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Human Perceptron Method to Design Robot Shapes and Develop Architecture for 3D Camera Device

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Abstract
In this paper, we study light weight material plastics. We study different shapes. They include connector, frame, ring, triangle shape, star and wheel. The shapes when assembled form the manual controlled robot. We develop human perceptron method to collect data of the dimensions, color and shape features of the robot. We include the method to develop 3D computer aided design (CAD) model. The structural similarity index (SSIM) is 0.42 giving good accuracy to actual object. We develop correlation model between the dimension and pixel. The pixel conversion factor is 19.2 pixels/mm. The calculated pixels for overall connector length of 50 mm are 960 pixels. We understand the relation between meter scale shape component of the robot to the pixel for the first time. We design an integrated 3D camera system. We use the neural network hardware rules to obtain the weight of individual connector pair segment to be used for training the segment movement. The segment neural network moves individually in x, y and z directions. The laser distance meter is used to record and store in excel sheet the x, y, z movement. The distance meter has Bluetooth enabled. The integrated system has laptop with python to visualize the given object. We visualize 3D image. We obtain high resolution camera image comparable to actual object. The weight for the connector pair segment in the neural network hardware predicts the new x, y and z, respectively. The advantages of lightweight materials are they can be frequently assembling or disassembled. There is no need to use physical wiring concept. It is easy to scale the shape and complete robot from millimetre to meter.

Keywords: Artificial Consciousness (AC), Artificial Intelligence (AI), Cognition, Cognitive System (CS), Semantic Artificial Intelligence.

Introduction

Robot device has many components. Each component has different shape. The dimensions of the components are given. The shape of the component helps to assemble two components together. Hence the shape of robot components has to be studied. The shape and number of components in the robot device depends on the task [1,2].

The robot can be manual control, electric control and fuel control. The fuel can be solid, liquid, polyethylene, fluid and gas. The structure design of the component in the computer is must. 3D computer aided design of the component should resemble the actual object. Generally, the size of the robot components vary from micrometre to few cm. Humanoid robot components are meter size. The assembly gives the manufactured robot of structures that the shapes comply. The science of geometry from similar shapes are usual in buildings and towers. The study of shapes at different positions gives fit rather any other compatibility aspects of structure [3,4].

The known function that is natural for robots are predominant shape movement to different positions with respect to the structure. The structure is fixed at given location. Recent studies are understanding the location of the shape in the structure [5,6].

There are studies to understand the stress in the robot components. The force, torque and velocity of the component are available. The study of overall robot movement is available [7-10].

The optimisation of material to construct the component and robot are looked in detail. The size and scale of the robot are with regard to the availability of the raw materials and mould shapes. Lightweight materials make soft robots. The robots are many walkers, bots, locomotors and four legged quadrupedal robots [11-14].

The tasks studied for the robots are terrain locomotion, package delivery and truck movers. The scan of robot structures are resourceful. The fact that robot needs task to work and it is machine to use towards art relevance are insightful. Swarm robots are designed to be independent and aware of the group to complete its task. Robots are used to image micro and nano morphology from samples of millimetre size [15-18]. They are used in air travel. There are works to draw inspiration of nature, animals, petals, plants to the robots and understanding to equal task from the locomotion methods. The control aspects of the robot are studied [19-32]. The locomotion can be controlled by electric motor for plant petal motion equals. The energy of the locomotor based from plant design are efficient and energy applied. Nowadays neural network architecture is studied [33-34]. The ecosystem to inspire robot design to perform the art includes the next integration. The art task robot with the ecosystem drives the understanding of healthy environment manufacturing.

In this paper we study the design of components of the robot. We study toy small size components. We study different shapes that include connector, triangle shape, ring, frame, star and wheel. We develop 3D computer aided design model of the components. We design various shapes. We develop human perceptron method to obtain the 3D design for different shapes for the first time. The dimension of the component are mm to cm size. We study the structural similarity index between actual component and 3D model. We develop high resolution 3D image. In this study we design complete robot to perform human task. We develop the design for 3D camera device.

The rest of the paper is outlined as follows. Section 2 discusses the materials and methods. The necessary theory is elucidated in Section 3. A detailed discussion of the design and component analysis are given in Section 4. The application design is provided in section 5. Finally, conclusions are presented in Section 6.

Materials and Methods

We use the material made of plastics. The toy robot size plastics are purchased from Hamleys, India. The toy shapes are large connectors and small connectors. The colors are pink, orange, and purple. We also study the shapes of ring, frame, star and wheels. The colors are orange, white, purple and green. We measured the object using scale and micrometer. The micrometer and Bosch GLM bluetooth enabled distance meter are purchased from Progressive Trading corporation, India. The camera images are taken using OM camera. The camera is purchased from Kesari Scientific Chemicals, India.

Theory

Human Perceptron Method

In this method the participants collect the data of the objects. The data of the components of toy robot are taken. For each component we collect and write the dimensions, shape, number of those components used in the study and colour as given in Table 1. We do not collect the sound data. Here, we study 11 shapes. The shapes are connectors, ring, frame, triangle shape, star and wheel. We study three small connectors of different color. Human perceptron method uses senses of the person. They include eyes and hands. The eyes show the shape and color of the object. The hands are used to measure their dimensions. Table 2 shows the senses of the person used for each component. The learning rule is predominantly the shape. The logic function is that if the component belongs to that shape.

Table 1: Components of the toy robot of small size. The brackets show the number of each component studied.

Components	Dimensions	Color
Large connectors (1)	Shaft diameter = 4 mm, neck diameter = 2mm, overall length = 50 mm, neck length = 3 mm, connector horizontal length after neck = 5 mm, connector C length = 3 mm, C width = 3 mm and C height = 4 mm.	Pink
Small connectors (3)	Shaft diameter = 4 mm, neck diameter = 2mm, overall length = 25 mm, neck length = 3 mm, connector horizontal length after neck = 5 mm, connector C length = 3 mm, C width = 3 mm and C height = 4mm.	Pink, orange and purple
triangle shape (1)	Equilateral length for all sides. Inner side length = 45 mm, outer side length = 55 mm, diameter = 5 mm and thickness = 5 mm.	Yellow
Big ring (1)	outer diameter = 50 mm, inner diameter = 40 mm and thickness = 5 mm	Lime
Small ring (1)	outer diameter = 35 mm, inner diameter = 25 mm and thickness = 5 mm	Purple
Big frame (1)	Inner length = 40 mm, inner width = 40 mm, outer length = 50 mm, outer width = 50 mm, depth = 5 mm and thickness = 5 mm.	Green
Small frame (1)	Inner length = 30 mm, inner width = 30 mm, outer length = 40 mm, outer width = 40 mm, depth = 5 mm and thickness = 5 mm.	White
star (1)	Length = 30 mm, width = 30 mm, depth = 5 mm, diameter = 5mm and joining length = 10 mm. Numbers are 10 to describe the object star. Color is purple.	Purple
wheel (1)	Outer diameter = 36 mm, inner diameter = 30 mm and thickness = 10 mm. The inner hole has outer diameter = 10 mm and inner diameter = 6 mm. The spoke length = 10 mm, width = 2 mm and height = 10 mm. There are 4 spoke lengths.	Gray

Table 2: Human Senses used for Each Component.

Components	Human senses		
	eyes	hands	ears
Large connectors	✓	✓	×
Small connectors	✓	✓	×
triangle shape	✓	✓	×
Big frame	✓	✓	×
Small frame	✓	✓	×
Big ring	✓	✓	×
Small ring	✓	✓	×
star	✓	✓	×
wheel	✓	✓	×

3D Computer Aided Design Model of the Shapes

We used python. We used def function. The important lines of the design are given below. They represent the connector and its dimensions. We use mm scale.

```
main_length, main_diameter = 50, 4
neck_length, neck_diameter = 3, 2
z_neck_top_end = main_length + neck_length
z_neck_bottom_start = -neck_length
tip_height_30 = 4.0
slant_length_50 = 3.0
bar_color = 'deeppink'
```

To represent the C clamp, sine and cosine functions with their dimensions are used. The color used is deeppink.

For small size connector we use separate def function.

```
main_length, main_diameter = 25, 4
neck_length, neck_diameter = 3, 2
z_neck_top_end = main_length + neck_length
z_neck_bottom_start = -neck_length
tip_height_30 = 4.0
slant_length_25 = 3.0
bar_color = 'deeppink'
```

To represent the C clamp, sine and cosine functions with their dimensions are used. The color used is deeppink.

Pixel Detailing

In this study we relate the image of the small size shapes to the pixel. We relate the image file to their pixel resolution in both width and height. We relate the individual dimensions of the shape to its pixel. We calculate the pixel used for each dimension in the shape. Here, we consider the large connector. The color of the connector is pink. The pixel properties of the image of the large connector are 960 pixels width by 1280 pixels height. The image is jpg file. The overall length of the large connector is 50 mm as given in Table 3.

Table 3: Relationship Between the Dimensions of the Large Connector Shape and Their Pixel.

Feature Name	Dimension (mm)	Calculated Pixels
Main Shaft Diameter	4.0	76.8
Neck Diameter	2.0	38.4
Overall Length	50.0	960.0
Neck length	3.0	57.6
Connector horizontal length after neck	5.0	96.0
Connector C length	3.0	57.6
Connector C width	3.0	57.6
C height	4.0	76.8

The pixel to relate each dimension is obtained using conversion factor. The conversion factor is given in Eq (1).

$$Conversion\ Factor = \frac{Reference\ width\ Pixels}{reference\ dimension\ in\ mm} \quad (1)$$

where Reference width pixels are 960 pixels. The reference dimension in mm for the large connector shape is the overall length. Here, the overall length is 50 mm. The conversion factor is 19.2 pixels/mm.

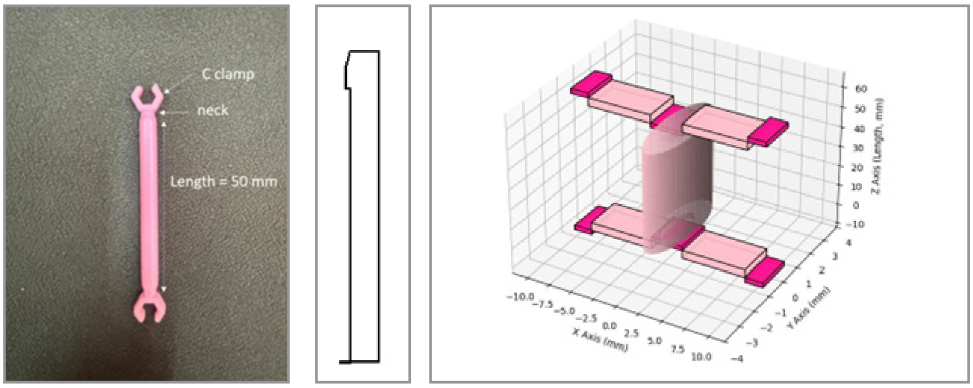
To obtain the calculated pixels for individual dimension of the large connector shape we use Eq (2).

$$Calculated\ pixels = Conversion\ factor \times individual\ dimension\ in\ mm \quad (2)$$

For instance, the main shaft diameter is 4 mm. The calculated pixels are 76.8 as given in Table 3. The calculated pixels for individual large connector dimensions are given in Table 3.

Results and Discussion

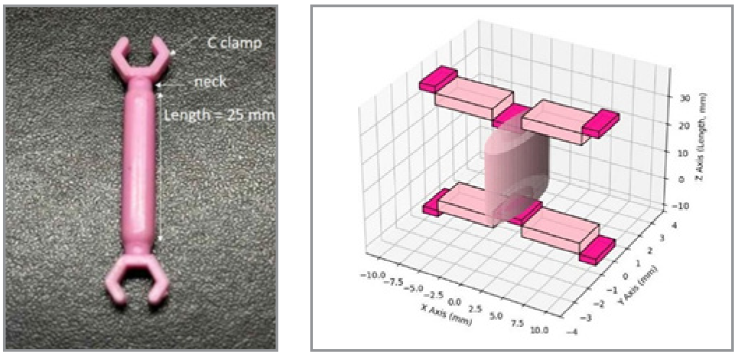
Figure 1 (a) shows the large pink connector. The connector has shaft type object. The shaft length is 50 mm and its diameter is 4 mm. The connector has neck and C clamp beyond the shaft. The neck length is 3 mm. The neck diameter is 2mm. There is horizontal object above the neck of length 5 mm and diameter 5 mm. The C length is 3 mm and their width is 3 mm. The C height is 4mm. Figure 1 (b) shows the incorrect shape obtained using present chrome ai mode. Figure 1 (c) shows the computer aided design model of the connector. Here, we use human perceptron method



(a) (b) (c)

Figure 1: (a) Pink Large Connector, (b) Chrome ai Mode Method (c) 3D CAD Model Obtained using Human Perceptron Method

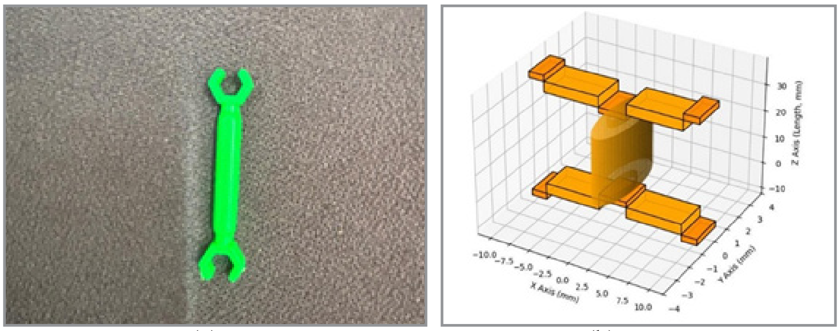
Figure 2 (a) shows the small pink connector. The connector has shaft type object. The shaft length is 25 mm and its diameter is 4 mm. The connector has neck and C clamp beyond the shaft. The neck length is 3 mm. The neck diameter is 2mm. There is horizontal object above the neck of length 5 mm and diameter 5 mm. The C length is 3 mm and their diameter is 3 mm. The C height is 4mm. Figure 2 (b) shows the CAD model of the small pink connector.



(a) (b)

Figure 2 (a) Pink Small Connector and (b) CAD Model

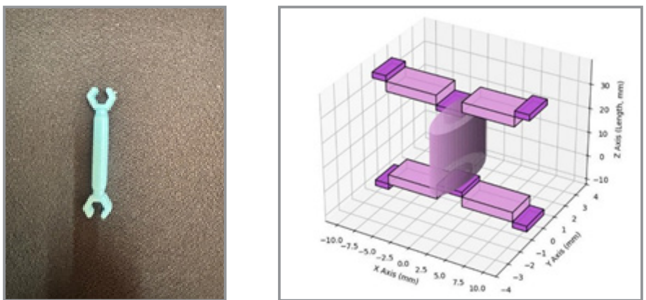
Figure 3 (a) Shows the Orange Small Connector. The Dimensions are Similar to Pink Small Connector given in Figure 2 (a). Figure 3 (b) Shows the CAD Model. We Define the Colour to Orange in the Model.



(a) (b)

Figure 3: (a) Orange Small Connector and (b) CAD Model

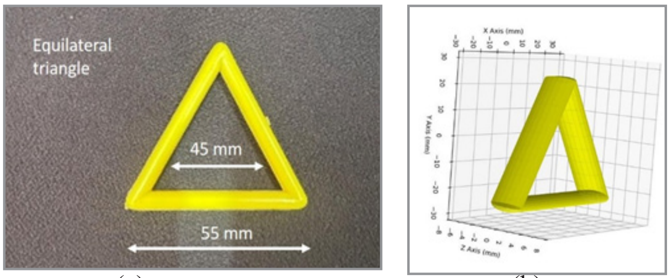
Figure 4 (a) Shows the Purple Small Connector. Figure 4 (b) shows the CAD model. We define the color to purple in the model.



(a) (b)

Figure 4: (a) purple small connector and (b) CAD model

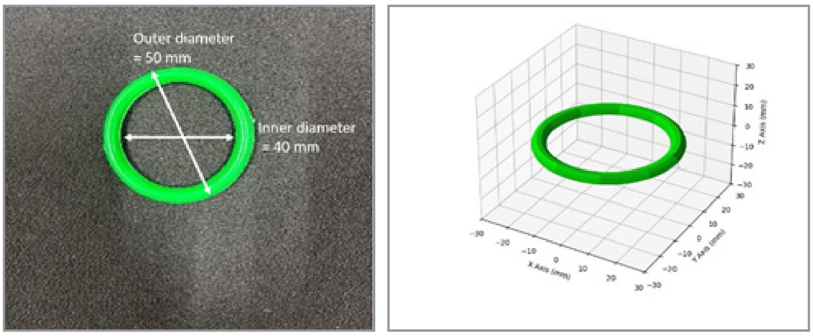
Figure 5: (a) shows the yellow triangle shape. The outer length of the triangle is 55 mm. The inner length is 45 mm. We study equilateral triangle. The diameter of the triangle is 5 mm. Figure 5 (b) shows the CAD model of the yellow triangle shape.



(a) (b)

Figure 5: (a) Triangle Shape and (b) CAD Model

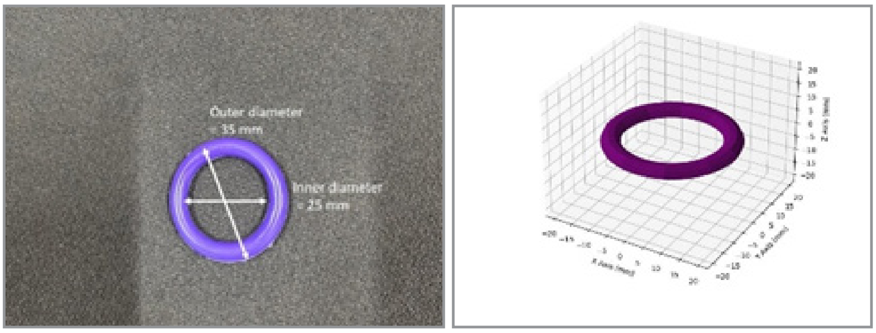
Figure 6:(a) shows the large size ring. The color is lime. The outer diameter of the ring is 50 mm. The inner diameter is 40 mm. The thickness of the large ring is 5 mm. Figure 6 (b) shows the CAD model of the lime ring.



(a) (b)

Figure 6: (a) big ring and (b) CAD model

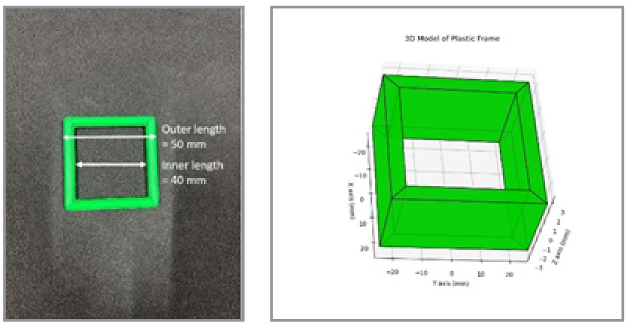
Figure 7: (a) shows the small size ring. The color is purple. The outer diameter of the ring is 35 mm. The inner diameter is 25 mm. The thickness of the small ring is 5 mm. Figure 7 (b) shows the CAD model of the purple ring.



(a) (b)

Figure 7: (a) Small Ring and (b) CAD Model

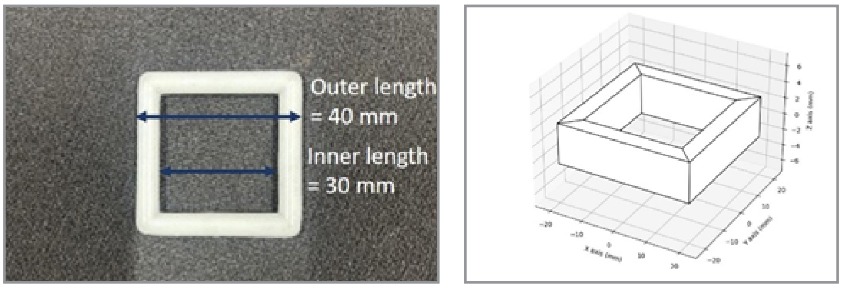
Figure 8: (a) shows big frame of green color. The outer length is 50 mm. The outer width is 50 mm. The inner length is 40 mm. The inner width is 40 mm. The thickness is 5 mm and depth is 5 mm. Figure 8 (b) shows the CAD model.



(a) (b)

Figure 8: (a) big green frame and (b) CAD model

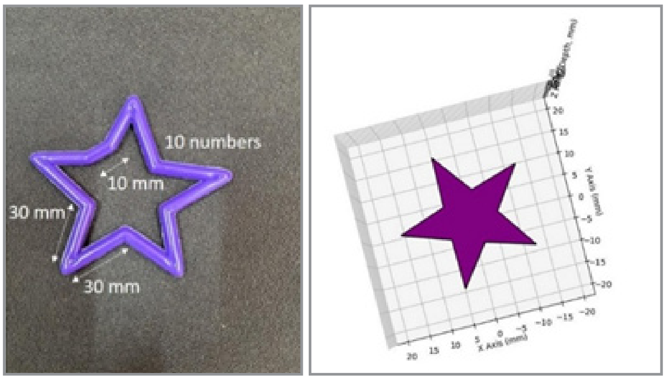
Figure 9: (a) shows small frame of white color. The outer length is 40 mm. The outer width is 40 mm. The inner length is 30 mm. The inner width is 30 mm. The thickness is 5 mm and depth is 5 mm. Figure 9 (b) shows the CAD model.



(a) (b)

Figure 9: (a) small frame and (b) CAD model

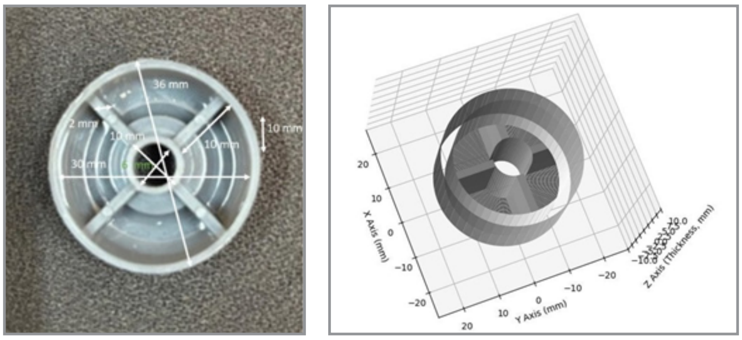
Figure 10: (a) shows star. They have 10 lengths. Each length is 30 mm, width is 30 mm and depth is 5 mm. The diameter is 5 mm. The joining length is 10 mm. The color of the star is purple. Figure 10 (b) shows the CAD model.



(a) (b)

Figure 10: (a) star shape and (b) CAD model

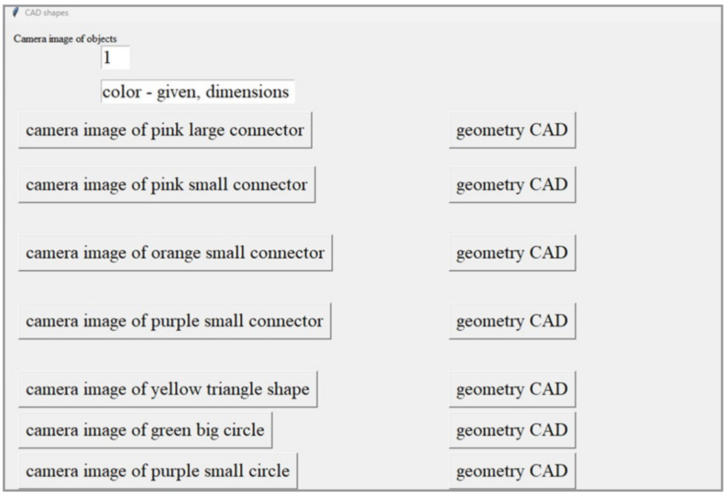
Figure 11: (a) shows wheel of gray color. The wheel outer diameter is 36 mm, inner diameter is 30 mm and thickness is 10 mm. The inner hole have outer diameter of 10 mm and inner diameter of 6 mm. The spoke length is 10 mm, width is 2 mm and height is 10 mm. There are 4 spoke lengths. Figure 11 (b) shows the CAD model.



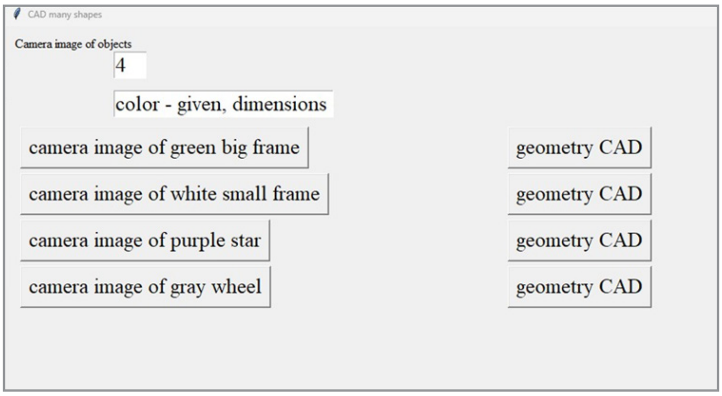
(a) (b)

Figure 11: (a) wheel and (b) CAD model

Figure 12: (a) shows the GUI layout to select the shapes of the robot toy small size shapes and their respective CAD model. The list continues as shown in Figure 12 (b). We have 11 shapes of the robot components. They are large connector, small connectors of pink, orange and purple color. There are yellow triangle shape, big ring and small ring. We have studied big and small frame, star and wheel. The color elements are available in the CAD model. The CAD shapes become visible on click of the button in the GUI layout.



(a)



(b)

Figure 12: (a) GUI for the (a) list 1 shapes, (b) list 2 shapes of the robot components and the button click to visualize their CAD model

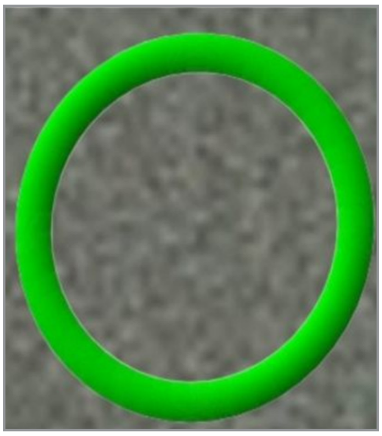
Similarity Index of the Shapes with Computer Aided Design Modxel

We use python structural similarity index (ssim) between two images module. We use skimage.metrics module in python. The structural similarity index is given by Eq (3).

$$SSIM\,(x, y) = \frac{(2\mu_x\mu_y + C_1)(2\sigma_{xy} + C_2)}{(\mu_x^2 + \mu_y^2 + C_1)(\sigma_x^2 + \sigma_y^2 + C_2)} \quad (3)$$

where x and y are two images. Here we consider the shape of the robot object big ring of lime color with its background. We used the same background in the computer aided design 3D model. We ensured the pixel width and height are 326 by 371 in the actual (x) and 3D computer aided design model (y). The two images are jpg images. We used python code. $\mu_x and\ \mu_y$ are the average intensity of images x and y. σ_x^2 and σ_y^2 are the variance of the images x and y. σ_{xy} are the covariance between x and y. C_1 and C_2 are constants. We used python default C_1 and C_2 constants. We obtain structural similarity index of 0.42 that is medium similar of the actual and 3D computer aided design model of the lime ring. The reason we believe is due to the luminance and light effects only. Figure 13 shows the comparison between the actual and 3D computer aided design model of the lime ring with the similar black color background.

(a)



(b)

Figure 13: Comparison between the (a) actual and (b) 3D computer aided design model of the lime ring shape of the robot having same black background. We understand the structural similarity index between the actual and model.

Scaling the Shapes and Relating to Pixel

In this section we consider the large connector. The overall length of the connector is 50mm. We model a scaled version of the connector. The overall length is 5 m. The scaled connector image pixels width are 4000 pixels and height are 4000 pixels. The image is jpg file. The individual dimensions of the scaled connector shape are given in Table 4.

Table 4: Relationship between the dimensions of the scaled connector shape and their pixel.

Feature Name	Dimension in mm	Calculated Pixels
Main Shaft Diameter	400.0	320.0
Neck Diameter	200.0	160.0
Overall Length	5000.0	4000.0
Neck length	300.0	240.0
Connector horizontal length after neck	500.0	400.0
Connector C length	300.0	240.0
Connector C width	300.0	240.0
C height	400.0	320.0

The pixel to relate each dimension is obtained using scale conversion factor. The scale conversion factor is given in Eq (4).

$$Scale\ Conversion\ Factor = \frac{Reference\ width\ of\ scale\ image\ in\ Pixels}{reference\ dimension\ of\ scaled\ shape\ in\ mm} \quad (4)$$

where Reference width of the scale image of the connector are 4000 pixels. The reference dimension in mm for the scaled connector shape is the overall length. Here, the overall length is 5000 mm. The conversion factor is 0.8 pixels/mm.

To obtain the calculated new pixels for individual dimension of the scaled new shape we use Eq (5).

$$Calculated\ new\ pixels = Scale\ Conversion\ factor \times individual\ dimension\ of\ new\ shape\ in\ mm \quad (5)$$

For instance, the main shaft diameter is 400 mm. The calculated pixels are 320 as given in Table 4. The calculated pixels for individual scaled connector dimensions are given in Table 4.

Figure 14 shows the CAD model of the scaled connector. The overall length is 5000 mm. The dimensions are given in Table 4.

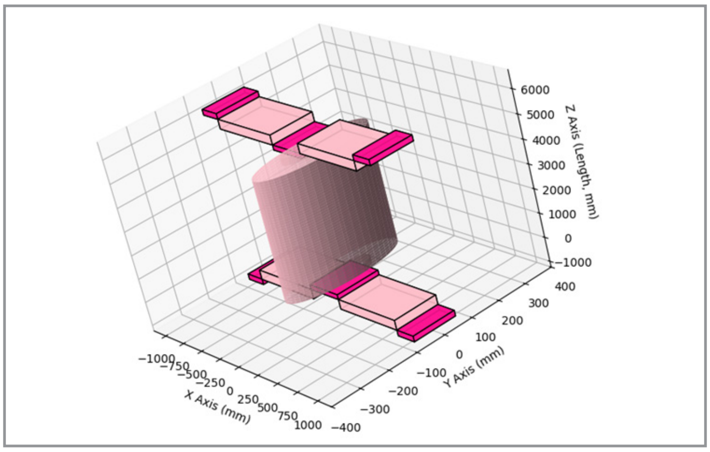


Figure 14: Scalable connector of metre dimensions.

Application: Robot Neural Network-Based Camera Manufacturing

Here, the connectors are used to join. The c clamp in the connector attaches to the horizontal bar of another connector. We use three such pairs. Each pair constitutes x, y and z component. They are positioned in such manner. The c clamp on the horizontal bar slides in the respective direction. This is manual operation. The combined three pairs make the manually controlled robot. The operation of the manually controlled robot is to move in the x, y and z directions to help complete the human task.

The material used for the robot are plastic connectors. The neural network hardware is available in the device. The weight parameter to move in the x direction are controlled by the x connector pair dimensions and their mass. Similarly, the weights are obtained for the y and z directions. The predict movement in the x direction are obtained based on the weight parameter of the x connector pair, their mass and dimensions. In the same manner the predict movement in the y, z direction is obtained from their connector pairs, mass and dimensions, respectively. Here, the weight parameters are independent of each direction. The movement of the x, y and z connector pairs are independent. The movement of each connector pair happens sequentially to complete the human task. We design the manually controlled robot neural network device. In our design we place the plastic tray on the connector pair. We consider three plastic trays. We place Bosch GLM Bluetooth distance meter on each of the plastic tray. The distance meter in the x connector pair gives the x distance.

Similarly, the distance meter in the y connector pair gives the y distance and distance meter in the z connector pair gives the z distance. The three distance meters x, y and z, respective output are stored in the laptop in our device. The x, y, z at each location of purple ball is measured. The diameter of the purple ball is 70 mm. The manually controlled robot neural network hardware provides fine resolution x, y and z points with spacing of 0.5 mm. We obtain 140×140×140 points in x, y and z directions respectively. The movement of the x connector pair with tray and distance meter are used for this purpose. In the same manner the movement of the y connector pair with tray and distance meter are used. The movement of the z connector pair with tray and distance meter are used for similar purpose. The fine resolution x,y,z array points are stored as excel file in the laptop. We install python in the laptop. We use mayavi and matplotlib python visualization code to obtain high resolution accurate 3D visual of the ball. We obtain 3D camera image using our device for the first time. Figure 15 shows the schematic representation of the manual controlled robot neural network 3D camera device.

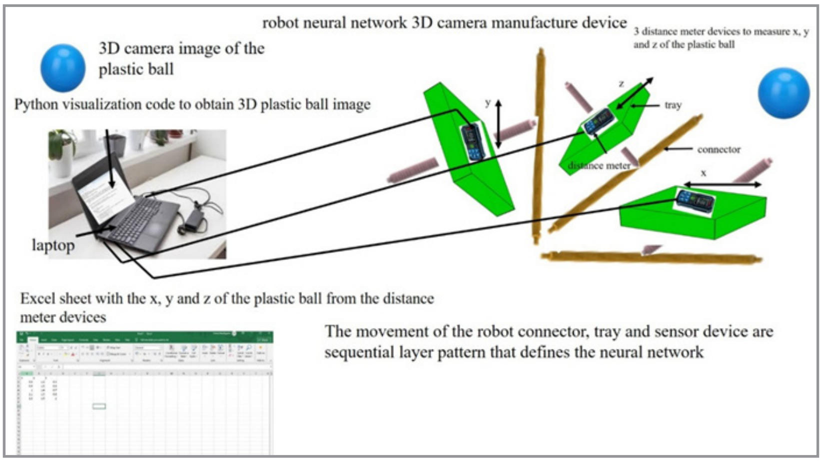


Figure 15: Schematic of the Camera Device to Output 3D Camera Image.

Conclusions

To conclude we study the components of the robot. We develop 3D computer aided design model for various shapes. The structural similarity index between the actual and 3D model are studied. We obtain good accuracy. We develop correlation between the pixel and dimensions of the component. We study the component from mm to meter size. We develop design for the 3D camera device. Our work is on light weight plastics. Our work can find applications in sensors, energy, transport, displays and packaging industry.

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Author Contributions

Nandigana V. R. Vishal: Conceptualization, Data curation, Formal analysis, investigation, methodology, resources, software, supervision, validation, visualization, writing – original draft, writing – review and editing.

Conflicts of Interest

The authors declare no conflict of interest.

Data Availability

The data from the current study are available from the corresponding author upon reasonable request.

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