Conveyor Performance based on Motor DC 12 Volt Eg-530ad-2f using K-Means Clustering

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Abstract. To produce goods in industry, a controlled tool to improve production is required. Separation process has become a part of production process. Separation process is carried out based on certain criteria to get optimum result. By knowing the characteristics performance of a controlled tools in separation process the optimum results is also possible to be obtained. Clustering analysis is popular method for clustering data into smaller segments. Clustering analysis is useful to divide a group of object into a k-group in which the member value of the group is homogeny or similar. Similarity in the group is set based on certain criteria. The work in this paper based on K-Means method to conduct clustering of loading in the performance of a conveyor driven by a dc motor 12 volt eg-530-2f. This technique gives a complete clustering data for a prototype of conveyor driven by dc motor to separate goods in term of height. The parameters involved are voltage, current, time of travelling. These parameters give two clusters namely optimal cluster with center of cluster 10.50 volt, 0.3 Ampere, 10.58 second, and unoptimal cluster with center of cluster 10.88 volt, 0.28 Ampere and 40.43 second.

Keywords: optimization, clustering, k-means.

1. Introduction
Separation process has become a part of production process. Separation process is carried out based on certain criteria to get optimum result. By knowing the characteristics performance of a controlled tools in separation process the optimum results is also possible to be obtained. Clustering analysis is popular method for clustering data into smaller segments. Clustering analysis is useful to divide a group of object into a k-group in which the member value of the group is homogeny. Homogeneity in the group is set based on certain criteria.

The work in this paper based on K-Means method to conduct clustering of loading in the performance of a conveyor driven by a direct current motor 12 volt eg-530-2f. The prototype system separation is controlled by using Omron PLC CPM1A for separating cube height of 2 cm and 5 cm running on a conveyor driven 12 V<sub>dc</sub> motor. The problems in this work can be defined is how the K-Means clustering method can optimize the loading on the performance of the conveyor 12volt dc motor-530ad-2f eg on a prototype system based on the height as separator items.

2. Workload Conveyors
Prototype system is separation equipment based on this height, using a base control PLC Omron Sysmac CPM1A with 30 Input–Output (I/O). Power Supply 12 V<sub>dc</sub> is used to give electric supply to all motors, relays and sensors. All buttons on the prototype is connected to a PLC by using relay.
The function of this prototype to separate the goods is in cube form. The cube has a height difference. For the height of 2.5 cm, it is called short body and a height of 5 cm high, it is called objects. All the cubes have the same length and width in 5 cm. Based on the loading of data acquisition, measurements are carried out in the term of parameters of voltage, current and time.

3. Research Methodology
Stages of the research is started by collecting data on the results of the loading conveyor system. The next stage is data calculation by using the K-Means clustering method. Analysis is carried out on the results of calculation loading data to get optimal performance of conveyor.

First step in this work is collecting loading data conveyors. The second is determining the method optimization loading data on performance of conveyor. In this case employed researchers are using K-means clustering. The pre-processing or the integration of data is carried out and it is followed by data processing and testing to get optimization analysis of K-means loaded data for the performance of conveyor. The stage of evaluation of the test results is also conducted. If the desired results are not obtained, then the data is returned to the stage of processing the data. If the data evaluation of test results is in accordance with the desired result, then the conclusion is drawn.

3.1. K-Means
Data Clustering is one method of Data Mining that is without direction. Clustering is a technique in data mining is used to enter data into a corresponding group without a deep knowledge of the group. There are two types of data clustering often used in the process of grouping data. Those are is hierarchical and non-hierarchical data clustering. This method of partitioning makes the data into clusters or groups so that the data with the same characteristics are grouped into the same cluster and data with different characteristics are grouped into another group [1-3].

On Clustering algorithms, the data load will be grouped into clusters based on the similarity of the data. Clustering is the principle of maximizing the similarity between members of the cluster and minimizes the similarity between members of different clusters. K-Means algorithm is a non-hierarchical clustering method based on the distance that divides the data into clusters and this algorithm works on numerical attributes. At the initial stage, the K-Means algorithm randomly selects k pieces of data as a centroid. The distance between the data and the centroid are computed using the Euclidean distance. Data placed in the nearby clusters, is calculated from the midpoint of the cluster. Centroid will be determined when all the data has been placed in the nearby clusters. The process of determining the centroid and placement of data in the cluster is repeated until the value of convergent centroid. Convergent is obtained when the centroid of the entire clusters do not change anymore. Distance Space is the process of calculating the distance between points with another point. Distance space used is Euclidean distance i.e. finding the shortest distance between the centroid point data or objects. Data that has a short distance or closest to the centroid will form a cluster [1, 4-6].

$$d_{\text{Euclidean}}(i,j) = \sqrt{(x_{i1}-x_{j1})^2 + (x_{i2}-x_{j2})^2 + \ldots + (x_{in}-x_{jn})^2}$$  \hspace{1cm} (1)

where \(d_{ij}\) is the distance between \(i^{\text{th}}\) and \(j^{\text{th}}\) data, \(x_{i1}\) is the first attribute value of the \(i^{\text{th}}\) data, \(x_{j1}\) is the first attribute value of the \(j^{\text{th}}\) data, and \(n\) is the number of attributes.

K-Means algorithm basically conducts two processes i.e. clustering the centre location detection process and the process of finding members of each cluster.

$$C_k = \frac{1}{n_k} \sum d_i$$ \hspace{1cm} (2)

where \(n_k\) is the amount of objects in cluster-k and \(d_i\) is the \(i^{\text{th}}\) object of cluster-k.

4. Result and Discussion
The test results on optimization performance of loading data conveyor driven by 12 volt dc motors eg-530ad-2f. By using the method of K-means clustering, data that has been prepared in data loading conveyor. Starting voltage, current and time will be integrated into one table. Data indicated loading data integration results are presented in V for voltage in Volt, I in current for Ampere) and t for time in second.

Table 1. Data integration imposition

| No | V (Volt) | I (Ampere) | t (second) |
|----|---------|------------|------------|
| 1  | 11.60   | 0.17       | 27.00      |
| 2  | 10.90   | 0.25       | 10.00      |
| 3  | 11.60   | 0.17       | 27.00      |
| 4  | 10.90   | 0.25       | 10.00      |
| 5  | 10.60   | 0.33       | 45.00      |
| 6  | 11.20   | 0.35       | 30.00      |
| 7  | 10.10   | 0.34       | 10.00      |
| 8  | 11.00   | 0.25       | 30.00      |
| 9  | 11.60   | 0.17       | 29.00      |
| 10 | 11.60   | 0.17       | 31.00      |
| ...| ...     | ...        | ...        |
| 84 | 10.90   | 0.28       | 35.00      |

Data processing optimization using the K-means clustering has been done through several stages. For K-Means stage 1, the determination of the centre of the centroid is done by taking three pieces of data from the original data with reference to Equation (1) and (2) to produce a new centroid. The K-Means stage 2 determining the center of the centroid is done by taking the data from the new first centroid, new second centroid and new third centroid on first stage K-means clustering and it refers to equations (1) and (2). K-means clustering processing process stops on second stage of cluster and yields optimal and not optimal condition by taking 10 data K-means to end result. Each member of the cluster has a characteristic resemblance as it is seen in Table 2.

Table 2. Result of Optimization cluster K-Means final stage

| No | V (Volt) | I (Ampere) | t (second) | Note   |
|----|---------|------------|------------|--------|
| 1  | 10.90   | 0.25       | 10.00      | OPTIMAL|
| 2  | 10.10   | 0.34       | 10.00      | OPTIMAL|
| 3  | 10.90   | 0.25       | 10.00      | OPTIMAL|
| 4  | 10.10   | 0.34       | 10.00      | OPTIMAL|
| 5  | 10.90   | 0.25       | 10.00      | OPTIMAL|
| 6  | 10.10   | 0.34       | 10.00      | OPTIMAL|
| 7  | 10.90   | 0.26       | 10.00      | OPTIMAL|
| 8  | 10.10   | 0.35       | 11.00      | OPTIMAL|
| 9  | 10.89   | 0.27       | 12.00      | OPTIMAL|
| 10 | 10.09   | 0.37       | 12.00      | OPTIMAL|
| ...| ...     | ...        | ...        | ...    |
| 24 | 10.09   | 0.37       | 12.00      | OPTIMAL|

| No | V (Volt) | I (Ampere) | t (second) | Note   |
|----|---------|------------|------------|--------|
| 1  | 11.60   | 0.17       | 27.00      | NOT OPTIMAL|
| 2  | 10.60   | 0.32       | 40.00      | NOT OPTIMAL|
| 3  | 11.20   | 0.35       | 30.00      | NOT OPTIMAL|
| 4  | 11.00   | 0.25       | 30.00      | NOT OPTIMAL|
| 5  | 11.00   | 0.25       | 30.00      | NOT OPTIMAL|
| 6  | 10.60   | 0.37       | 80.00      | NOT OPTIMAL|
| 7  | 10.99   | 0.28       | 35.00      | NOT OPTIMAL|
| 8  | 11.59   | 0.20       | 42.00      | NOT OPTIMAL|
| 9  | 10.99   | 0.28       | 35.00      | NOT OPTIMAL|
| 10 | 10.99   | 0.28       | 35.00      | NOT OPTIMAL|
| ...| ...     | ...        | ...        | ...    |
| 60 | 10.99   | 0.28       | 35.00      | NOT OPTIMAL|
The final result of optimization loading data on performance of the dc motor DC12 volt conveyors with method of K-means clustering is displayed in 3-dimensional maps of data clustering and it is classified by optimal and not optimal results with centroid position as it is shown in Figure 1.

![Figure 1. Optimization of loading 3D curve by the method of K-means clustering](image)

Optimization Vit K-Means indicates that the optimal cluster is in cluster 1 where centroid position right in the centre of cluster 1 and cluster 2 is not optimal. Finally on each cluster member that has the characteristics of similarity. This character is the same as groups of clusters as a result of optimizing loading data conveyor 12 volt dc motor.

5. Conclusion
The implementation of the K-Means method to optimize loading data on the performance of the conveyor 12volt dc motor-530ad-2f eg on prototype separator system can produce the goods grouping or clustering of data. Data with similar characteristics similar will be grouped into one cluster. The optimization loading data by using the K-Means clustering has analyzed 84 data. The used data is divided into two clusters that marked as optimal cluster for 24 data and non optimal cluster for 60 data. The optimal data with central cluster consists of 10.50 Volt, 0.30 Ampere, and travel time in 10.58 second. Non optimal cluster with central cluster consists of 10.88 Volt, current 0.28 Ampere, and travel time in 40.43 second.

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