Predictive maintenance in LED street lighting controlled with telemanagement system to improve current fault detection procedures using software tools.

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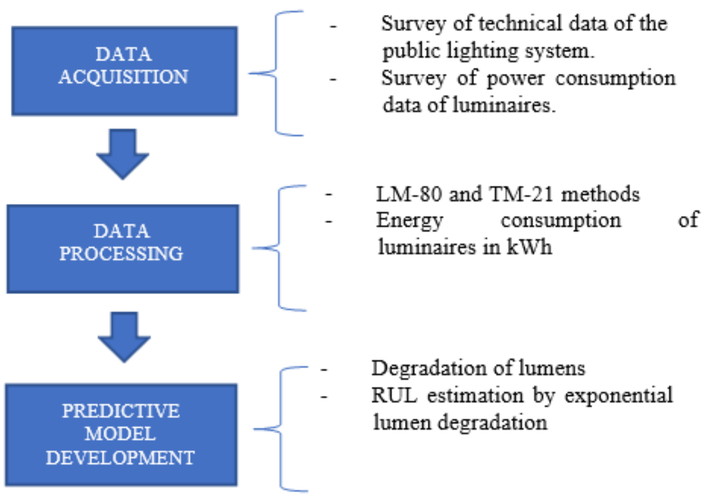
1. Introduction

Predicting the lifetime of LED light sources becomes quite challenging because the time to failure is long. The LM-80 and TM-21 methods are the main used by companies to establish the product lifetime. Accurate the RUL prediction can facilitate predictive maintenance. Predictive maintenance allows estimating when a failure will occur. In this context, the maintenance can be planned in advance, eliminating unplanned outage and maximizing the useful life of the equipment.

In this work, the LM-80 and TM-21 methods are used for the acquisition and extrapolation of luminous flux data, wich are entered into an algorithm developed from an exponential degradation model. With the result obtained, it is possible to establish actions that allow predictive maintenance in LED street lighting controlled by a remote management system and achieve a longer service life.

2. Methodology



2.1 Data acquisition.

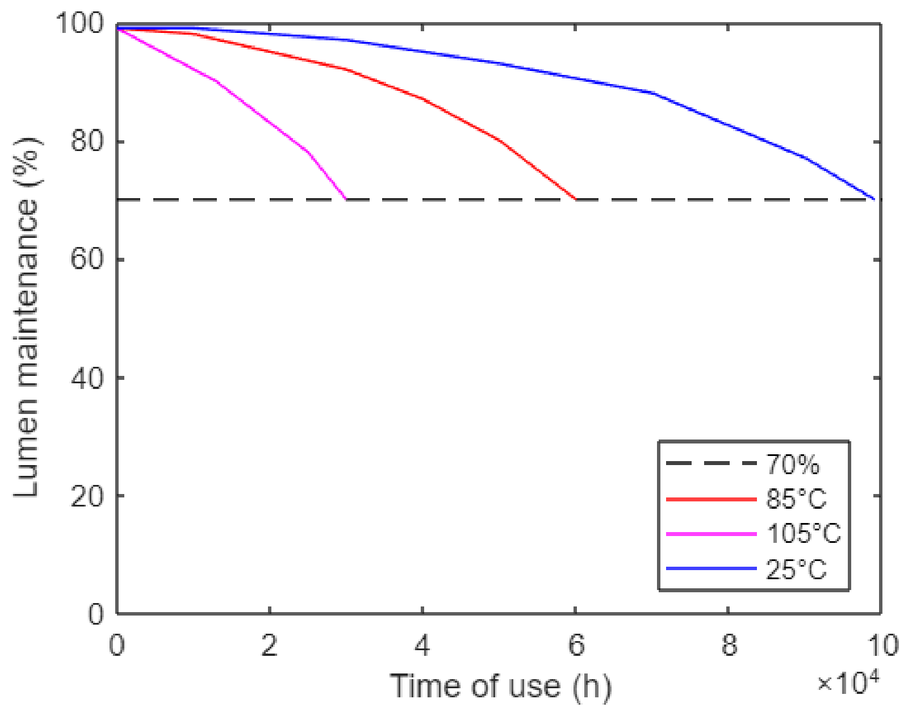
LM-80 Test Inputs

Description of LED Light Source Tested (manufacturer, model, catalog number)
RALED III 80 LEDs 210W Modulo FasFlex DAX LED CREE XPG3 18-P421-1

LM-80 Testing Details	
Total number of units tested per case temperature:	25
Number of failures:	0
Number of units measured:	25
Test duration (hours):	9072
Tested drive current (mA):	1050
Tested case temperature 1 (T_c, °C):	85
Tested case temperature 2 (T_c, °C):	105
Tested case temperature 3 (T_c, °C):	

Test Data for 85ºC Case Temperature		Test Data for 105ºC Case Temperature	
Time (hours)	Lumen Maintenance (%)	Time (hours)	Lumen Maintenance (%)
0	100.00%	0	100.00%
168	99.99%	168	99.37%
1008	99.72%	1008	98.28%
1512	99.54%	1512	97.69%
2016	99.32%	2016	97.41%
2520	99.23%	2520	97.15%
3024	99.13%	3024	96.98%
3528	98.93%	3528	96.69%
4032	98.74%	4032	96.40%
4536	98.68%	4536	96.35%
5040	98.69%	5040	96.19%
5544	98.69%	5544	96.24%
6048	98.73%	6048	95.87%
6552	98.57%		
7056	98.52%		
7560	98.39%		
8064	98.28%		
8568	98.42%		
9072	98.26%		

2.2 Data processing.



2.3 Predictive model development.

$$h(t) = \phi + \theta(t)e^{(\beta(t)+\xi(t)-\frac{\sigma^2}{2})}$$

```
mdl = exponentialDegradationModel('LifeTimeUnit',"TIEMPO");
fit(mdl,datos2,"TIEMPO","LUX")
mdl.Prior
threshold = 11;

N=height(datos1)
for t = 1:N
 update(mdl,datos1(t,:))
end
estRUL = predictRUL(mdl,threshold)
```

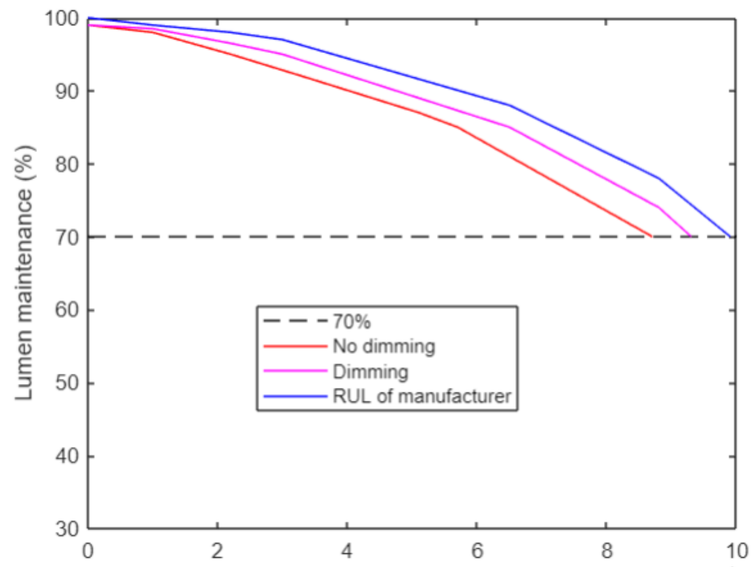
3. Results and Discussion

```
threshold = 11;

N=height(datos1)
for t = 1:N
 update(mdl,datos1(t,:))
end
estRUL = predictRUL(mdl,threshold)
```

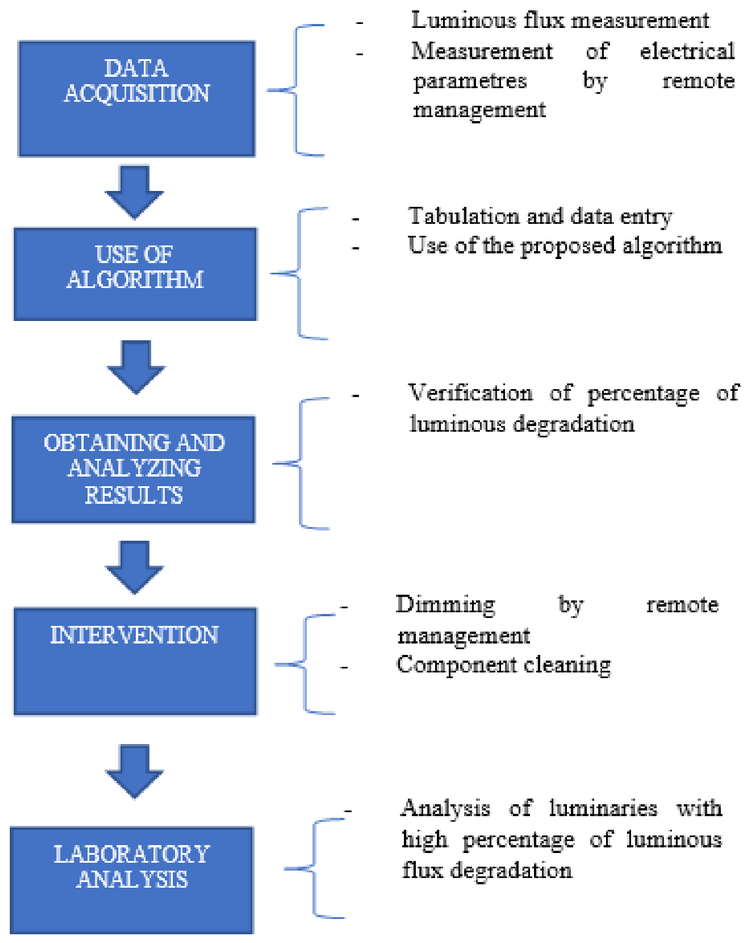
```
estRUL = 9.9381
```

Figure shows how this dimming technique can influences directly to the useful life of the luminaries, optimizing their performance and operation according to the needs. That is, if the dimming technique is applied, their useful life would only be reduced by approximately 6%.



4. Results analysis

To obtain accurate results using Matlab, an algorithm was developed with functions that are based on exponential degradation**.**
This formulation was used to calculate the lifetime of the luminaires from the data collected and entered into the algorithm. The result obtained with this algorithm helps to plan actions that help to maintain a long useful life before the equipment fails.



5. Conclutions

This paper has made it possible to establish specific tasks to carry out predictive maintenance using an algorithm designed in an engineering software, based on the degradation of lumens, and whose accuracy depends on the amount of historical data that are entered. Temperature and luminous flux were identified as the main variables that allow predicting the useful life of the luminaires. The control of power dimming by remote management is a key element to obtain a longer useful life of LED luminaires with this type of technology. With the results obtained, it is possible to establish actions that allow predictive maintenance of the LED street lighting system with remote management, and to achieve a longer useful life.