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Tele-Weight

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Abstract:

This study was designed to create a system and hardware device that measures the weight of an item that is virtually transmitted through SIM communication system from another location. The implementation section of the project is divided into two main parts, software and hardware. For the software part, we will develop a program that connects an Arduino PC with an SMS module that will allow the weight of the object to be translated into Newton power and then transmitted virtually. The hardware part of the project consists of connecting a simple weight scale. This scale is connected through electric signals to an Arduino PC, which is a small computer that is in charge of transmitting the weight of the object in (x grams) to a SIM device connector in Newton power. The SIM connector is a basic device that only needs a SIM card inserted in for it to work. It works as a basic mobile phone that sends and receives texts only it cannot be used for calling. The receiver location also has an Arduino and an SMS module as well as a motor that will generate the Newton power into pressure. The motor’s end is connected with a chain. The user then lifts up the chain feeling the weight of the virtually transmitted object.

Keywords:- Haptic; device;tele;weight;

1. INTRODUCTION

Haptic Devices are devices that involve physical contact between the computer and the user’s body through an I/O device [1]. The user can not only program the computer with information while using haptic devices, but can also obtain information from the computer in the form of a felt sensation on a specific part of the body. This is referred to as a haptic interface [2].

Haptics involves multiple sensorial channels such as visual, smell, auditory and taste. 3D or interactive stereo displays are used for visualization modalities, 3D or interactive sounds are used for auditory modalities and force feedback, data gloves, and joysticks are used for sensation modalities [3]. On the other hand smell and taste are modalities are a bit behind in research. Both tactile feedback and force feedback define haptic devices [4]. Tactilefeedback is used when a temperature of an object is sensed, or to let the user feel the smoothness of a surface, while simulating objects such as the weight and hardness of an object uses force feedback [5].

Exploring objects can be done in many different methods. The ways to discover an object can differ from a person to another. Some prefer exploring the environment first and follow that with feeling the

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object they want to explore [6,7]. A simulation to interact with elastic objects has been created in a research done by Doug L. James and Dinesh K. Pai [8]. The challenge was the complication of physically accurate simulation and the complexity of building beneficial estimates appropriate for real time interaction.Many efficient solutions exists to solve the run-time computational costs by using precomputed Green's functions and fast low-rank updates based on Capacitance Matrix Algorithms. These matrices allow contact forces to be computed much faster than global deformation behavior by establishing exact force response models [8].

Sensing the shape and exploring the texture, softness and hardness of a virtual object can be done through force feedback/haptic interface. Force feedback is a haptic device that allows the user to interact with virtual items in a teleported system or virtual environments. The feeling of the virtual object is done by using hands in a real-time world [9].

The PHANTOM haptic feedback co is an invention of J.Kenneth Salisbury [10] and Thomas Massie at a technology institution. The PHANTOM haptic interface is a stylus (pen-like device) that the user can replace his/her fingertip in order to measures a user's fingertip. The PHANTOM haptic device allows the user to feel and interact with several virtual objects and it is used to control remote manipulation [10].A system called sandpaper was created by Minsky and his fellow colleagues [11]. This system was designed for experimenting the texture's feeling. The main goal of this system was to design a laboratory for conducting experiments on haptic devices focusing on the sense of touch. A description of texture in terms of low level physical models and mechanical independence was emphasized in the sandpaper research.The size-weight illusion in natural and virtual environment was discussed in a research by Edger Heineken and Frank P.Schulte [12]. The expected degree of illusion depends on the realism provided in different kinds of virtual environments.

Thus, this work focuses on creating a system that will virtually transmit the weight of an object through SMS connected devices in different locations. To clarify the meaning, there is a technical store in China that has a unique type of object; the user wants to know the weight of the object before purchasing and shipping it. The Tele-Weight's job is to allow the user to feel the weight of the object that is virtually transmitted from China. To create a system and hardware device which measures the weight of an item that is virtually transmitted through SIM communication system from another location. Our aim is to be able to measure the weight of an object and feel it in a different location virtually as well as understand how to use Arduino PC in computer interface and communication media. We also expect to achieve the usage of different communication media to send messages representing physical quantities.

2. METHODOLOGY

The weight can be placed on the one of the flexible end of the weight scale and then the measured weight can be transferred in to the receiving end. The receiving end decodes the weight. After decoding, the mathematical value is stored and corresponding points is moved by the motor. This is the case for the first value. The load cell has a limit of 5kg. For instance, if 4kg is placed on the Load cell, then the 4V is delivered using the communication device. The receiving end decodes the value and after decoding, it will generate the value with the help of moveable gears (weight) attached to the motor. The gear will move to the position of 4kg scale via motor movement. If a weight is replaced to 3kg, then the system using efficient approach moves to 3kg by decreasing the weight of 1kg. The button is also connected that is required to press for passing the value from sending to receiving end. The weight obtained can be mapped into the corresponding weight value using gears weight. The gears connected weight moves to a specific value depending on the weight placed on the Load cell.

The project has been divided into two ends:

1. Sending End.

2. Receiving End

2.1 Sender End

The Sending end consists of weight measurement circuit. The weight measurement circuit includes Load Cell, Hx711 Amplifier, Arduino Microcontroller and a GSM. The Load cell is a transducer or sensing device that converts the weight signal into the corresponding voltage value.The Hx711 amplifier is a 24-bit ADC circuit Amplifier that is designed for weight scales. It is used to obtain data from the Load cell and Strain Gauge. The Hx711 is connected in

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between the Load cell and the microcontroller.Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. Figure 1 shows the sender end circuit.

2.2 Receiving End

The receiving end includes the motor driver circuit and DC geared motor. The motor driver circuit is the dual H-Bridge that is used to run the high power motor in both directions. Using H-bridge, immediate stopping of the motor, Dual Braking, Active Switching and Buzz sound can be produced using the Dual H-Bridge circuit.The DC geared motor is the device that converts electrical power into the mechanical power. The principle of motor depends on the Faraday's Law of Electromagnetic induction. DC geared motor have high Torque as compared to the normal electric motor.They are used to lift large weights. The DC geared motor used in this project carries weight up to 10-15 Kg.The receiving side circuit is shown in Figure 2.

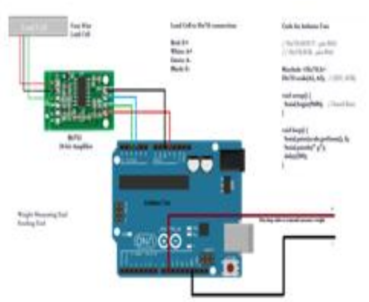

Figure 1. Sender End Circuit Diagram

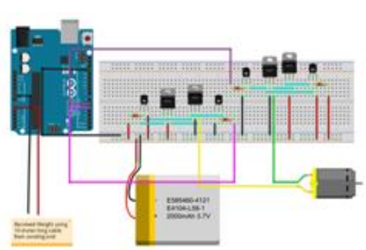

Figure 2. Receiving end Circuit Diagram

2.3 System Architecture

System architecture is the conceptual model that characterizes many things such as structure, behavior, and more views of a system. An architecture description is a formal portrayal and representation of a system, sorted out in a way that backings thinking about the structures and behaviors of the system. In Tele- Weight, system architecture diagram in Figure 3 will show how the system will work.

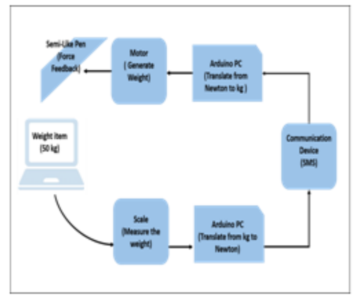

Figure 3. System Architecture

2.4 Prototype

The prototype is made to clarify the implementation of the system, let's assume there is a technical store in China that has a unique type of object; the user wants to know the weight of the object before purchasing and shipping it to Jeddah The Tele-Weight's job is to allow the user to feel he weight of the object that is virtually transmitted from China. We will need to connect both the Arduino PC and the SIM connector devices without using much electric cables for it to look acceptable. Also, we will try to get a good scale that weights the object precisely and gives accurate weight measurements. System architecture is the conceptual model that characterizes many things. The prototype is shown in Figure 4.This system is developed to help customers and manufactures to communicate.

The user should be able to feel force feedback of an object through a semi like penThe user should be able to scale objects up to 50Kg only. The user should be able to display the weight on the LCD screen

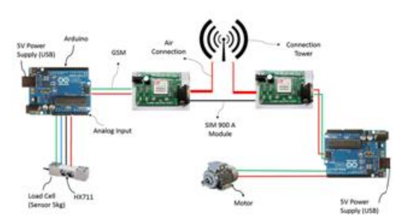

Figure 4. Prototype

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3. IMPLEMENTATION

3.1 Sending End

The sending end measures the weight using Load cell and HX711 interface with Arduino. The Load cell is a device based on the principle of the Wheatstone bridge and by using the bridge balancing principle, weight is measured. So Load cell gives the low value weight signal corresponding to the Load placed on it. So the low value signal needs to be amplified and provided to some memory based device for processing and converts the voltage signal from Load cell into the Weight. The amplifier used is HX711 and micro-controller is Arduino. The Load cell required for this purpose is a four wire Load cell.The connection for the Load cell, Hx711 amplifier and Arduin has been given in Figure 5.

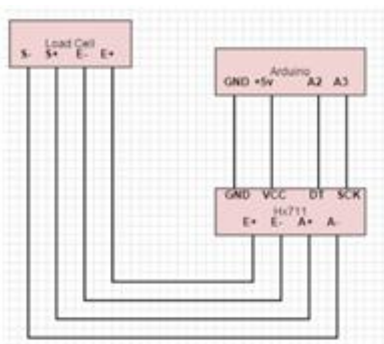

Figure 5. Connection Diagram

In order to increase the range of the messaging service, antenna needs to be connected with the GSM module. In order to increase the range of the messaging service, antenna needs to be connected with the GSM module.Any network SIM that is allowed to send message can be installed in the GSM module in the SIM jacket.

3.2 Receiving End

In the receiving end, the GSM module is configured with Arduino to read and decode the weight keyword. Once the weight is known, using the keyword in the message, then the correct weight can be shown using the actuating actions of the DC geared motor. Some sample weight with string can be attached with DC geared motor at the end location that can be moved up and down depending on the weight placed on the Load Cell at the sending end.

4. TESTING

4.1 Testing Scenarios

The designed weight prototype works for 0 - 387 g due to the receivingchain limit even though the load cell takes up to 5 kg. The communication mediumthat gives the result is a chain attached to the motor. Arduino-Uno has beenused for programming both the sender and receiver parts. The weight from thesending end is coded into the form of a voltage. At the receiving end, the voltageis decoded back into the mathematical value entered at the other end, after which,the motor driver provides the command to map into the respective point.To test our system, we have divided it into two main parts that will allowus to test it accurately without errors and then combine them together .

4.2 Testing Scenarios

Our sender end consists of four parts which are: load cell (scale), Arduino-Uno Genuino, weight amplifier and the GSM module. Testing the sender end alone was conducted by applying weights varying from 1 g – 50 g and then another test that used scaled weights from 50 g – 387 g which is the complete weight of the chain at the receiving end. Adding more weight than 387 g would take the weight in but would refuse to send it. The Arduino was programmed to scale the weight and send a text message to the assigned number giving the weight in integer numbers only. Meaning that, if we weighted an object of 4.98 grams, the Arduino would send to the GSM module the following message: (#a4) both the (#) and (a) were set to simply show if the weighted object was correct or not for the users to understand. 25 different items were tested with very few to none errors, resulting in the accuracy of the load cell and transmitting the data through the Arduino.

Figure 6 shows the test result of the sending end and Figure 7 shows the test result at the receiver end.As shown in Figure 6, the actual weight of a weighted object gave thesame result as the measurement on the load cell. The text sent shows only the integer part of the weighted number. The items that we chose were scaled between 1g and 50 g. Based on Figure 7, the text received only contains an integer number of the weighted item. The total number of points of the chain is 108. Each point of the motor weights 3.6 g, allowing us to calculate the actual weight more or less accurately. After that, the scale under the motor weights the chain that comes

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down giving us an accurate measurement of the item's weight.

#	Known Weight	Measured Weight	Sent Text
1	2 g	2.58 g	#a2
2	4g	4.62 g	#a4
3	6 g	6.08 g	#a6
4	8 g	8 g	#a8
5	10 g	10.2 g	#a10
6	12 g	12.40 g	#a12
7	14 g	14.65 g	#a14
8	16 g	16.22 g	#a16
9	18 g	18 g	#a18
10	20 g	20.80 g	#a20
11	22 g	22.01 g	#a22
12	24 g	24 g	#a24
13	26 g	26.70 g	#a26
14	28 g	28.59 g	#a28
15	30 g	30 g	#a30
16	32 g	32.90 g	#a32
17	34 g	34.25 g	#a34
18	36 g	36.87 g	#a36
19	38 g	38.52 g	#a38
20	40 g	40.83 g	#a40
21	42 g	42.10 g	#a42
22	44 g	44.32 g	#a44
23	46 g	46.89 g	#a46
24	48 g	48.04 g	#a48
25	50 g	50 g	#a50

Figure 6. Weight of a Weighted Object

#	Received Text	Motor Motion in Point	Weight by Wire
1	#a2	1 point	2.58 g
2	#a4	2 points	4.62 g
3	#a6	2 points	6.08 g
4	#a8	3 points	8 g
5	#a10	4 points	10.2 g
6	#a12	4 points	12.40 g
7	#a14	5 points	14.65 g
8	#a16	6 points	16.22 g
9	#a18	7 points	18 g
10	#a20	7 points	20.80 g
11	#a22	8 points	22.01 g
12	#a24	9 points	24 g
13	#a26	10 points	26.70 g
14	#a28	10 points	28.59 g
15	#a30	11 points	30 g
16	#a32	12 points	32.90 g
17	#a34	12 points	34.25 g
18	#a36	13 points	36.87 g
19	#a38	14 points	38.52 g
20	#a40	14 points	40.83 g
21	#a42	15 points	42.10 g
22	#a44	16 points	44.32 g
23	#a46	17 points	46.89 g
24	#a48	17 points	48.04 g
25	#a50	18 points	50 g

Figure 7. Test Results of Receiver End

5. CONCLUSION

The purpose of this study is to successfully create a system that will transmit the weight of an object through an SMS network to a different location. The receiver point will be able to feel the weight of the object through a haptic device and force feedback.that the system will be of use in the industry in the near future. There are many weighting scales available but not all allow a costumer to feel the actual weight of a certain object.

REFERENCES

[1] Hotelling, S., Strickon, J. A., Huppi, B. Q., Chaudhri, I., Christie, G., Ording, B., ... &Ive, J. P. (2016). *U.S. Patent No. 9,348,458*. Washington, DC: U.S. Patent and Trademark Office.

[2] Pasquero, J., Stobbe, S. J., & Stonehouse, N. (2011, May). A haptic wristwatch for eyes-free interactions. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 3257-3266). ACM.

[3] Falcão, C., Soares, M. M., &Ahram, T. (2016). 22 Applications of Haptic Devices and Virtual Reality in Product Design Evaluation. *Ergonomics in Design: Methods and Techniques*, 359.

[4] Basdogan, C., &Loftin, R. B. (2009). Multimodal display systems: Haptic, olfactory, gustatory, and vestibular. *The PSI handbook of virtual environments for training and education*, 116-134.

[5] Dahiya, R. S., Metta, G., Valle, M., &Sandini, G. (2010). Tactile sensing—from humans to humanoids. *IEEE transactions on robotics*, *26*(1), 1-20.

[6] Rubin, H. J., & Rubin, I. S. (2011). Qualitative interviewing: The art of hearing data. Sage.

[7] Krueger, R. A., & Casey, M. A. (2014). *Focus groups: A practical guide for applied research*. Sage publications.

[8] James, D. L., &Pai, D. K. (2005, July). A unified treatment of elastostatic contact simulation for real time haptics. In *ACM SIGGRAPH 2005 Courses* (p. 141). ACM.

[9] Romano, J. M., & Kuchenbecker, K. J. (2012). Creating Realistic Virtual Textures from Contact Acceleration Data. *IEEE Trans. Haptics*, *5*(2), 109-119.

[10] Salisbury, J. K., & Srinivasan, M. A. (1997). Phantom-based haptic interaction with virtual objects. *IEEE Computer Graphics and Applications*, *17*(5), 6-10.

[11] Minsky, M., Ming, O. Y., Steele, O., Brooks Jr, F. P., &Behensky, M. (1990, February). Feeling and seeing: issues in force display. In *ACM SIGGRAPH Computer Graphics* (Vol. 24, No. 2, pp. 235-241). ACM.

[12] Ehrsson, H. H., Spence, C., &Passingham, R. E. (2004). That's my hand! Activity in premotor cortex reflects feeling of ownership of a limb. *Science*, *305*(5685), 875-877.