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CONICIDE WITH THE 16TH ARAB MAINTENANCE EXHIBITION

USING INTERNET OF THINGS TO OPTIMISE MAINTENANCE COSTS

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Agenda

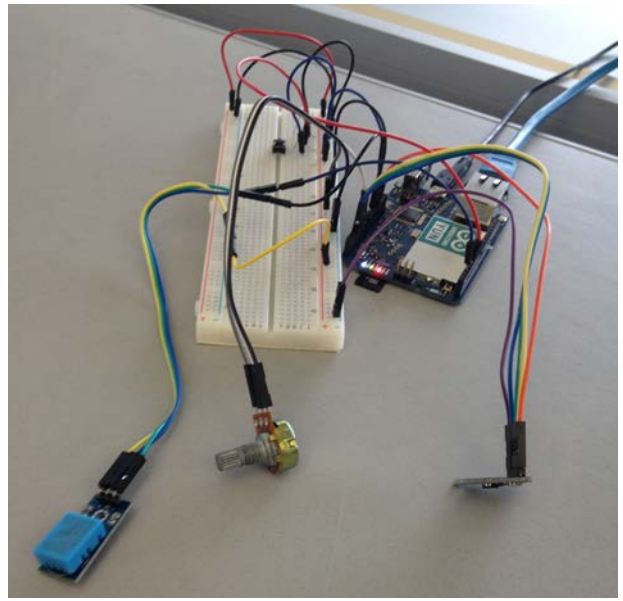
- Introduction
- Project overview
- Cost estimation framework
- Example application
- Concluding remarks

Introduction

- The challenge of the manufacturing sector is to avoid creating waste during maintenance delivery.
- The research aims to demonstrate that information technology can help reduce maintenance cost by evaluating the interlinkages between components.
- This is achieved by a framework developed that indicates the best time to change a component.

Project overview

The hardware part is used to acquire and send data to the Internet; the acquisition is done thanks to sensors connected to the Internet (IoT).

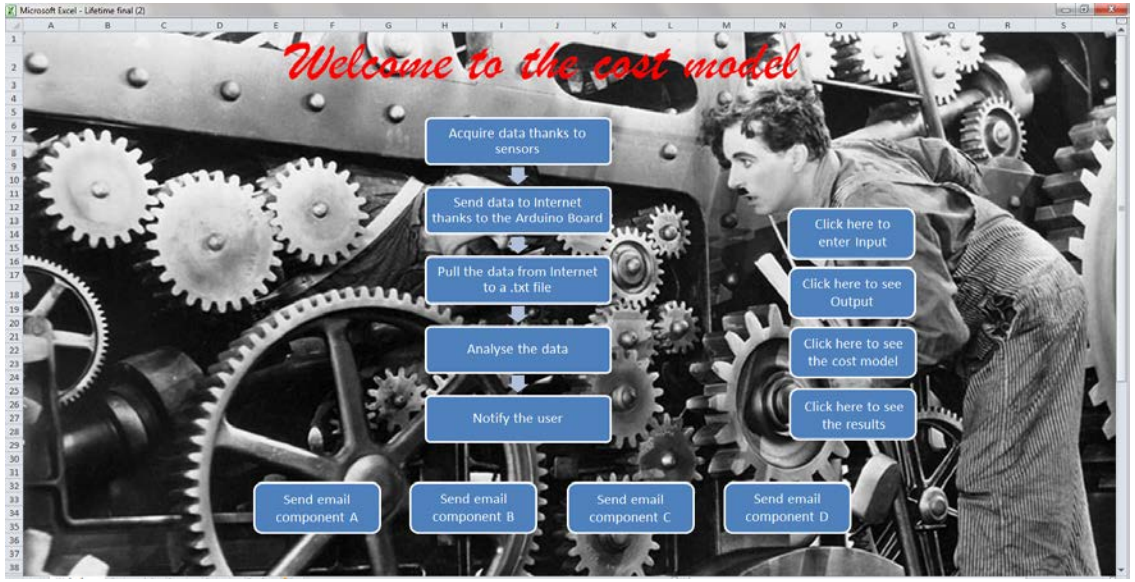


- The software part is used to determine and warn the user when a component needs to be changed.
- Past data are used in the cost model to determine when a component needs to be changed using the percentage of lifetime degradation according to an interval of data.

Project aim

- The objectives of the project are to build a process where real time data are collected and computed in order to be considered into maintenance decision making.
- In the industrial sector, the Internet of Things can help reducing maintenance and diagnostic cost and also improves the safety within the plant.

To aim of the project is to develop a cost model to minimise the average down time costs (lost use) and maintenance cost.



Overview of the framework

text file automatically refreshed every minute

The data are automatically sent on a web page through Internet

Sensors (IoT)

A C B D

Components

The cost model pull automatically the data from the text file every minute.

Other Inputs such as:
- cost to change a component
- lifetime of a component
- lifetime reduction according to an interval of value
- interval of value that corresponds to a lifetime reduction

	Date	.txt entry				Offset entrance			
Days	Mon Aug 03 15:10:03 BST 2015	23	0	448	279	A	B	C	D
1	Mon Aug 03 15:11:04 BST 2015	23	1	132	289	23	0	448	279
2	Mon Aug 03 15:12:05 BST 2015	23	0	132	290	23	1	132	289
3	Mon Aug 03 15:13:05 BST 2015	23	0	133	290	23	0	132	290
4	Mon Aug 03 15:14:06 BST 2015	23	0	133	290	23	0	133	290
5	Mon Aug 03 15:15:06 BST 2015	23	0	133	291	23	0	133	290
6	Mon Aug 03 15:16:08 BST 2015	23	0	133	291	23	0	133	291
7	Mon Aug 03 15:17:08 BST 2015	22	0	132	290	23	0	133	291

Cost model

Notify the user when a component needs to be changed

Determine the money spent on maintenance

Determine if money has been saved / lost

Assumed relations between components

Components	Others components that will be damaged
A	A & C
B	B
C	A & C
D	B & D

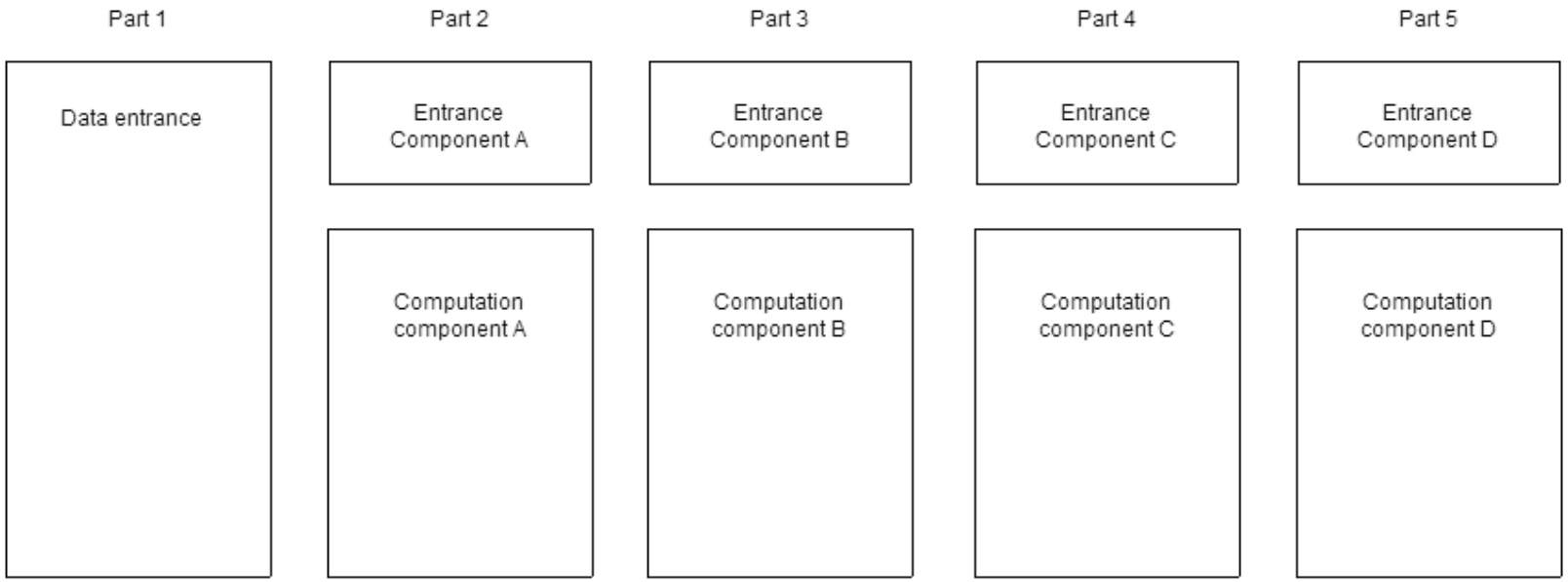
- The aim of the first type of assumptions is to allocate a percentage of lifetime reduction to an interval of value e.g. if the temperature is between 40°C and 43°C the lifetime reduction is 30%.
- The aim of the second type of data is to link the components to analyse the repercussion on costs. A damaged component can reduce the lifetime of another component e.g. component A and component C are related. If one of the two components is damaged, it will damage the other one with the same percentage.

Data collected and stored on internet

Type of data	Sensor for acquiring the data
Temperature	Temperature sensor
Contact	Push button
Vibration	Potentiometer
Acceleration	Accelerometer

- The data are acquired in real time and sent to the Internet every 50 ms; this time can be changed by modifying the Arduino code.
- To send the data to the Internet a bridge has been created, once the board is connected the process of acquiring and sending data can start.
- Data are stored on a web page at a specific URL. The URL depends on the IP address and the IP address depends on the location.
- On campus at Cranfield University there are two different IP addressesThe general rule for the URL is the IP address of the Arduino board/arduino/digital/13, for instance http://138.250.194.70/arduino/digital/13.

Cost modelling



- Each part used to do the calculation is divided into two parts; one part used as an entrance (percentage of lifetime reduction depending on the interval of value) and the other used to compute the maintenance cost.
- The cost model acquires one data per day.
- The cost model is used to determine when to change the components; the decision is based on the degradation of life time according to real time data.

Example application of the cost model

Sensor A									
Temperature	10	35	36	37	38	40	41	42	43
lifetime (x100%)	1		0,8		0,6		0,4		0
Reduction lifetim	0		0,2		0,4		0,6		1
Associated cost	0		10		20		30		10

cost £	lifetime days
10	20
50	40
40	60
100	100

Sensor A									
Temperature	10	35	36	37	38	40	41	42	43
lifetime (x100%)	1		0,8		0,6		0,4		0
Reduction lifetim	0		0,2		0,4		0,6		1
Associated cost	0		10		20		30		10

	1	2	3
Tab A	Component A	Associated cost sensor A	Cost without overpassing the price of the component
Offset entrance	Sensor A (T°)		
A B C D			
24 0 384 279	24 10°<T°<35° 1	0	0
42 0 384 278	42 36°<T°37° 0,8	30	10
36 0 385 285	36 38°<T°<40° 0,6	10	10

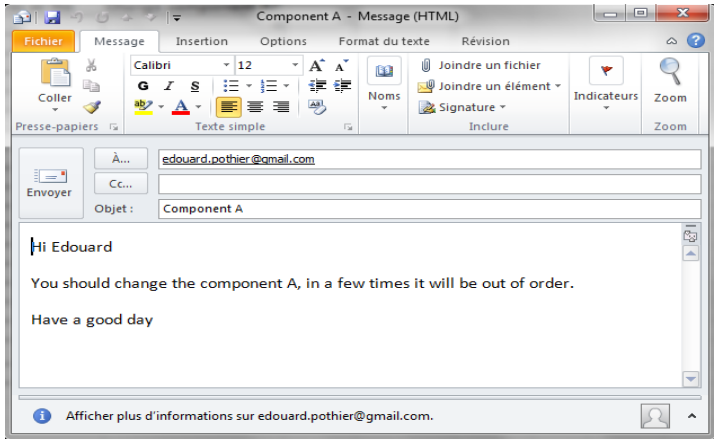
Sensor A						
36	37	38	40	41	42	43
0,8		0,6		0,4		0
0,2		0,4		0,6		1
10		20		30		10

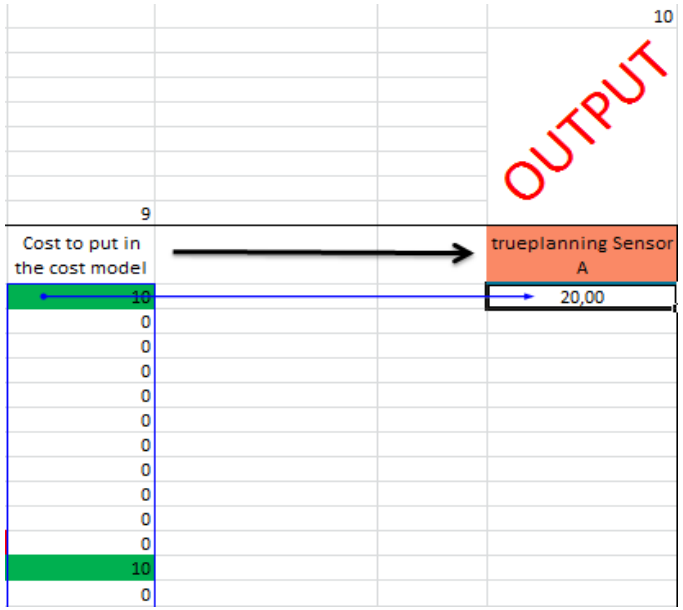
	2	3	4	5	6	7	8	9
	Associated cost sensor A	Cost without overpassing the price of the component	Remaining days	Days of work	Total cost per day	Average cost per day	When should we change the component?	Cost to put in the cost model
1	0	0	20,0	0,0	0,0			10
0,8	30	10	15,0	5,0	2,5	2,5	5,0	0
0,6	10	10	11,0	9,0	4,5	2,3	6,5	0
0,4	10	10	7,8	12,2	6,1	2,0	7,7	0

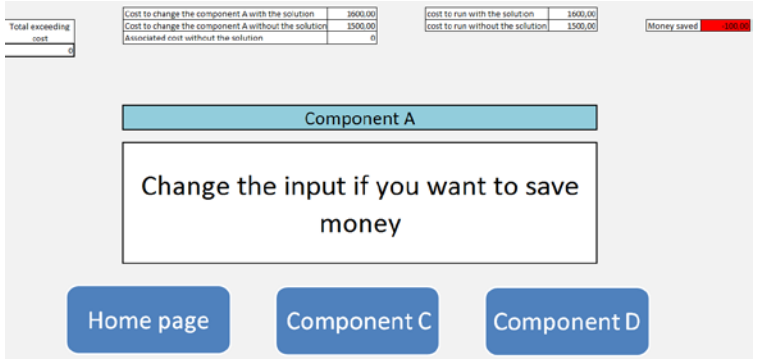
Example application of the cost model

4	5	6
Remaining days	Days of work	Total cost per day
20,0	0,0	0,0
15,0	5,0	2,5
11,0	9,0	4,5
7,8	12,2	6,1
6,8	13,2	6,6

4	5	6	7	8
Remaining days	Days of work	Total cost per day	Average cost per day	When should we change the component?
20,0	0,0	0,0		
15,0	5,0	2,5	2,5	5,0
11,0	9,0	4,5	2,3	6,5
7,8	12,2	6,1	2,0	7,7
6,8	13,2	6,6	1,7	7,1
5,8	14,2	7,1	1,4	7,6
4,8	15,2	7,6	1,3	8,1







Conclusions and future work

- The cost of maintaining components can be challenging to predict in the world of interlinked systems.
- When a component can damage another component which is expensive to change, the developed cost model allows to save money.
- If the cost to change the component is really low, money will be lost. This solution works well with expensive components.
- The cost model developed considers the surrounding components using IoT and allows to not damage these components by changing the first component as soon as the other components start being damaged.

Thank you!

Any questions or comments?

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