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KARYA ILMIAH : JURNAL ILMIAH**

C-3

Judul Jurnal Ilmiah (Artikel) : Design of Sorting Machine Shaped Based Classification Using Seven Hu's Invariant Moments

Jumlah Penulis : 2 orang

Status Pengusul : Penulis Pertama

Identitas Jurnal Ilmiah :

- a. Nama Jurnal : International Journal of Engineering and Information Systems (IJEAIS)
- b. Nomor ISSN : 2000-000X
- c. Vol, No., Bln Thn : Vol. 1 Issue 6, August – 2017, Hal : 45 - 53
- d. Penerbit :
- e. DOI artikel (jika ada) :
- f. Alamat web jurnal : <http://www.ijeais.org/ijeais/>  
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<http://www.ijeais.org/wp-content/uploads/2017/08/IJEAIS170807.pdf>  
Url Turnitin: (3%) <https://goo.gl/rUxsup>
- g. Terindex : Terindex : Indexed by reaserch gate ( <http://www.ijeais.org/ijeais/index.php/indexing/> ) Impact Factor : 3,80

Kategori Publikasi Jurnal Ilmiah (beri ✓ pada kategori yang tepat) :

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- Jurnal Ilmiah Nasional Terakreditasi
- Jurnal Ilmiah Nasional Tidak Terakreditasi

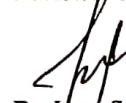
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<b>Total = (100%)</b>	<b>20,00</b>			<b>17</b>
	<i>16,75 x 0,6 = 10,05</i>			

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2. Ruang lingkup dan kedalaman pembahasan: lingkup pembahasan pada jurnal ini telah fokus pd. Metode deteksi bentuk, hanya pembahasan yg dituliskan dan tulisan ini relatif kurang mendalam. Nilai = 5
3. Kecukupan dan kemutakhiran data/informasi dan metodologi: metode yg digunakan dalam tulisan relatif jelas, tetapi data, info dan referensi yg digunakan dan tulisan kurang mutakhir. Nilai = 5
4. Kelengkapan unsur dan kualitas terbitan: semua unsur terbitan telah ada hanya saja beberapa persamaan hkl konsisten telah penomerannya. Nilai = 5.

Semarang  
Reviewer 1



Dr. Iwan Setiawan, ST, MT  
NIP. 197309262000121001  
Unit Kerja : Teknik Elektro FT UNDIP

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**HASIL PENILAIAN SEJAWAT SEBIDANG ATAU PEER REVIEW**  
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Hasil Penilaian Peer Review :

Komponen Yang Dinilai	Nilai Maksimal Jurnal Ilmiah			Nilai Akhir Yang Diperoleh
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a. Kelengkapan unsur isi jurnal (10%)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1,5
b. Ruang lingkup dan kedalaman pembahasan (30%)	2,00	6,00	6,00	5
c. Kecukupan dan kemutakhiran data/informasi dan metodologi (30%)	6,00	6,00	6,00	5
d. Kelengkapan unsur dan kualitas terbitan/jurnal (30%)	6,00	6,00	6,00	5
<b>Total = (100%)</b>	<b>20,00</b>	<b>20,00</b>	<b>20,00</b>	<b>16,5</b>
<i>16,75 x 0,6 = 10,05</i>				<i>16,5</i>

**Catatan Penilaian artikel oleh Reviewer :**

a) Kesesuaian dan kelengkapan unsur isi jurnal:  
 Materi jurnal sesuai dengan penulis unsur isi jurnal ada yg. kurang kelas ilmu-kejuruan (metodologi) dan pembahasan, referensi kurang dan komputer.

b) Ruang lingkup dan kedalaman pembahasan:  
 Pembahasan terbayat secara dan akan namun hasil referensi ada yg. tertulis dan nomor, tabel 13

c) Kecukupan dan kemutakhiran data/informasi dan metodologi:  
 metodologi kurang di jelaskan dan pengujian satu sm 7 data pustaka karya sm 5 tahun

d) Kelengkapan unsur dan kualitas terbitan:  
 penyajian tulisan dan yg. model dan nomor, tabel 13, 14. Maksimal disajikan dan jurnal internasional yg. ter bereputasi

Semarang,  
Reviewer 2

Dr. Wahyudi, S.T., M.T.  
 NIP. 196906121994031001  
 Unit Kerja : Teknik Elektro FT UNDIP

**LEMBAR  
HASIL PENILAIAN SEJAWAT SEBIDANG ATAU PEER REVIEW  
KARYA ILMIAH : JURNAL ILMIAH**

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**Impact Factor : 3,80**

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Hasil Penilaian Peer Review :

Komponen Yang Dinilai	Nilai Reviewer		Nilai Rata-rata
	Reviewer I	Reviewer II	
a. Kelengkapan unsur isi jurnal (10%)	2	1,5	1,75
b. Ruang lingkup dan kedalaman pembahasan (30%)	5	5	5
c. Kecukupan dan kemutahiran data/informasi dan metodologi (30%)	5	5	5
d. Kelengkapan unsur dan kualitas terbitan/jurnal (30%)	5	5	5
<b>Total = (100%)</b>	<b>17</b>	<b>16,5</b>	<b>16,75</b>

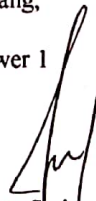
Reviewer 2



Dr. Wahyudi, S.T., M.T.  
 NIP. 196906121994031001  
 Unit Kerja : Teknik Elektro FT UNDIP

Semarang,

Reviewer 1



Dr. Iwan Setiawan, ST, MT  
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**Authors:** Tawfikur Rahman, S. M. A. Motakabber, M. I. Ibrahimy  
**Keywords:** Full phase PSI, PWM, zero crossing, LC filter, microgrid  
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Sumardi Sumardi &lt;sumardi.undip@gmail.com&gt;

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**Re: A New Manuscript have been Submission**

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IJEAIS Journal &lt;ijeaisjournal@gmail.com&gt;

25 Juli 2017 18.37

Kepada: Sumardi Sumardi &lt;sumardi.undip@gmail.com&gt;

Dear Dr. Sumardi,

We have received your new manuscript titled: "Design of Sorting Machine Shaped Based Classification Using Seven Huâ€™s Invariant Moments" and will let you know the status very soon.

**Best Regards**

---

**Ms. Kathy Miller**  
**Secretary of IJEAIS**  
[www.ijeais.org](http://www.ijeais.org)

On Tue, Jul 25, 2017 at 1:01 PM, &lt;sumardi.undip@gmail.com&gt; wrote:

A user Sumardi has submitted a paper :

Name: Sumardi

Type : 1

Country: 82

Branch: 45

Other:

Area of Research: Control, Instrumentation

University: Diponegoro University

Title: Design of Sorting Machine Shaped Based Classification Using Seven Huâ€™s Invariant Moments

Abstract: Sorting machine is used in many production processes in industries especially for those who produce various kinds of products. Sorting machine is used to classify object that have a similiarity just like have a shape similiarity. This research makes a design of sorting machine based on shape, which is the shape of square, circle, rectangle, and triangle. The shape recognition process uses invariant moment method and ANFIS with ATmega16 microcontroller as the overall system controller. The machine uses object sensor and webcam. By using object sensor, that is LED and photodiode, the sorting machine gets to know the existence of the objects as a signal for webcam to captured the image of the object and a signal for pneumatic to separate the object to a basket based on its shape. Actuators on the system are DC motors as a motor conveyor, pneumatic to separate objects, and LCD to display the results. From the tests performed, the system success rate in whole system in separating objects is 80%.

Keyword: sorting machine, image processing, seven Huâ€™s invariant moments, microcontroller ATmega16, ANFIS, shape



Sumardi Sumardi &lt;sumardi.undip@gmail.com&gt;

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**Re: A New Manuscript have been Submission**

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IJEAIS Journal &lt;ijeaisjournal@gmail.com&gt;

29 Juli 2017 03.29

Kepada: Sumardi Sumardi &lt;sumardi.undip@gmail.com&gt;

Dear Dr. Sumardi,

Your manuscript titled: "Design of Sorting Machine Shaped Based Classification Using Seven Huâ€™s Invariant Moments" is accepted and will be published in Vol1 issue 5, July 2017.

**Best Regards**

---

**Ms. Kathy Miller**  
**Secretary of IJEAIS**  
[www.ijeais.org](http://www.ijeais.org)

On Tue, Jul 25, 2017 at 1:01 PM, &lt;sumardi.undip@gmail.com&gt; wrote:

A user Sumardi has submitted a paper :

Name: Sumardi

Type : 1

Country: 82

Branch: 45

Other:

Area of Research: Control, Instrumentation

University: Diponegoro University

Title: Design of Sorting Machine Shaped Based Classification Using Seven Huâ€™s Invariant Moments

Abstract: Sorting machine is used in many production processes in industries especially for those who produce various kinds of products. Sorting machine is used to classify object that have a similarity just like have a shape similarity. This research makes a design of sorting machine based on shape, which is the shape of square, circle, rectangle, and triangle. The shape recognition process uses invariant moment method and ANFIS with ATmega16 microcontroller as the overall system controller. The machine uses object sensor and webcam. By using object sensor, that is LED and photodiode, the sorting machine gets to know the existence of the objects as a signal for webcam to capture the image of the object and a signal for pneumatic to separate the object to a basket based on its shape. Actuators on the system are DC motors as a motor conveyor, pneumatic to separate objects, and LCD to display the results. From the tests performed, the system success rate in whole system in separating objects is 80%.

Keyword: sorting machine, image processing, seven Huâ€™s invariant moments, microcontroller ATmega16, ANFIS, shape



Sumardi Sumardi &lt;sumardi.undip@gmail.com&gt;

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**Re: A New Manuscript have been Submission**

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Sumardi Sumardi <sumardi.undip@gmail.com>  
Kepada: IJEAIS Journal <ijeaisjournal@gmail.com>

29 Juli 2017 10.09

Dear publisher, I decide my article should be published in august.

Pada tanggal 29 Jul 2017 09:47, "IJEAIS Journal" <ijeaisjournal@gmail.com> menulis:

Dear Dr. Sumardi,

Ok, we will postpone your paper until you tell us to publish it or not.

**Best Regards**

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**Ms. Kathy Miller**  
**Secretary of IJEAIS**  
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On Sat, Jul 29, 2017 at 4:52 AM, Sumardi Sumardi <sumardi.undip@gmail.com> wrote:

Dear publisher . According to my paper title "Design of Sorting Machine Shaped Based Classification Using Seven Huâ€™s Invariant Moments" that have been submitted & accepted, can I change the publication time in July 2017 to the next month in August 2017 or Sept 2017. I'll wait for your response. Thanks.



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Terima kasih

Sumardi  
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Your manuscript titled: "Design of Sorting Machine Shaped Based Classification Using Seven Huâ€™s Invariant Moments" is accepted and will be published in Vol1 issue 5, July 2017.

**Best Regards**

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Title: Design of Sorting Machine Shaped Based Classification Using Seven Huâ€™s Invariant Moments

Abstract: Sorting machine is used in many production processes in industries especially for those who produce various kinds of products. Sorting machine is used to classify object that have a similiarity just like

have a shape similiary. This research makes a design of sorting machine based on shape, which is the shape of square, circle, rectangle, and triangle. The shape recognition process uses invariant moment method and ANFIS with ATmega16 microcontroller as the overall system controller. The machine uses object sensor and webcam. By using object sensor, that is LED and photodiode, the sorting machine gets to know the existense of the objects as a signal for webcam to captured the image of the object and a signal for pneumatic to separate the object to a basket based on its shape. Actuators on the system are DC motors as a motor conveyor, pneumatic to separate objects, and LCD to display the results. From the tests performed, the system success rate in whole system in separating objects is 80%.

Keyword: sorting machine, image processing, seven Huâ€™s invariant moments, microcontroller ATmega16, ANFIS, shape

# Design of Sorting Machine Shaped Based Classification Using Seven Hu's Invariant Moments

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**Abstract:** *Sorting machine is used in many production processes in industries especially for those who produce various kinds of products. Sorting machine is used to classify object that have a similarity just like have a shape similarity. This research makes a design of sorting machine based on shape, which is the shape of square, circle, rectangle, and triangle. The shape recognition process uses invariant moment method and ANFIS with ATmega16 microcontroller as the overall system controller. The machine uses object sensor and webcam. By using object sensor, that is LED and photodiode, the sorting machine gets to know the existence of the objects as a signal for webcam to captured the image of the object and a signal for pneumatic to separate the object to a basket based on its shape. Actuators on the system are DC motors as a motor conveyor, pneumatic to separate objects, and LCD to display the results. From the tests performed, the system success rate in whole system in separating objects is 80%.*

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## 1. INTRODUCTION

In the current era, the technology developed rapidly. Everything is made to be automated to reduce human error because human tends to become tired and ineffective when come to continuous work for a long time [1]. Industrial owner begin to do their production using automated industrial process. Moreover industrial that have to manufacture various kinds of products in large quantities have to sort them according to their respective types. Nowadays there have been several ways to do the sorting such as using camera [2], color sensor [1] [3] photodiode sensor [1], etc.

Design of the sorting conveyor with pattern recognition and color pattern using webcam has also been done by Rudi et al [2]. Zhihu [4] analyzes the invariant moments of hu on scaling and rotating image. There is also research conducted by Eskanesiari [5] about leaf image identification using 7 invariant moment method. Dewi [6] conducted a study on an ANFIS based identification model. Similarly, Nurul [7] uses ANFIS for the identification of human eye retinas.

This research uses objects with various shapes such as cube, cylinder, beam, and equilateral triangle prism. A webcam used to produce 2-dimensional images of squares, circles, rectangles, and equilateral triangles with RGB level as system input. The first image processing is to transform the image of the object into a gray-shaded image and then there is a segmentation process to convert it into binary image. The binary image calculated using 7 invariant moments to produce parameter features of each image. For the image identification process, Adaptive Neural Fuzzy Inference System (ANFIS) method is used. The resulting image identification data will be transmitted to the ATmega16 microcontroller to control conveyors and pneumatic actuators to separate objects in accordance with their respective forms.

## 2. SEVEN HU'S INVARIANT MOMENTS

This design use seven hu's invariant moments to extract the object feature parameter and ANFIS to identify the shape of the object. Input for this process is object's image which is captured by webcam. Fig. 1 shows the inputs for this sorting machine are push buttons, object sensors, and webcam. A PC is needed as the image processor and sends itu through serial communication to microcontroller which control the pneumatic and DC motor. Flowchart of the main program is shown in Fig. 2.

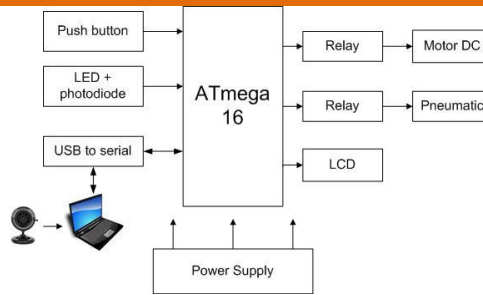


Fig. 1. System Design Block Diagram

### 2.1 Image Processing using Invariant Moments

Image processing begin by captured image objects on the conveyor using webcam. RGB image then converted to grayscale image then to black and white image or biner image. Finally, invariant moments extract parameter feature from the binary image. The processes of invariant moments are listed below:

1. Biner image is used to be the input for feature extraction. Use command “size” from matlab to find size of the image (matrix).
2. Input Matrix will be calculated resulting in moments of several ordes.
3. By (1), we can find regular moment of object image. Moments orde 00, 01, and 10 are used to be input to find center of image coordinate. To obtain moments that invariant to rotation, central moment is calculated based on the center of image coordinate.

$$m_{pq} = \sum_x \sum_y x^p y^q f(x, y), p, q = 0, 1, 2, \dots \quad (1)$$

4. To obtain moments that invariant to scale, moment invariant normalized using (2).

$$\eta_{pq} = \frac{\mu_{pq}}{\mu_{00}^\gamma}, \gamma = \frac{p+q+2}{2}, p + q = 2, 3, \dots \quad (2)$$

5. From the normalized moment, find the seven-tuplet moments set that invariant to translation, scaling, mirroring, and rotation of the image shape using (3)-(9).

$$\phi_1 = \eta_{20} + \eta_{02} \quad (3)$$

$$\phi_2 = (\eta_{20} - \eta_{02})^2 + 4\eta^2 \quad (4)$$

$$\phi_3 = (\eta_{30} - 3\eta_{12})^2 + (3\eta_{21} - \eta_{03})^2 \quad (5)$$

$$\phi_4 = (\eta_{30} + \eta_{12})^2 + (\eta_{21} + \eta_{03})^2 \quad (6)$$

$$\phi_5 = (\eta_{30} - 3\eta_{12})(\eta_{30} + \eta_{12})[(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] + (3\eta_{21} - \eta_{03})(\eta_{21} + \eta_{03})[3(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2] \quad (7)$$

$$\phi_6 = (\eta_{20} - \eta_{02})[(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2] + 4\eta_{11}(\eta_{30} + \eta_{12})(\eta_{21} + \eta_{03}) \quad (8)$$

$$\phi_7 = (3\eta_{21} - \eta_{03})(\eta_{30} + \eta_{12})[(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] + (3\eta_{21} - \eta_{03})^2(\eta_{21} + \eta_{03})[3(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2] \quad (9)$$

### 2.2 ANFIS Training

ANFIS training uses 39 images of square, circle, rectangle, and triangle that have rotation, translation, and scaling variation. Matlab provide toolbox for ANFIS Training. The processes of ANFIS Training are listed below:

1. Choose .xls file that contain feature extraction training data.
2. Train ANFIS using FIS Sugeno orde 1.
3. Input the number of membership functions, number of epoch, error goal, and type of membership functions, as the training parameters.
4. From training ANFIS we will get epoch-error graphic and the number of last rmse result.
5. After training ANFIS finished, save the network into \*.mat document and use it for ANFIS examination.

### 2.3 ANFIS Examination

The steps in ANFIS examination for sorting machine are listed below:

1. After the characteristic extraction process is completed, the result will be converted into a matrix. Then it will be called to become examination data.

2. Generated weights and biases data will deliver the examination data to the nearest output value through the root mean square error calculation shown in equation 2.9.
3. The resulting output determined which pneumatic should be active by send commands from matlab to the microcontroller.
4. Once the object is successfully sorted by pneumatic, then the process can run from the beginning.

### 2.4 Software Design

In this system, software design divided into 2 sections:

1. Design of microcontroller ATmega 16 program
2. Design of matlab program

This microcontroller acts as a main controller of input and output system. While matlab is used to perform image processing of objects that have been detected to determine the shape of object. Figure 2 show flowchart of the system process.

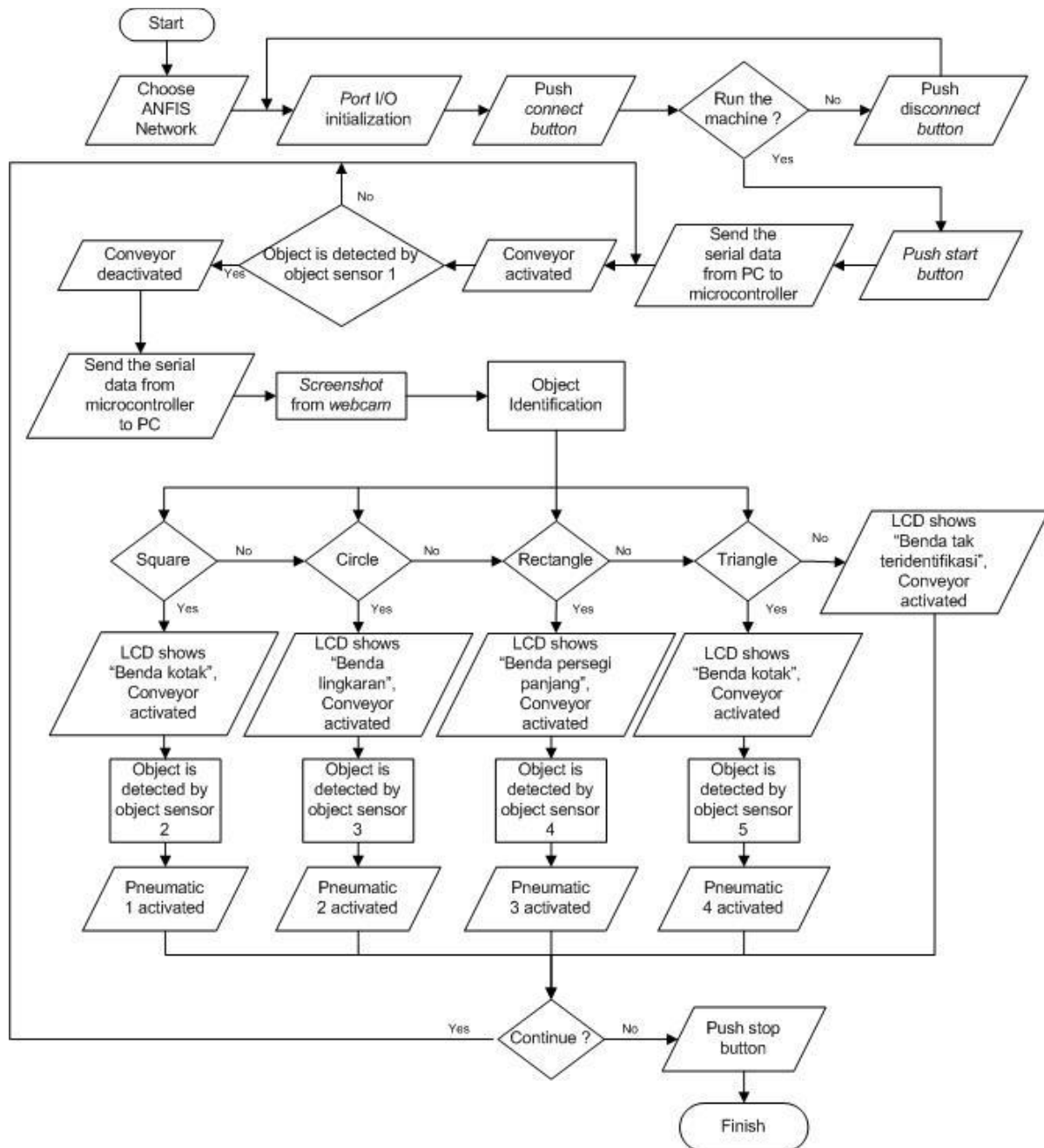


Fig. 2. Main Process Flowchart

### 3. RESULTS AND ANALYSIS

The result that monitored from this sorting machine are the output voltage on the object sensor, the value of seven hu's invariant moments, and the success rate of the system.

#### 3.1 OBJECT SENSOR EXAMINATION

Purpose of this examination is to get the output voltage on the object sensor either an object is detected or not. This examination uses a digital multi-meter to know the magnitude of the output voltage.

##### 3.1.1 Object Sensor 1

The examination measure the output voltage on the object sensor 1 when an object is detected. Table 1 shows object sensor 1 examination result, the sensor output voltage when an object detected is 4.27 V and when object not detected is 2.786 V. Table 1 shows object sensor 1 examination result, the sensor output voltage when an object detected is 4.27 V and when object not detected is 2.786 V.

##### 3.1.2 Object Sensor 2

The examination measure the output voltage on the object sensor 2 when an object is detected. Table 2 shows object sensor 2 examination result, the sensor output is 4.764 V voltage when an object detected and 2.86 V and when object not detected.

##### 3.1.3 Object Sensor 3

The examination measure the output voltage on the object sensor 3 when an object is detected. Table 3 shows result of object sensor 3 examination result, the sensor output is 4.61 V voltage when an object detected and 2.4 V and when object not detected.

##### 3.1.4 Object Sensor 4

The examination measure the output voltage on the object sensor 4 when an object is detected. Table 4 shows result of object sensor 4 examination result, the sensor output is 4.83 V voltage when an object detected and 2.89 V and when object not detected.

##### 3.1.5 Object Sensor 5

The examination measure the output voltage on the object sensor 5 when an object is detected. Table 5 shows result of object sensor 5 examination result, the sensor output is 4.55 V voltage when an object detected and 2.52 V and when object not detected.

Table 1. Object sensor 1 examination result

Number	Condition	
	Object detected	Object not detected
1	4,26 V	2,8 V
2	4,26 V	2,8 V
3	4,27 V	2,78 V
4	4,24 V	2,77 V
5	4,32 V	2,78 V
Average	4,27 V	2,786 V

Table 2. Object sensor 2 examination result

Number	Condition	
	Object Detected	Object not Detected
1	4,77 V	2,86 V
2	4,76 V	2,86 V
3	4,77 V	2,86 V
4	4,76 V	2,86 V
5	4,76 V	2,86 V
Average	4,764 V	2,86 V

Table 3. Object sensor 3 examination result

Number	Condition	
	Object Detected	Object not Detected
1	4,61 V	2,39 V
2	4,61 V	2,4 V
3	4,61 V	2,4 V
4	4,61 V	2,4 V
5	4,61 V	2,4 V
Average	4,61 V	2,4 V

**Table 4.** Object sensor 4 examination result

Number	Condition	
	Object Detected	Object not Detected
1	4,83 V	2,87 V
2	4,83 V	2,91 V
3	4,83 V	2,90 V
4	4,83 V	2,90 V
5	4,83 V	2,87 V
Average	4,83 V	2,89 V

**Table 5.** Object sensor 5 examination result

Number	Condition	
	Object Detected	Object not Detected
1	4,55 V	2,52 V
2	4,55 V	2,52 V
3	4,55 V	2,52 V
4	4,55 V	2,52 V
5	4,55 V	2,52 V
Average	4,55 V	2,52 V

From the examination performed on object sensor 1 to object sensor 5 there is difference of output voltage result when sensor detects object and when sensor does not detect object. The difference of output voltage result can determine whether there are object on the conveyor or not.

**3.2 SEVEN HU’S INVARIANT MOMENTS METHOD EXAMINATION**

This examination purpose to prove that seven hu’s invariant moments is invariant to scaling, translation, and rotation of the image.

**3.2.1 Seven hu’s invariant moments on square object**

In this examination, the image of the detected object is processed to obtain a value of 7 hu invariant moment. The results obtained in this examination shown in Table 6

Based on the examination results in Table 6, it can be seen that the average difference of hu value for objects with variation of rotation to the normal position is 5.0194. This can be affected because the process of pre-image processing is less perfect because of the edges of the object that is formed have many curve.

**3.2.2 Seven hu’s invariant moments on round object**

Based on the examination results in Table 7, the difference between the hu values for each variation of rotation, translation, and size are 0.8313, 0.4974, and 0.008. This calculation proves that seven hu’s invariant moment is invariant to scaling, rotation, and translation.

**3.2.3 Seven hu’s invariant moments on rectangle object**

Based on the examination results in Table 8, the difference between the hu values for each variation of rotation, translation, and size are 1,2761, 0,3464, and 0,2325 This calculation prove that seven hu’s invariant moment is invariant to scaling, rotation, and translation.

**3.2.4 Seven hu’s invariant moments on triangle object**

Based on the examination results in Table 9, the difference between the hu values for each variation of rotation, translation, and size are 0,0926, 0,0839, and 0,1844. This calculation proves that seven hu’s invariant moment is invariant to scaling, rotation, and translation.

**Table 6.** Invariant moment examination result on square object

Object	Placing	Seven hu’s invariant moments value						
		1	2	3	4	5	6	7
Square	Normal	1,78	9,22	18,23	18,01	36,45	23,76	36,64
Square	Rotation	1,77	10,94	21,68	23,32	46,63	28,81	46,08
Square	Translation	1,78	9,22	18,23	18,01	36,45	23,76	36,64
Square	Scaling	1,78	9,54	16,84	18,54	36,37	24,06	39,60

**Table 7.** Invariant moment examination result on round object

Object	Placing	Seven hu’s invariant moments value						
		1	2	3	4	5	6	7
Round	Normal	1,77	12,37	20,24	20,86	42,09	30,23	41,57

Round	Rotation	1,77	9,70	19,04	21,28	41,86	27,95	41,71
Round	Translation	1,77	11,04	20,11	21,19	42,40	27,00	42,12
Round	Scaling	1,76	15,20	18,59	20,52	43,42	29,56	40,08

**Table 8.** Invariant moment examination result on rectangle object

Object	Placing	Seven hu's invariant moments value						
		1	2	3	4	5	6	7
Rectangle	Normal	1,76	6,50	19,95	19,07	38,63	22,39	39,71
Rectangle	Rotation	1,75	6,59	18,11	19,93	29,78	23,69	39,21
Rectangle	Translation	1,75	6,33	17,77	19,87	39,01	26,50	39,19
Rectangle	Scaling	1,76	6,61	17,49	19,66	38,48	23,22	39,15

**Table 9.** Invariant moment examination result on triangle object

Object	Placing	Seven hu's invariant moments value						
		1	2	3	4	5	6	7
Segitiga	Normal	1,76	10,00	12,75	16,01	30,58	21,02	32,30
Segitiga	Rotation	1,76	10,38	13,17	15,44	29,92	20,88	32,23
Segitiga	Translation	1,76	10,05	12,86	15,90	30,44	20,94	33,07
Segitiga	Scaling	1,75	11,36	12,33	15,44	29,51	21,13	31,62

### 3.3 System Examination

The object separation system examination is done continuously when the system starts running from the initial stage to the final stage, then observes the change in the input / output step by step until the process is complete. The objects are square, circle, rectangle, and triangle.

#### 3.3.1 Detection Examination Square Object

This examination aims to determine the success rate of the system in separating the square object. In Table 10 it can be seen that the examination performed can separate the square object and the object sensor 2 is able to detect the existence of the object so that the pneumatic 1 is active. From 5 times examination, this sorting machine is able to sort the square object as much as 4 times.

#### 3.3.2 Detection Examination Object Round

This examination aims to determine the success rate of the system in separating the circle object. In Table 11 it can be seen that the examination performed can separate the circle object and the object sensor 3 is able to detect the existence of the object so that the pneumatic 2 is active. From 5 times examination, this sorting machine is able to sort the square object as much as 4 times

#### 3.3.3 Detection Examination Object Rectangle

This examination aims to determine the success rate of the system in separating the rectangle object. In Table 12 it can be seen that the examination performed can separate the rectangle object and the object sensor 4 is able to detect the existence of the object so that the pneumatic 3 is active. From 5 times examination, this sorting machine is able to sort the square object as much as 3 times.

**Table 10.** Pengujian Object Square

No	Object	Condition Object	Sensor Object 1	Sensor Object 2	Hasil Pengamatan
1	Square	Dtected	Activated	Deactivated	Pneumatic 1 Deactivated
2	Square	Dtected	Activated	Activated	Pneumatic 1 Activated
3	Square	Dtected	Activated	Activated	Pneumatic 1 Activated
4	Square	Dtected	Activated	Activated	Pneumatic 1 Activated
5	Square	Dtected	Activated	Activated	Pneumatic 1 Activated

Table 11. Pengujian Object Round

No	Object	Condition Object	Sensor Object 1	Sensor Object 3	Results
1	Round	Detected	Activated	Deactivated	Pneumatic 2 Deactivated
2	Round	Detected	Activated	Activated	Pneumatic 2 Activated
3	Round	Detected	Activated	Activated	Pneumatic 2 Activated
4	Round	Detected	Activated	Activated	Pneumatic 2 Activated
5	Round	Detected	Activated	Activated	Pneumatic 2 Activated

Table 12. Pengujian Object Rectangle

No	Object	Condition Object	Sensor Object 1	Sensor Object 4	Results
1	Rectangle	Detected	Activated	Deactivated	Pneumatic 3 Deactivated
2	Rectangle	Detected	Activated	Activated	Pneumatic 3 Activated
3	Rectangle	Detected	Activated	Deactivated	Pneumatic 3 Deactivated
4	Rectangle	Detected	Activated	Activated	Pneumatic 3 Activated
5	Rectangle	Detected	Activated	Activated	Pneumatic 3 Activated

### 3.3.4 Detection Examination Triangle Object

This examination aims to determine the success rate of the system in separating the triangle object. In Table 13 it can be seen that the examination performed can separate the triangle object and the object sensor 5 is able to detect the existence of the object so that the pneumatic 4 is active. From 5 times examining, this sorting machine is able to sort the square object as much as 5 times.

### 3.3.5 Whole Examination

The process of separating the object is done 20 times by doing 5 times examination for each shape of the object that is square, circle, rectangular and triangular objects. This examination is done randomly. The examination results can be seen in Table 14. Pada proses ini dilakukan pemisahan object sebanyak 20 kali dengan menggunakan 5 buah object dari masing-masing bentuk yaitu object berbentuk Square, round, Rectangle dan segitiga. Pengujian ini dilakukan secara acak. Hasil pengujian tersebut dapat dilihat pada Table 14.

Based on Table 14 we can see that the results of examining the separation of objects is good enough although still not maximal because there are 4 pieces of objects that have not been able to be identified. This is because the imperfect image processing process, the ANFIS training process is still limited due to the limitations of computing on the PC used, so that the sorting machine is not able to identify the shape of the object correctly. Based on the results of the examination, then obtained the success rate on the whole system can be calculated (10).

So the success rate of the sorting engine is 80%. The examination process of this sorting machine is still not maximal because the process of separating objects is done alternately, the process can not be done by alternating. This is due to the microcontroller reading the program in sequence.

$$\frac{16}{20} \times 100\% = 80\% \quad (10)$$

Table 13. Pengujian Object Segitiga

No	Object	Condition Object	Sensor Object 1	Sensor Object 4	Results
1	Triangle	Terbaca	Aktif	Aktif	Pneumatic 4 Activated
2	Triangle	Terbaca	Aktif	Aktif	Pneumatic 4 Activated
3	Triangle	Terbaca	Aktif	Aktif	Pneumatic 4 Activated
4	Triangle	Terbaca	Aktif	Aktif	Pneumatic 4 Activated
5	Triangle	Terbaca	Aktif	Aktif	Pneumatic 4 Activated

Table 14. Pengujian pemisah object

Object	Number of Object	Number of Identified Object	Number of Unidentified Object (Error)
Square	5	4	1
Round	5	4	1
Rectangle	5	3	2
Triangle	5	5	0

#### **4. CONCLUSION**

The sorting machine is running well enough with a success rate of 80%. The sorting machine can identify and separate square objects 4 times, circle objects 4 times, rectangular objects 3 times, and triangle objects 5 times. The average of the object's sensor output voltage when there is an object is 4.6 V and when no object is 2.69 V. From the invariant moment method examining on square objects, circles, rectangles, and triangles capable of proving that the invariant moment method is invariant to rotation, size, and orientation of the image shape. In rectangular objects with rotation variation there is an average difference of hu value of 5,0194 to the normal position. This is because the image processing process is less perfect so that the edge of the object that is formed there are still many indentations.

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