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Harbor Crane Demonstrator - Quant Data Analysis

EDGE PROJECT
FINAL REPORT
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Krishna Mishra

Doctoral Researcher

ATME/TAU

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EDGE PROJECT
Harbor Crane Demonstrator

- Demonstrator target was a RMG crane in Rauma Harbor.
- Quant Sataservice Oy defined the goals for the demonstrator.
- The goals were:
  - Develop analytics to support the service and predictive maintenance of crane.
  - Develop analytics for estimation of remaining lifetime for electric motors, bearings, brakes and ropes.
  - Utilize the already existing measurement system in the crane, connected to ABB frequency converter.
- There were 16 electric motors in the crane for lifts and movements, and total of 75 measurement channels available for the development of analytics.

- The main research approach was the prediction of electric current needed for motors based on load and lifting/moving speed. Other considered parameters included load balancing on portal, trolley and gantry, and environmental variables, such as wind speed.

- Meluta Oy carried out a parallel development project for this demonstrator. That work is not included in this presentation.

- *Note: The demonstrator company Quant AB left the EDGE project due to strategic reasons in July 2020. Due to this the demonstrator was not completed as planned.*
  In this presentation we indicate only the planned research approach and methods, and list challenges related to the available data and analysis.

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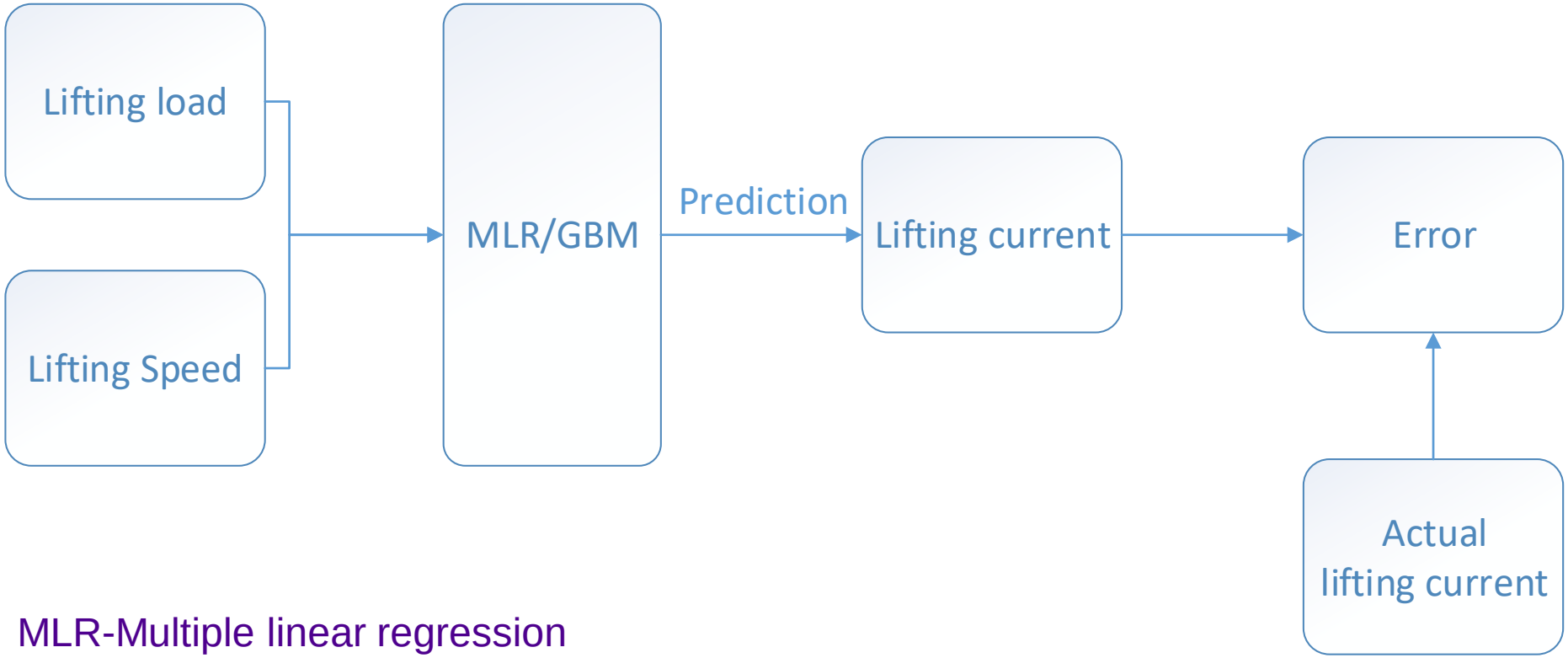
Research Approach



MLR-Multiple linear regression
GBM-Gradient Boosting machine

Results

	GBM	MLR
R-squared	0.96	0.09
RMSE	0.66	2.95

The most common interpretation of r-squared is how well the regression model fits the observed data. In this case, an r-squared of 96% with GBM model reveals that 96% of the data fit the regression model. Generally, **a higher r-squared indicates a better fit for the model.**

The Root Mean Square Error (RMSE) is the square root of the variance of the residuals. It indicates the absolute fit of the model to the data–how close the observed data points are to the model's predicted values. Whereas R-squared is a relative measure of fit, RMSE is an absolute measure of fit. **Lower values of RMSE indicate better fit.**

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Results-Prediction (GBM vs MLR)

Lifting current	GBM	MLR
14.57193	13.43466	13.01151
14.86909	14.83406	12.66294
14.83519	14.83725	13.42629
14.84074	14.83725	13.91025
14.85741	14.83725	12.87737

In this case, we can see that GBM has predicted much closer values of the current as compared to the lifting current original values.

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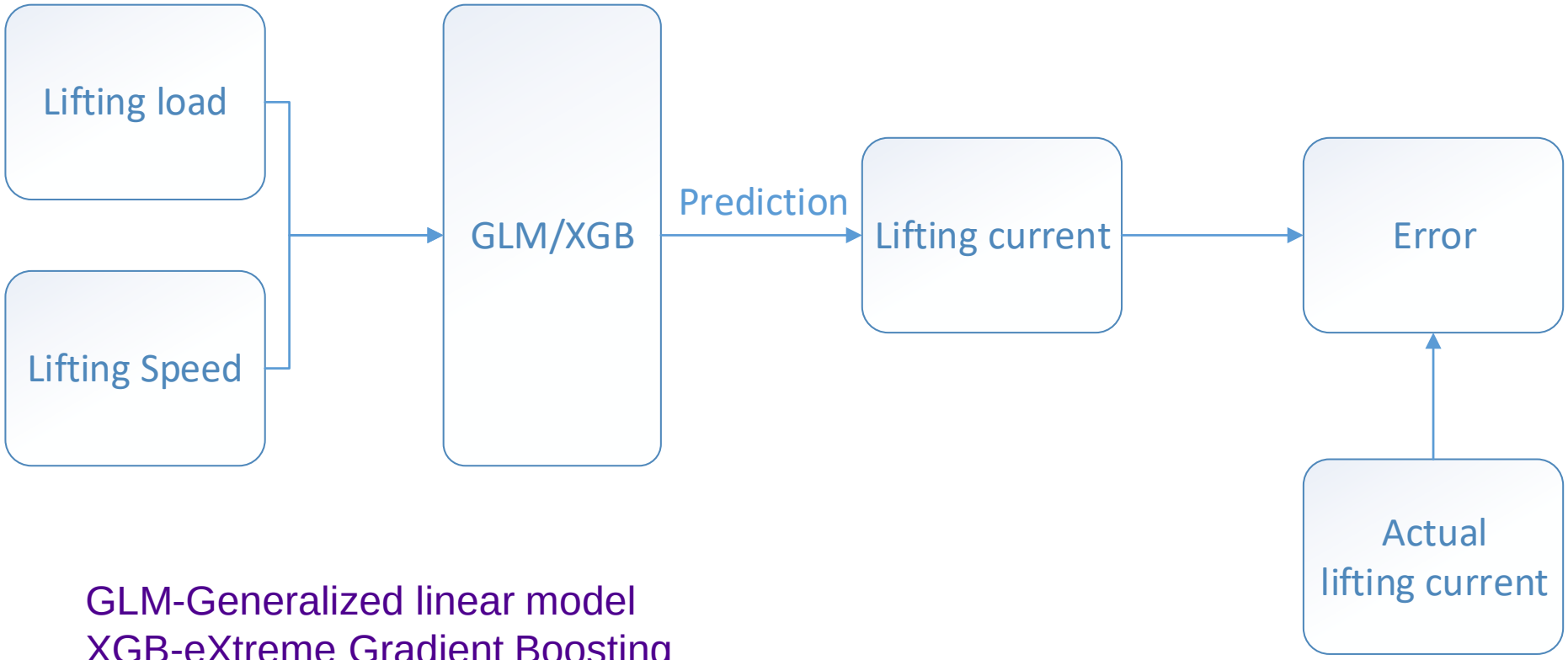
Research Approach



GLM-Generalized linear model
XGB-eXtreme Gradient Boosting

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Results

	XGB	GLM
R-squared	0.92	0.10
RMSE	0.80	2.95

The most common interpretation of r-squared is how well the regression model fits the observed data. In this case, an r-squared of 92% with XGB model reveals that 92% of the data fit the regression model. Generally, **a higher r-squared indicates a better fit for the model.**
The Root Mean Square Error (RMSE) is the square root of the variance of the residuals. It indicates the absolute fit of the model to the data–how close the observed data points are to the model's predicted values. Whereas R-squared is a relative measure of fit, RMSE is an absolute measure of fit. **Lower values of RMSE indicate better fit.**

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Results-Prediction (XGB vs GLM)

Lifting current	XGB	GLM
14.57193	13.27705	12.03758
14.86909	14.81296	12.86078
14.83519	14.77577	13.34326
14.84074	14.75431	13.28275
14.85741	14.74924	13.43261

In this case, we can see that XGB has predicted much closer values of the current as compared to the lifting current original values.

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Challenges

- Feature Selection: Relevant feature selection have been done out of more than 90 features present in the data, which requires domain knowledge.
- Averaged measured values: The data output rate from frequency converter was only 1 Hz.
- Missing Values: There are many missing values present in the data, which have been removed before analysis.
- Unstructured Data: No label information present e.g. healthy and faulty data.
- Machine Learning Compatibility: Data pre-processing required before using machine learning.
- Algorithms: Regression/ classification algorithms.
- Data pre-processing: Feature selection, missing values removal and other data pre-processing techniques required.
- False positives: In classification problems false positives need to be reduced.