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Palm Sensor Module Design Robotic Legs in Monopedal Conditions Using the Resultant Force Method

Imam Sutrisno[1], Argya Satriya Bomantara[2], Dimas Pristovani[3] , Projek Priyonggo[4], Boedi Herijono[5], Rini Indarti[6], and Muhammad Khalil[7]

[1,2,3,4,5,6]*Politeknik Perkapalan Negeri Surabaya, Indonesia*

[7]*Politeknik Negeri Tanah Laut, Indonesia*

Abstract: Dance robot is one of the implementations of technology in the field of robotics which has the ability to imitate human movements when dancing and walking. This dance robot is designed to resemble the shape of the human body, which has two arms and two legs as its means of movement. The most important thing to note before standing and walking is balance. The sensor used is a pressure sensor of type RP-C18.3. Force is any influence that can cause an item to change, either in the form of movement or direction. a force can cause an object with a certain mass to change its speed. The use of the resultant force equation is one of the methods that can be used to determine the coordinates of the fulcrum on the soles of the robot's feet. A vector is a force that has both magnitude and direction. The sum of all the forces acting is the resultant force or the total force. Force is a vector magnitude so that the total force is calculated based on the provisions of the vector addition. Data analysis results from the theory contained in the force resultant equation obtained the highest percentage error value of 0.87% and the lowest 0%, this error is due to differences in the process of rounding off the decimal points. System testing between visual basic sensor and servo modules can also be run. The balance sensor module works well, it can be seen about the system testing that valid data is obtained on reading the coordinate directions and there are no reading errors in data processing. This sensor module can be a reference for robotics developers.

Keywords: Robot Dance, balance, sensor RP-C18.3.

INTRODUCTION

Technology in the field of robotics is growing very rapidly day by day. Robots are made to help human work that requires accuracy, speed, high accuracy and work that has a high risk (work that can cause disability and even death), this affects the need for robotics to increase, such as in the industrial, civil, medical, transportation, sports, disaster management, to the arts. Research in the field of robotics is also increasing, of course this is not without purpose. Likewise research on humanoid robots, this humanoid robot is a robot that can move or do something like a human and also has a human-like structure. This humanoid robot can perform many tasks or purposes such as sports, disaster management, and the arts. So a humanoid robot is a robot whose overall appearance is formed based on the human body which is capable of interacting with equipment and the environment made by humans.

An important feature of the humanoid robot is form and has a direct impact on research in this field. movement similar to that of humans. This type of robot is expected to walk and move like a real human. It can also climb, walk on uneven ground, run, and dance. Robot Dance is one of the implementations of technology in the field of robotics which has the ability to imitate human movements for dancing and walking. This dance robot is designed to resemble the shape of the human body, which has two arms and two legs as its means of movement. (Sutrisno, 2020).

To be able to do these activities, the most important thing to note beforehand is the balance to stand and walk. To overcome this balance problem we can use sensors, there are many sensors that are usually used as balance sensors, namely gyroscope sensors, accelerometers, and magnetometers.

But actually there are still many kinds of sensors that can be used to help with robot balance problems. In this final project the sensor used is a pressure sensor of type RP-C18.3, this sensor has a working principle where each of these sensors gets a different pressure, so the resistance value obtained will be different and cause the output voltage to be different. The RP-C18.3 sensor has a fast response and an affordable price. On each sole of the robot's foot there will be 4 RP-C18.3 pressure sensors. Each sensor will be placed in the outer corner of the sole of the foot. In searching for the heaviest fulcrum on the soles of the author's feet using the resultant force method used to calculate all the forces acting on each sensor. With the creation of this foot sensor module, every step of the robot can be monitored easily so that the robot does not become overloaded on the pedestal which causes the servo to be damaged. (Sutrisno, 2013).

***Corresponding Author:** Imam Sutrisno

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METHOD

A. System Analysis

System requirements analysis is a step to find out the system requirements that will be used by taking into account the required requirements. With the analysis of system requirements, it will simplify the system design process to be made. The components needed are as follows:

1. *Hardware*

a. Laptop
b. Sensor *Pressure RP-C18*
c. ESP Wroom 32
d. Modul FT2322RL
e. Battery lipo 12 Volt 2200maH

2. *Software*

a. Visual basic
b. Arduino IDE

Based on Figure 1. Data retrieval from each RP-C18.3 sensor will be read in the ADC function so that the data can be processed directly by the ESP 32 microcontroller. And before processing the data the data will be calibrated by a voltage divider circuit to get the most appropriate and good value . Furthermore, the data will be sorted and the data that has been sorted will then be grouped again and sent to Visual Basic using the help of the FT232RL USB to Serial Module. The data that has been received is then grouped again so that it will become data from existing variables, then it will be displayed in the Visual Basic interface that has been created. The data is also used to move the servo as proof that the sensor reading data can be used as reference data.

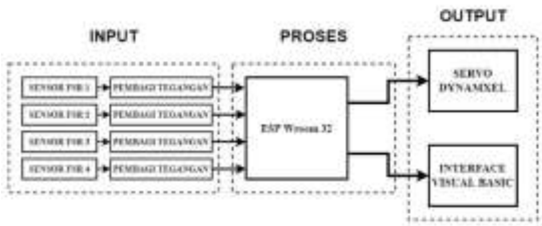

Figure 1: system concept

B. Force Resultant Equation

Force is any influence that can cause an object with mass to change, either in the form of movement, direction or geometric construction. In other words, a force can cause an object with a certain mass to change its speed (including to move from rest), or to be deformed. Vector is a force that has magnitude and direction.

The sum of all the forces acting on an object is the resultant force or the total force. Force is a vector magnitude so the total force is calculated based on the rules of vector addition. Using generated styles is for better scaling and will provide better data. For the use of the resultant force is very simple and very easy.

With raw data, namely reading the output voltage of the RP-C18.3 sensor with a voltage divider circuit, the raw data is digitized with the help of the ADC function on the microcontroller used. Raw data is converted into digital data that is easier to process and process. This raw data is processed with the formulas generated from the style above. So this is a combination of the resulting formula of the force based on the direction of the axis and the size of the force. The resultant force and the direction of the force can be seen as figure 2:

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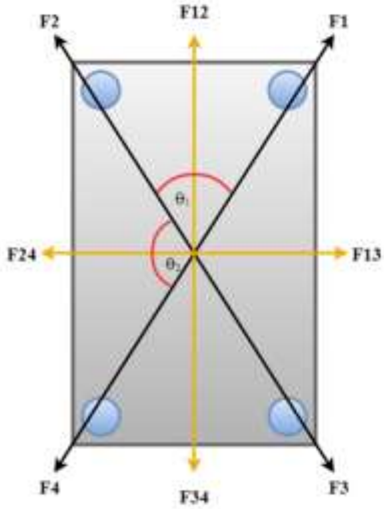

Figure 2: The Resultant Direction of the Force

From the force of each point on F1, F2, F3 and F4 there are 2 types of force results, namely in the direction of the X axis and Y axis. On the X axis there is a resultant force F13 with a positive value and a resultant force F24 with a negative value. In the Y direction, the resultant F12 is positive and the resultant F34 is negative.

C. FSR Sensor Output Voltage Reading and Delivery

The FSR sensor which has the correct resistance ratio value in the voltage divider circuit simplifies the reading process on the microcontroller. This output voltage measurement uses the Analog Digital Converter (ADC) function on the microcontroller. The ADC function on the ESP Wroom 32 microcontroller has a data area of up to 12 bits. To make transmission easier, the 12-bit ADC data is converted to 8-bit data.

RESULTS AND DISCUSSION

1. Sensor Output Voltage Testing

This output voltage test aims to find the output voltage that suits you, starting from the range to its sensitivity as well. In this test several tests were carried out, namely by using a comparison resistor worth 50K, 33k, 22k, 10k, and 4.7k.

The test is carried out by measuring the output voltage through a voltage multimeter so that when the FSR sensor is subjected to a force, the output voltage will be taken from the data and compared to which data has a large range so it will have high sensitivity.

It is known that the max voltage that can be obtained from this measurement is the same as Vin so that the maximum output voltage is 3.3V and the lowest is the same as Ground or 0V.

2. FTDI USB to Serial Communication Testing

The use of USB to Serial communication is to make it easier for the circuit to become more practical so that it is expected to be more efficient in its use. USB to Serial has a speed of more than 11Mbps. But in its use, the speed is usually set to a baud rate of 57600.

Testing this USB to serial communication by sending data and data can be displayed on a hyperterminal that can be accessed on a PC. The test to be carried out is to send data in the form of a STRING containing "90 10 40 75". In this trial using the serial monitor function of the Arduino software. The following is a display of data that has been sent and displayed on the Arduino serial monitor. The USB to Serial communication is considered successful, as evidenced by the receipt of data that has been sent from the microcontroller with the String contents arranged in such a way that it turns out to be well received and the String contents remain in such an arrangement.

3. Visual Basic Interface Testing

The use of the interface here is a way to simplify the process of monitoring the load sensor module and the processed data from the load sensor module can be visualized. Visual Basic is used because the language is easy to understand. Making this interface design according to the needs used to monitor the soles of the robot's feet. Several features will be displayed in this interface design, namely the real-time display of the robot's foot which shows the location of the load point on the leg and an indicator of the size of the pressure that occurs on the robot's foot which is displayed

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on a green BAR which will continue to increase if the pressure increases..

Testing this interface is by displaying the data sent by the load sensor module in the form of the coordinates of the fulcrum and the amount of compressive force that occurs on the sole of the foot and at the same time the data sent will also be displayed.

4. Testing the Resultant Force Formula

Each RP-C18 Sensor reading on the sole of the robot's foot will be transformed into X and Y point coordinate data, and from the average RP-C18 value obtained it will be transformed into Z-axis data or compressive force. The experiment that will be carried out is data collection from each RP-C18 sensor which has been converted into 8-bit data. The data from each RP-C18 will be entered in the equations as described above. The data obtained will later be compared with data calculated directly from theory and can be further elaborated.

Experiments were carried out when the load sensor module was subjected to a force on one of the RP-C18 sensors and when two RP-C18 sensors were subjected to a compressive force.

Table 1: X and Y coordinate data and compression force data (8-bit units)

NO	F1	F2	F3	F4
1	0.03	0.02	5.22	3.82
2	7.10	0.02	4.06	0.02
3	6.90	3.47	4.16	0.02
4	4.94	0.02	3.09	0.02
5	0.03	3.55	0.02	0.02
6	6.47	0.02	0.02	2.07
7	4.05	0.92	0.02	0.02
8	0.03	3.74	0.02	2.74
9	5.76	0.02	3.30	0.02
10	6.74	3.86	1.78	3.35
11	3.35	0.02	2.41	3.10
12	6.77	4.93	5.50	4.22

X	Y	Z
1.36	-1.47	2.27
3.23	3.05	2.80
-0.50	2.09	3.64
2.01	1.86	2.02
-3.55	3.53	0.90
4.37	4.41	2.15
3.10	3.74	1.25
-5.40	1.02	1.63
2.61	2.47	2.27
-0.96	4.55	3.93
-1.97	2.57	2.22
-5.75	5.01	5.50

Table Description:

F1 is data obtained from sensor FSR1 readings

F2 is the data obtained from the FSR2 Sensor reading

F3 is the data obtained from the FSR3 Sensor reading

F4 is the data obtained from the FSR4 Sensor reading

Y is the Y coordinate data obtained from processing reading data from each FSR sensor so as to get Y coordinate data

X is the X coordinate data obtained from processing reading data from each FSR sensor so as to get X coordinate data

Z is the Z coordinate data or compressive force obtained from processing reading data from each FSR sensor so as to obtain Z coordinate data or compressive force.

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Table 2: F12, F34, F14, and F23 data (8-bit data units)

NO	For Y		For X	
	F12	F34	F13	F24
1	0.03	1.50	5.19	3.83
2	7.09	4.04	3.26	0.03
3	6.24	4.15	2.98	3.48
4	4.93	3.08	2.04	0.03
5	3.54	0.01	0.01	3.56
6	6.46	2.05	6.45	2.08
7	3.75	0.01	4.03	0.93
8	3.73	2.72	0.01	5.40
9	5.75	3.28	2.64	0.03
10	6.15	1.60	5.03	5.99
11	3.34	0.77	1.13	3.11
12	6.42	1.41	1.85	7.60

CONCLUSION

Based on the research that has been done, several conclusions are obtained, namely as follows:

The use of the resultant force equation used is one way that can be used to determine the coordinates of the fulcrum on the soles of the robot's feet. By using the resultant equation of this force, we can also obtain data on the pressure force acting on the robot's legs. The use of the force resultant equation is easy and has few equations but produces very good and effective data.

In the tests that have been carried out in this study, there are several things that must be considered and further developed for further research, namely:

This sensor module can be a reference for robotics developers or robotics lovers.

The placement of the sensors and also the mechanics of the robot greatly affect the results or sensor readings so that they are even more optimal. Monitoring can use a website or one that does not require communication with a cable so that the robot's movement can be free without wire interference.

REFERENCES

1. Fahd, M. A. "Rancang Bangun Robot Penari Humanoid Dengan 25 Dof Untuk Melakukan Gerakan Tari Remo." *Surabaya: Institut Teknologi Sepuluh Nopember* (2018).
2. Ginting, H. O. "Alat Ukur Volume Air Dengan Menggunakan." *Medan: Universitas Sumatra Utara* (2018).
3. Hilal, M. N. "Perancangan Kaki Robot Humanoid Untuk Robot Penari Gambyong Berbasis Mikrokontoler Atemega8535." Surakarta: Universitas Muhammadiyah Surakarta (2013).
4. Manupibul, U., Charoensuk, W. & Kaimuk, P. "Design and Development of SMART Insole System for Plantar Pressure Measurement in Imbalance Human Body and Heavy Activities." *Biomedical Engineering International Conference* 1(2014): 1-5.
5. Napitupulu, E. O. P. "Esp-32 Merupakan Salah Satu Mikrokontroler Wireless Berdaya Rendah Dan Terintegrasi. In: Karakterisasi Sistem Kendali Pompa Pada Simulator Aliran Air Kanal Terbuka Mini." *Medan: Repositori Universitas Sumatera Utara* (2020): 4.
6. Pratama, F. A. "Rancang Bangun Sistem Pengaman Sepeda Motor Menggunakan Sensor Fsr(Force Sensitive Resistor), Mikrokontroler Arduino Dan Modul Sim800l." *Yogyakarta: Universitas Islam Negeri Sunan Kalijaga* (2017).
7. Riananda, P. D. "Rancang Bangun Modul Sensor Keseimbangan Robot Humanoid Soccer Dengan Menggunakan Sensor Fsr(Force Sensing Resistance)." *Surabaya: Politeknik Elektronika Negeri Surabaya* (2014).
8. Semoi, H. C. A. D. B. "Perancangan Humanoid Robot Berbasis Atmega128." *Yogyakarta: Universitas Sanata Dharma* (2014)
9. Silaonang, J. B. "Sistem Informasi Koperasi Simpan Pinjam Menggunakan Visual Basic 6.0 Dan Sql Server 2000." *Yogyakarta: Universitas Sanata Dharma* (2007).
10. Sriyanto, J. "Perancangan Sistem Kendali Robot Berkaki Dua." *Yogyakarta: Universitas Islam Indonesia* (2011).
11. Suryadi. "Komunikasi Serial dan Port Serial." *Surakarta: Teknik Informatika Universitas Muhammadiyah Surakarta* (2012).

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12. Zendrato, A. "Analisa Dan Perancangan Sistem Informasi Penggajian Pada Pt. Delta Bumi Perkasa Berbasis Visual Basic 2008." *Batam: Sekolah Tinggi Manajemen Informatika Dan Komputer (Stmik) Gici*. (2018).
13. Zhang, L., Suzuki, H. & Koyama, A. "Recognition of Meal Information Using Recurrent Neural Network and Gated Recurrent Unit Internet of Things." 1.13(2021):1-9.
14. Sutrisno, I. "Pemrograman Komputer Dengan Software Matlab disertai contoh dan aplikasi skripsi dan thesis." (2011).
15. Sutrisno, I., Firmansyah, M., Widodo, R.B., Ardiansyah, A., Rahmat, M.B., Syahid, A., Handoko, C.R, Santoso, A.D., Santosa, A.W.B., Rulaningtyas, R., Setiawan, E., Hidayat, E.P. and Wiratno, D. "Implementation of backpropagation neural network and extreme learning machine of ph neutralization prototype." (2019).
16. Abu Jami'in, M., Sutrisno, I. and Hu, J. "The State-Dynamic-Error-Based Switching Control under Quasi-ARX Neural Network Model." (2015).
17. Sutrisno, I., Syauqi, A.W., Hasin, M.K., Rahmat, M.B., Asmara, I.P.S., Wiratno, D. and Setiawan, E. "Design of pothole detector using gray level co-occurrence matrix (GLCM) and neural network (NN)." (2020).
18. Setiawan, D.B., Khumaidi, A., Priyonggo, P., Rahmat, M.B., Sutrisno, I., Nasikhin, K. and Sahputera, A.W. "Ball Direction Prediction for Wheeled Soccer Robot Goalkeeper Using Trigonometry Technique." (2019).
19. Santoso, A.D., Cahyono, F.B., Prahasta, B., Sutrisno, I. and Khumaidi, A. "Development of PCB Defect Detection System Using Image Processing With YOLO CNN Method." (2022).
20. Sutrisno, I., Jami'in, M.A. and Hu, J. "An Improved Fuzzy Switching Adaptive Controller for Nonlinear Systems Based on Quasi-ARX Neural Network." (2013).
21. Sutrisno, I., Jami'in, M.A. and Hu, J. "Implementation of Lyapunov Learning Algorithm for Fuzzy Switching Adaptive Controller Modeled Under Quasi-ARX Neural Network." (2013).
22. Rifai, M., Budiman, R.A., Sutrisno, I., Khumaidi, A., Ardhana, V.Y.P., Rosika, H., Setiyono, M., Muhammad, F., Rusmin, M. and Fahrizal, A. "Dynamic time distribution system monitoring on traffic light using image processing and convolutional neural network method." (2021).
23. Rahmat, M.B., Sutrisno, I., Santosa, A.W.B. and Nofandi, F, "Vibration Analysis of Ship-RUV Structure in Operational Conditions." (2020).

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