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HIGH QUALITY COTTON TEXTILE IN EGYPT BY VAMM WIND TURBINES

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ABSTRACT

*Like many countries, our country faces problems nowadays, some of which must be taken seriously, as they are grand challenges for Egypt. One of the biggest challenges urgently needing to be solved the lack of energy due to its high consumption for industrial purposes. We must focus on a source of energy not traditional to generate energy and make a feedback mechanism. The industry that was chosen to work on is the cotton textile industry. A suitable solution was selected with requirements (quality, effectiveness, sustainability, availability and amplitude, and safety) and using wind energy due to high efficiency, availability, and the turbines design VAMM (vertical-axis Magnus model). We constructed a prototype with sensors and other components, all put into a wooden box, to make a test plan for the design requirements, which are the dimensions quality and color quality of the cotton textile product. After finishing the prototype and moving to the test part, a test plan was done for the prototype to evaluate the design requirements well. Three trials were made for dimensions and three others for the color. In dimensions trials, the obtained results were promising. We got results of lengths from the sensors (49.8, 50.1 and 49.7 cm) as the actual width is 50 cm, so we calculated the average error (0.4+ +0.2 + 0.6 / 3)*100 = 0.4%. Also, in color results, sensors showed in the three trials of each RGB color: Red: 254, 252, and 255, so the average is 253.67 (0.785%), green: 252, 253, and 250, so the average is 251.67 (1.3%) and blue: 253, 251, and 25, so the average is 253 (1.18%).*

KEYWORDS: *Cotton textile - VAMM – Feedback control system – Arduino – RGB – Ultrasonic.*

INTRODUCTION

The industry's value is a substantial value for all over the world. We know that the industrial base is essential to each country's economy. Each country makes actual GDP (Gross Domestic Product) and MVA (Manufacturing value-added) in their statistics. As we live, in Egypt, in an ever-changing world surrounded by many overwhelming changes, we should improve our industrial base in all fields as far as possible. The energy used in industries (traditional energy) is from steam turbine energy (which generates more than 1300 MW, like in Shubra-Elkheyma) and fossil fuels energy. But the ratio of using green energy sources is small. We should work on green energy sources to save money and effort. Our challenge is to replace a traditional manufacturing process of any product that needs improvements using a feedback control system with any green energy to confirm the best product quality as all automated industry systems. A feedback control system consists of five main components: (input reference, controller, process, and sensor). Many prior solutions were researched, and we chose wind turbines among all the energy resources used in this industry sector. Egypt produces nearly 1375 MW of wind-generated energy (generated by blades that collect the kinetic energy KE of the wind) annually. So, we can rely on this resource because the cotton textile industry needs only between 0.45 to 0.55 kWh per meter of cotton fabric. Wind power plants are beneficial because each plant gives a very excellent amount of produced energy used in the factories to make textile products.

Wind plants already exist in Egypt, like the Ras Ghareb wind farm (262.5 MW) and Zaafarana (545 MW). Many advantages exist of wind energy like cleanliness, less expensive, advanced resources, free fuel, reduce our dependence on fossil fuels, and do no disrupt farmland operations. Also, there are some disadvantages such as noise, danger to some wildlife, and unpredictability (suffers from intermittency caused by the inconsistency of wind itself). After research and brainstorming,

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the best solution was detailed, and wind power was chosen because it is the most efficient green energy source and is common in Egypt. Its turbine design is based on the VAMM (Vertical-axis Magnus model) shown in Figure 1.

We selected our prototype from two parts: The first is the feedback system composed of sensors for color and dimensions, an Arduino board, jumpers, ultrasonic sensors, breadboard, a small LCD monitor, 5-kΩ variable resistor, and 220-Ω resistor, and all were put in a wooden box. The second part is the animated video as illustrated for the whole process.

MATERIALS & METHODS

Table 1 Materials used for the physical prototype of the feedback system

Material	Cost (EGP)	Usage	Source
Arduino Nano	150	The main component that connects Arduino sensors	Free Electronics – Cairo
Breadboard	30	Complete the connection of the electronic circuit	Free Electronics – Cairo
Jumper Wires	40 (20 male-male & 20 male-female)	The linkage wires between every component and another one	Free Electronics – Cairo
Ultrasonic Sensor (HC-SR04) with its holder	40	Measuring the width of the test product	El Asfory Electronics – Ismailia
Color Sensor (TCS3200)	225	Detecting the color of the test product	RAM Electronics – Cairo
LCD Monitor	60	Displaying the sensors' measurements	Amazon.eg
220-Ω Resistance	5 (Quantity 100)	Completing the connections of the color sensor circuit	Free Electronics – Cairo
5-kΩ Rheostat	80	Completing the connections of the color sensor circuit	Free Electronics – Cairo
Wooden Plate	50	Constructing the body of the prototype	Allam Carpenter - Giza

Procedures for the construction

To construct our prototype, we used these materials by the following methods:

1. Cutting the wooden plate to fit an area of length of 60 cm and width of 33.3 cm and mounting another piece with the height of 12 cm To hold the color sensor, the breadboard, and the Arduino Nano.
2. Stick the Arduino nano to the breadboard.
3. Mounting the holder of the ultrasonic sensor at the rectangle's length (at 20 cm). These two steps resulted in the frame shown in Figure 3.1.
4. Forming the code of the color sensor.
5. Connect the color sensor and the LCD monitor to the breadboard and consequently to the Arduino nano to do the first test of the prototype initially.
6. Forming the code of the ultrasonic sensor.
7. Connect the ultrasonic sensor to the circuit formed in step 4 to do the second test.

Procedures for the test

For making the test plan for the prototype to evaluate the design requirements:

Dimensions quality: Using an ultrasonic sensor after putting a sample in the prototype to calculate the length (which equals = the length of the box – length between the sensor and cotton textile piece). Then, calculate the length of the sample in 3 trials to get the results (shown on an LCD monitor). The length should be 50 cm, "the desired value ."Then, calculating the error and then getting the average (sensor-measured value/ desired value) to specify how far the sensor measurements are from the ideal estimations. This is done by the Arduino code.

Color quality: after putting a sample of cotton textile products in the prototype, we used a color sensor with LED lights to measure the color (as we know from RGB that each color is a mix of red, green, and blue) by its ideal value (255-255-255). Three trials were done to detect the error and then the average. It should be between 98% to 100% to pass.

At the end of the two tests, if the piece passes the two tests, it will be considered accepted; else, it will be rejected, with

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showing how far it is from the desired value to facilitate the task for the controller of the feedback system as we aimed from selecting our solution requirements.

RESULTS

We have informed the test by one piece of cotton fabric to pass it through the feedback system, and it was recorded for dimensions as indicated in the table below (in 3 trials).

Simultaneously, the color sensor detects the color of each piece and confirms that it is between 250-250-250 and 255-255-255, which means that the percentage is between 98% and 100% by the RGB scale. We used the percentages that appeared on the LCD of the color to calculate the actual RGB scales and the average percent error to analyze these results and see how they will be compatible with the design requirements we selected. The MAPE value is the Mean Average Percentage Error which is the mean value of percentage error. And the results shown are found. Also, the results of the calculations we did are shown:

Table 2 The 3 trials for detecting the color on RBG scale with convenience and average error (MAPE values)

Trial	R		G		B		Result on LCD Monitor
1	254	0.39%	252	1.18%	253	0.78%	Accepted (99.6-98.8-99.2)
2	252	1.18%	253	0.78%	251	1.57%	Accepted (98.8-99.2-98.4)
3	255	0	250	1.96%	255	0	Accepted (100-98-100)
Average	253.67	**0.785%**	251.67	**1.3%**	253	**1.18%**	

Table 3 The 3 trials for measuring the width

Trial	Result on LCD Monitor	The Sensor's Calculated Width (Centimeters)	The Actual Width (Centimeters)	Absolute Error	Percent Error
1	Accepted (99.6%)	49.8	50	-0.2	0.4%
2	Accepted (100.2%)	50.1	50	+0.1	0.2%
3	Accepted (99.4%)	49.7	50	-0.3	0.6%
MAPE		0.4%			

DISCUSSION

After we tested our prototype, we determined how it met the design requirements we chose. Here, we will consider the behavior of the prototype while testing it.

Our prototype is composed of a wooden body, which holds the color sensor and the LCD monitor above, and the ultrasonic sensor is on the box below it. The textile piece of cotton, or more precisely, the bleached piece, is put on the box, and the color sensor detects its color and determines whether it exists in the range of white color grades allowed or not. At the same time, a plastic rod is put at the end of the length of the piece to allow the ultrasonic sensor to work. The LCD monitor shows the percentage of "convenience" of the piece to the criteria selected. Which are: the white color of RGB between 245-245-245 and 253-253-253. RGB is a set of colors. They are the grades of Red, Green, and Blue used in many fields such as Android Apps (CS.2.05).

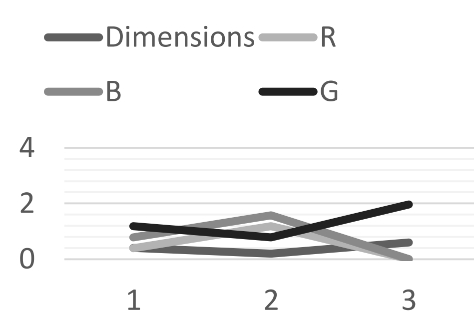
With the brief description of the last part that represents "Constructing and Testing the prototype" above, we can analyze the results by determining how it suits the design requirements.

First, we tested the quality of the dimension by the ultrasonic sensor and a simple calculation in the Arduino code. This calculation gets the percent of what the sensor measured to the actual width that is measured manually to determine how is the product compatible with our criteria, to facilitate the task of the Feedback system's controller, which needs many scenarios to be considered, as it is an essential part of a Feedback system, which has the components shown in Figure 3 as Feedback systems by a simpler example which is the human reproductive systems hormonal cycle (BI.2.09). However, the test we have done in three trials showed that the sensor is very effective. It recorded a MAPE of 0.4%, which is obtained by calculating the mean value for the errors in the sensor's measured width to that is assumed to be the real width, which is calculated by taking the absolute value of the difference between the measured value and actual value to divide it by the actual value and multiplying the result by 100.

We used the same piece of cotton textile in the three trials, as we had to observe the behavior of the prototype and what affected it. We observed that the ultrasonic sensor is mainly dependent on the plastic rod we put into making the ultrasound waves reflect and allow the sensor to calculate the distance passed by giving the speed of the waves and the time at which they passed and reflected. The mathematical equation was used: Distance = (Time × speed of waves)/ 2. Also, we wanted to know the length of the cotton textile piece, so we used the equation:

Length of cotton textile piece = length of the box – length between the sensor and cotton textile piece. Second, about the color sensor, we observed that it is affected by the LED lights and how far it will be from the tested product. Increasing the distance or brightening the surrounding may affect the error of the sensor.

Graph 1 Test results in the three trials



Generally, the prototype showed that a Feedback System for cotton textile products, especially those produced from the bleaching stage, must produce certain color (White) with certain dimensions, and the error of the sensor is very small and does not affect the working of the Feedback loop. As represented in Graph 1, which shows the percent error of dimensions (in gray), RGB colors indicate the errors in their detection among the three trials.

After that, we calculated the color quality percentage by the equation:

Percent Error= Detected RGB Decimal Code-Desired Code/Desired Code×100

As we detailed, the desired color for RGB is (255-255-255).

CONCLUSIONS & RECOMMENDATIONS

After discussing the behavior of the prototype, there are some conclusions to be under consideration which are:

1. Arduino programming is a good choice to be a sensor for a Feedback system. It has very low error rates. The ultrasonic sensor recorded an error of 0.4%, while the error recorded by the color sensor was approximately 1%.
2. we got results from color quality, 0.785%, 1.3%, and 1.18%. And dimensions quality results as averages, 253.67, 251.67, and 253 as from RGB value (255-255-255).
3. The manual controller is not the best choice for a Feedback system; it will be better to use an automated way of thinking about problem-solving. This to be applied.
4. Understanding the way how Arduino's sensors work is important for the controller. For example, when we exclude the use of plastic rods for the ultrasonic sensor and the LED lights for the color sensor, it will be harmful to the results will be resulted from.

According to what we concluded, there are some recommendations for who will continue working on this project and for applying our solution in real life.

1. Prototype carrying-box should be from a stronger and cheaper material like some sorts of plastics as in HDPE (High-Density Poly Ethylene and PP (types of plastic). They have good hardness, good preservation, and good sustainability.
2. The controller of our feedback system is the human. It can be replaced with artificial intelligence (AI), which leaves the decision to the technology. It can receive the error and manipulate the reasons without any human intervention.
3. Color sensor ISL29125 can be used because it is newer and has more accuracy than the TCS3200 color sensor we used (which uses nearly 10-bit signals in each color channel. It uses a 16-bit digital representation of each color instead of outputting a variable frequency.
4. To make the passage of the electricity clear and better, it is preferred to use fiber in place of copper. Because they are not affected by electromagnetic interferences and power fluctuations, they make them a better replacement.
5. In real life, most machines transmit undesirable gas, which is harmful to the environment and has some consequences. To deal with this situation, it is preferred to get rid of it through a chemical reaction in the presence of resins.
6. To avoid any damage to the machine operated by the VAMM wind turbines or any other alternative energy resources, in the case of the instability in the produced energy, we recommend using an automated converting system; to convert the electrical energy coming from the turbines to a traditional one.

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