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Assessment of the Expansion Levels of the Remote Control on the Water Pump Station

Elsanosy M. Elamin[1], Zohair Mohammed Elhassan Husein[2]
Abdelrasoul Jabar Alzubaidi[3]

[1]Dept. of Electrical Engineering, Faculty of Engineering, University of Kordofan, Sudan
[2]Electrical & Electronic Dept., College of Engineering and Architecture, Bahri University, Sudan
[3]School of electronic Engineering, College of Engineering, Sudan University of Science and Technology, Sudan

ABSTRACT

The systems are now generally deploying rapidly in their both quality and quantity to meet the current requirements of the development. The running operating expenses are also increasing proportionally to the system sophisticated. Therefore, the aided tools are required to assist in reducing the overall expenses versus the total throughput. The expansion levels of remote control are used as aided tool. The paper discusses the impact of expansion levels of remote control on the water pump station for three cases for better operation and maintenance. The remote control levels are applied gradually and consequently the impact is evaluated. The cost decreased as the remote control levels increased. The remote control system can be trusty applied to such systems.

Keywords: control levels, decoders, devices, cost reduction.

INTRODUCTION

The water pump station was operated manually because of locating in far spacing positions. So, it required to be controlled according to the need of water size as a maximum throughput. Therefore, the control process can be carried out remotely to assist in reducing the cost of operators when high demand. The paper illustrates the way exploiting the remote control system and its impact on the station as overall cost reduction when applying the remote control levels gradually. The station is working 24 hours a day to provide a continuous supply of water. The working team is divided into three equal qualified shifts. Each one is consists of engineers and technicians when the station performing the full capacity. The overall team members of all shifts are include different number of members according to each case. The water pump station is composed of 128 water pumps to be switched on/off according to the need.

THE REMOTE CONTROL SYSTEM

Is used to reduce the working team members at each shift. The key factor in expanding this system into multi-different levels is the decoders that are shown in the table 1[1], [2].

Table1. *Shows the decoders used in expansion levels*

Decoder Type	No of Decoders	No of Controlled Devices	Controlled Devices
1:2	7	14	10%
2:4	6	24	18%
3:8	5	40	31%
4:16	4	64	50%
5:32	3	96	75%
6:64	2	128	100%

The beating heart that of selecting devices according to the pre-defined scenario is the PC. The team member has to enter a controlling value related to the controlled device remotely through cell phone1

Address for correspondence:
esanosy@hotmail.com

(MS1) via wireless network to the cell phone2 (MS2) as shown in figure 1. The controlling signal is generated by the remote user who carries MS1 in all the wireless coverage area to assure all the required security features such as authentication, integrity, and ciphering. The controlling signal is captured by the MS2 that attached to the DTMF. DTMF decoder extracts the controlling signal and converted into equivalent binary values and then transmitted to the PC through DB25 connector. The related PC codes react to the incoming controlling signal and processed to provide an appropriate decision to switch the relevant device. Selecting the relevant device is depending upon the addressing by 3:8 decoders. The 3:8 decoder is the basic element of building 8:128 decoder. It consists of two groups of 6:64 decoder. Every group is controlled by the Enable terminal (É) [1], [3]. The Enable terminal is selected and generated through the DB25 connector (2 and 3). When the terminal 2 is selected, it can activate the devices that belonged to the group 1 (dev1 up to dev65). And the terminal 3 can also activate the devices of group 2 (dev65 up to dev128). The HCF4069 is exploited to invert the values of output 2 and 3 of DB25 connector, because 3:8 decoder is enabled with low logic level. Whereas the rest of DB25 pins (9,8,7,6,5, and 4) are used as address to activate the relevant device.

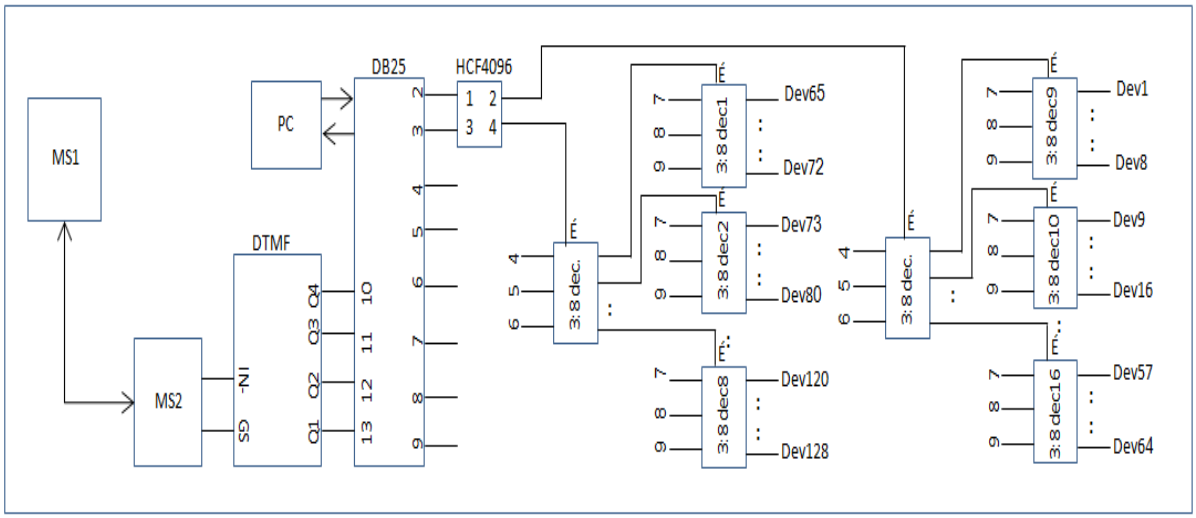

Figure1. *Illustrates the maximum expansion level of remote control [4]*

WATER PUMP STATION

It established to provide a continuous water stream and operated under supervision of qualified shifts. Every working shift team members is formed of engineers and technicians for three departments: mechanical, electrical, and instrumental as shown in table 2 below for three cases. [5], [6].

Table2. *shows the team members per a shift*

	Case 1			Case 2			Case 3		
	Mech.	Elect.	Instrum.	Mech.	Elect.	Instrum.	Mech.	Elect.	Instrum.
Eng.	3	3	3	3	3	3	2	2	2
Tech.	12	12	12	9	9	9	12	12	12

Case1: is designed to the standard to meet the required demand of engineers and technician so as to satisfied the need to the system operation and maintenance. In this case and all later are cost evaluated for all three shift as total cost to show the economic and technical effect on system performance.

Case2: based on case 1 but decreased the number of technicians to the minimum so as to keep the system running normally.

Case3: is also based on the case 1 and decreased the engineers to the minimum whereas the number of technician is increased to the maximum in order to maintain the system performance normally.

The three cases are evaluated to show the importance of decreasing engineers or increasing the technician and which one is affect greatly.

Now, the remote control system is gradually applied to the station. As a result, there is a number of left members from each shift as shown in table 3. The number of left members (LM) can be calculated as equation 1.

$$LM = Factor \times Overall\ team\ members \quad (1)$$

$$Factor = (No\ of\ Controlled\ Devices / Max\ No\ of\ Devices) \times 0.75 \quad (2)$$

Table3. *shows the number of left members for three shifts versus applied expansion level for all cases*

No of Cont. Devices	Controlled Devices (%)	Left members (%)	Case 1	Case 2	Case 3
			No of left mem.	No of left mem.	No of left mem.
14	10	7	9	7≈6	6
24	81	13	17≈15	14≈15	14
40	31	23	31≈30	24	24
64	50	37	49≈48	39	38
96	75	56	75≈69	60	61
128	100	75	101≈99	81	81

The total number of the left members is distributed among the three different departments depending upon the criterion that for every left engineer there are also four technicians are left. The number of left members in table 3 is approximated to comply with the aforementioned criterion. Table 4 illustrate the distribution of both working and left members per shift relating to the different levels of the remote control system when applied.

THE RESULTS

The main cost that is been evaluated is the total payment to the working members according to the fact that the cost of four technicians is equal to the one engineer cost. So, the overall cost of 27 engineers and 108 technicians, in case1, is equal to the cost of 216 technicians. The cost reduction can be calculated as follows:

$$Cost\ Reduction = (LT+4\times LE)/TC \quad (3)$$

Where, ***LT***: the total left number of technicians, ***LE***: the total left number of engineers, ***TC***: equivalent overall cost: in case1 the ***TC***=216, case2 the ***TC***=189, and case3 the ***TC***=180.

Table 4 shows the total cost reduction when applying the remote control system. It is found that the remote control system has a great impact when it applied to 50% of the water pumps of the station and up. The number of left members below the 50% is generally consists of technicians rather than engineers. Whereas above 50%, the number of left engineers is greatly increased.

Table4. *shows the total cost reduction versus the total left members*

Cont. Devices (%)	**Case 1**				**Case 2**				**Case 3**			
	Left members			**Cost red.%**	Left members			**Cost red.%**	Left members			**Cost red.%**
	Eng.	Tech.	Total		Eng.	Tech.	Total		Eng.	Tech.	Total	
10	0	9	9	**4.2**	0	6	6	**3.2**	0	6	6	**3.3**
18	3	12	15	**11.1**	3	12	15	**12.7**	2	12	14	**11.1**
31	6	24	30	**22.2**	6	18	24	**22.2**	3	21	24	**18.3**
50	12	36	48	**38.9**	9	30	39	**34.9**	5	33	38	**29.4**
75	15	54	69	**52.8**	15	45	60	**55.6**	7	54	61	**45.6**
100	18	81	99	**70.8**	18	63	81	**71.4**	9	72	81	**60**
Max ratio	66.7%	75%	73.3%	-	66.6%	77.8%	75%	-	50%	66.7%	64.3%	-

Both figure 2 and 3 shows the relationship between controlled devices and both left members and cost reduction. In both case1 and 2, the number of engineers is equally decreased by 66.7% and in case3 by 50%. The number of decreased technicians is also decreased in case1, 2, and 3 by 75%, 77.8% and

64.3% respectively. Case3 shows the lowest cost reduction of 60% whereas case2 shows the highest cost reduction of 71.4%. Therefore, it is clearly that the remote control system is affect greatly on the station in reducing the working team members for each shift especially at full remote control. As a result, the payment for the working members is also reduced.

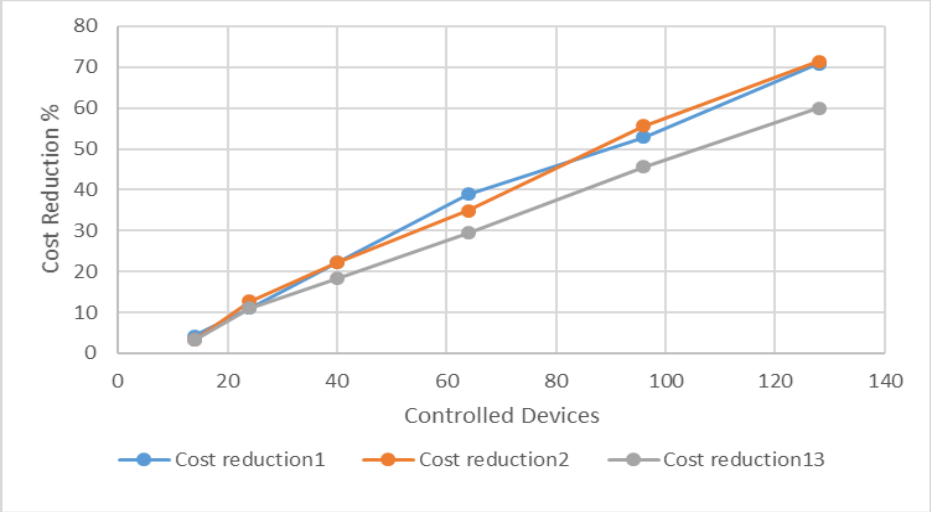

Figure2. *The controlled devices versus cost reduction*

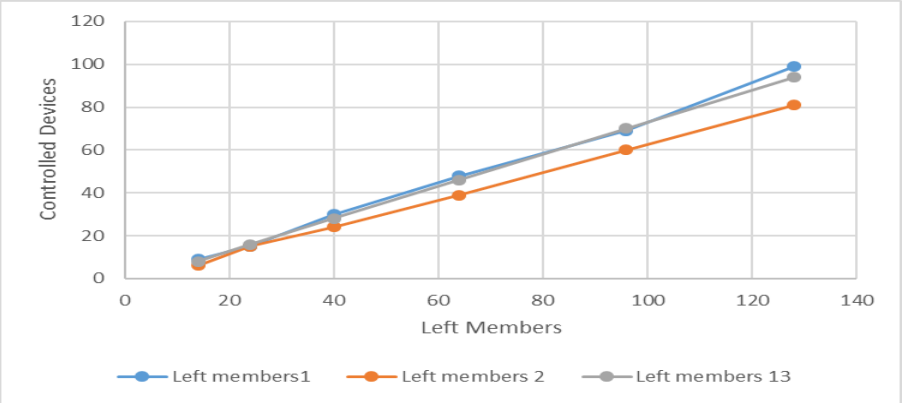

Figure3. *Left members versus cost reduction*

CONCLUSION

The remote control system is successfully and gradually applied and properly assessed. Its impact shows the feasibility of using such systems especially the complicated one. The study focused only on the cost of member's payment. Also the system can be re-evaluated for running, maintenance, and capital cost to show the great impact.

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AUTHORS' BIOGRAPHY

Dr. Elsanosy M. Elamin, obtained his BSc in Electrical and Computer Engineering at Omdurman Islamin University 1999. Received his MSc. In Communication at Karary Academy of Technology 2003 and Ph.D. in Electronics at Sudan Academy of Sciences 2014. Assistant Professor and head department of electrical engineering, University of Kordofan. His field interest is in Electronic Design, Data Communication Networks, and Mobile Communication Networks.

Mr.Zohair Elhassan, B.Tech Passed in 2000 in electrical & electronic Engineering at sudan universityof scince and technololgy, M.sc.in 2003 from Karrary university at Sudan (communication) Phd in 2015from Sudan unverisity of science and Technology (ral time optimization of parabolic refletor antenna parameters) I have published seven papers in journals and presently Iam working as Assistant Professor, Department of Electrical &Elctronic Engineering at bahri Uneversiy at Sudan.