar kepada akuakultur. Di antara krustasean spesies di Malaysia, spesies Cherax Quadricarinatus atau juga dikenali sebagai lobster air tawar telah menjadi kegemaran para petani untuk membiakkannya. Pemantauan kualiti air telah menjadi masalah bagi penternak kerana ramalan mengenai kualiti air diperhatikan melalui pengalaman. Dalam penyelidikan ini integrasi IoT dengan ramalan untuk udang air tawar dikembangkan untuk melakukan ramalan berdasarkan data masa nyata. Sistem IoT ini terdiri daripada pelbagai sensor seperti Kekonduksian Elektrik (EC), jumlah pepejal terlarut (TDS), Oksigen Terlarut (DO), pH, suhu dan kelembapan disatukan ke Arduino untuk mengesan dan menghantar data sebagai unit simpul akhir *End Node Unit (ENU).* Untuk memastikan kebolehpercayaan data yang dikumpul, penderia telah ditentukur dengan merujuk kepada lembaran data pembuatan yang menyumbang kepada jumlah 25,920 data yang dikumpul dari Ogos 2020 hingga Januari 2021. Data tersebut dihantar secara wayarles *daripada End Node Unit (ENU)* dan diterima melalui get laluan dan berkas data ini telah dimuat naik secara selari ke *Cayenne Cloud* melalui protokol *MQ Telemetry Transport (MQTT)* dan disimpan dalam pangkalan data dalam pelayan melalui Wi-Fi. Data masa nyata *ENU* dalam *Structured Query Language* (SQL) dipaparkan di laman web dengan sengaja untuk pemantauan jarak jauh. Pergumpulan data masa nyata dari *ENU* disalurkan melalui *SQL* terus ke R Studio dan ramalan *ARIMA* dilakukan pada jadual pertanyaan. 70% daripada pertanyaan data masa nyata aliran ini diambil sebagai set data latihan sementara 30% lagi diambil sebagai set data pengujian. Fungsi Auto.*ARIMA* diterapkan dalam kumpulan data streaming dari *SQL* kerana secara automatik memilih model *ARIMA* berdasarkan pola set data. *ARIMA* dalam projek ini ditetapkan untuk meramalkan 24 jam sambil mengemas kini masa nyata dan grafik ramalan ditetapkan menjadi satu jam. Pembangunan laman web mesra pengguna menjadikan pemantauan masa nyata kualiti air di tangki udang kara menjadi lebih mudah. Laman web boleh dibuka di kedua-dua peranti penyemak imbas dan android. Pemberitahuan perubahan tahap parameter dalam tangki lobster dapat dilakukan melalui SMS sehingga membantu petani untuk melakukan kawalan jauh. Untuk *DO*, ketepatan ARIMA, *NNetAR* dan *Naïve Bayes* hampir sama dengan ketepatan yang diperoleh berada dalam julat 95% hingga 99%. Untuk pH, ARIMA berada dalam julat 95% hingga 100% sementara ramalan *Naïve Bayes* 89% hingga 95% dan julat ramalan *NNetAR* antara 85% hingga 95% sementara untuk EC, *NNetAR* dan *Naïve Bayes* menunjukkan bahawa nilai ramalan kedua model ini tidak tepat 10% hingga 15% berbanding *error* ARIMA iaitu bawah 5%. Keberkesanan model sistem ini adalah berkadar 92.8%.

ABSTRACT

Majority of the population are directly or indirectly dependent on aquaculture. Recent development in technology has a great impact on aquaculture. Among the crustacean breeds in Malaysia, Cherax Quadricarinatus species or also known as freshwater lobster has become favourable for farmers to breed them. Water quality monitoring has become a problem to farmers as predictions on water quality were observed conventionally through experience. In this research integration of IoT with forecasting for the freshwater lobsters were developed to do predictions based on real-time data. This IoT system consist of variety of sensors such as Electrical Conductivity (EC), Total dissolved Solid (TDS), Dissolve Oxygen (DO), potential of Hydrogen (pH), temperature and humidity were integrated to Arduino for sensing and transmitting data as End Node Unit. To ensure the reliability of collected data, the sensors have been calibrated with reference to manufacturing datasheet which contribute to the total of 25,920 data collected from August 2020 until January 2021. Those data were transmitted wirelessly from End Node Unit (ENU) and received by gateway and this bundle of data were parallelly uploaded to Cayenne Cloud via MQ Telemetry Transport (MQTT) protocol and saved in database in server through Wi-Fi. The real-time data of ENU in Structured Query Language (SQL) was displayed on the website purposely for remote monitoring. The real-time data query from ENU is streamed through Structured Query Language (SQL) right into R Studio and Autoregressive Integrated Moving Average (ARIMA) predictions were done on the query table. 70% of this stream real-time data query were taken as training dataset meanwhile another 30% were taken as testing dataset. Auto.arima functions are applied in the streaming dataset from SQL as it automatically chooses ARIMA models based on the pattern of the dataset. ARIMA models in this thesis were set to predict 24 hours while updating the real-time and prediction graph were set to one hour which monitored through the developed website. Moreover, the changes of parameter level in lobster's tank can be notified through SMS in order to help the farmers to do remote monitoring. For DO, ARIMA, Neural Network Autoregressive (NNetAR) and Naïve Bayes accuracy on average are almost similar, with accuracy obtained in the range of 95% to 99%. For pH, ARIMA prediction are in the range of 95 % to 100 % while Naïve Bayes prediction range 89 % to 95 % and NNetAR prediction range are between 85 % to 95 % while for EC, NNetAR and Naïve Bayes indicate that prediction error of these two models are inaccurate by range 10% to 15% compared to error by ARIMA which is below 5%. In conclusion, ARIMA analytics does provide accurate predictions for monitoring water quality in freshwater lobster farms. The efficiency of this system has been proven with a 92.8% mortality rate.

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