Moment Invariants based object Recognition for Different Pose and Appearances in Real Scenes

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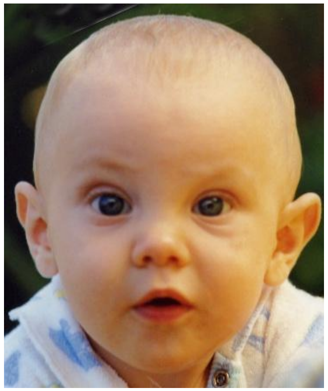
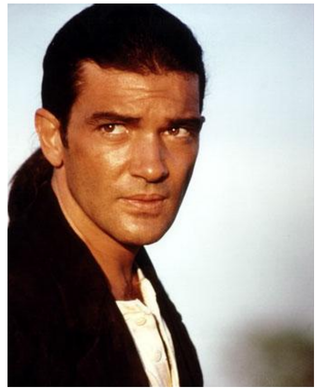
- Two-Dimensional Geometric Transformations
- Shape based object recognition
- Moment Invariants
- The Proposed Approach
- Results
- Comparison with other methods
- Measures for different recognition methods
- Conclusion

Goal

- A new approach had been proposed for shape based reco gnition of object(Human) in real world.

Goal (Cont..)





Introduction

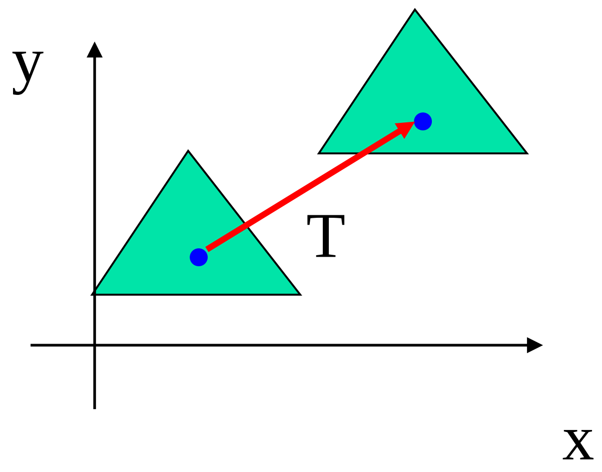
- With the emergence of computer vision application obje ct recognition in real scenes has become an active resear ch area.

Two-Dimensional Geometric Transformations

- **Basic Transformations**
  - Translation
  - Rotation
  - Scaling

Translation

- Moves objects without deformation

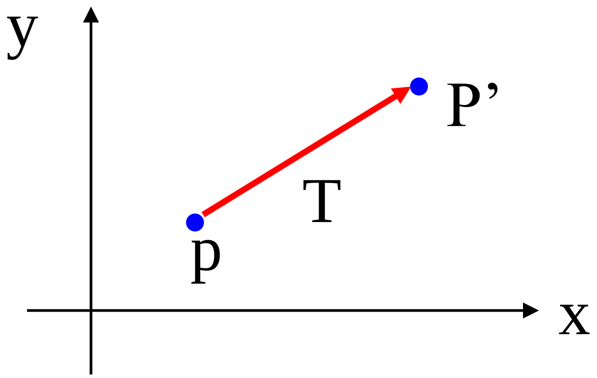


Translation

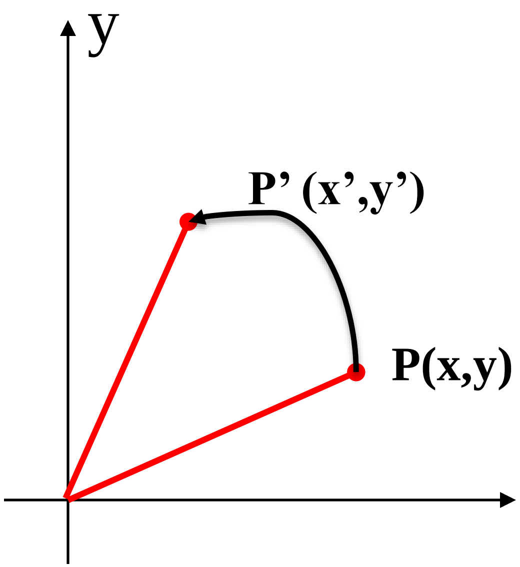
- Translation transformation

$$x' = x + t_x$$

$$y' = y + t_y$$



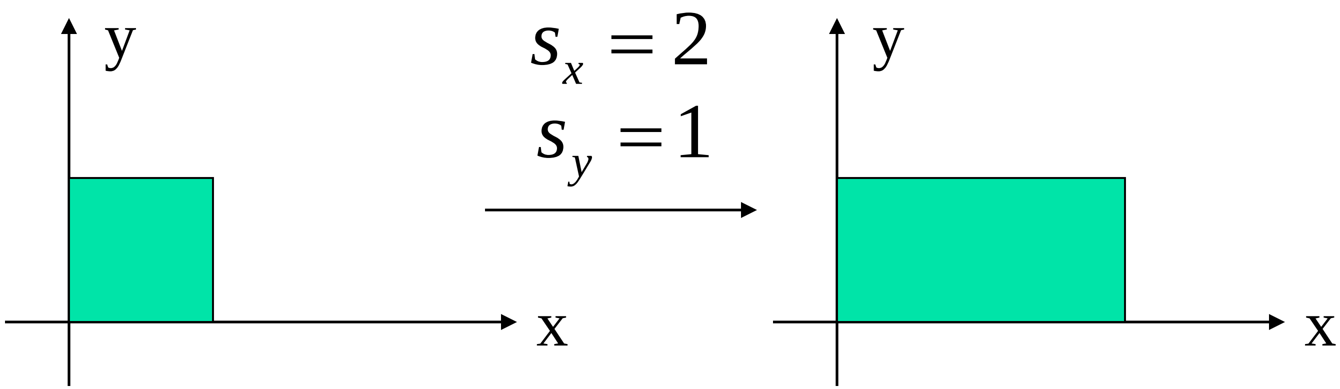
Rotation



Rotation

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} \cdot \begin{bmatrix} x \\ y \end{bmatrix}$$

Scaling



Scaling

$$x' = x \cdot s_x$$

$$y' = y \cdot s_y$$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} s_x & 0 \\ 0 & s_y \end{bmatrix} \cdot \begin{bmatrix} x \\ y \end{bmatrix}$$

Shape based object recognition

- Shape based object recognition
  - Boundary based object recognition
  - Region based object recognition

Boundary based object recognition

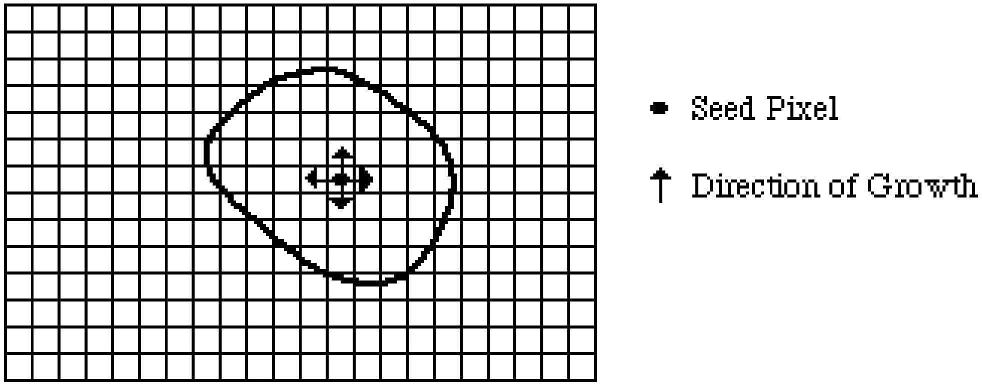
- At which point the image brightness / intensity changes sharply

Boundary based object recognition

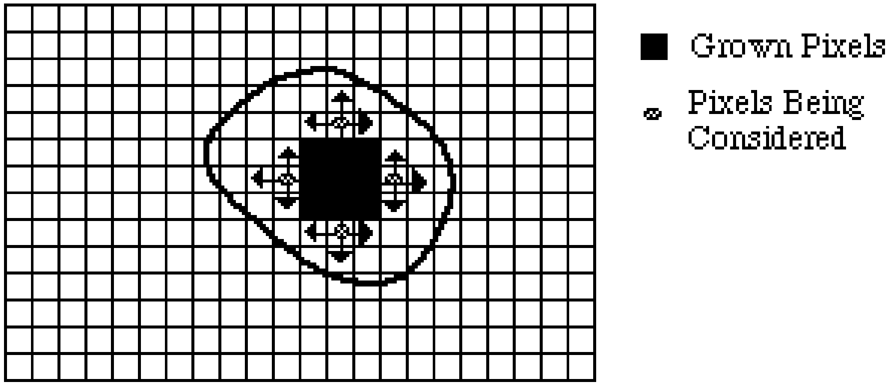
Region based object recognition

- This method takes a set of seeds as input along with the i mage. The seeds mark each of the objects to be segment ed.

Region based object recognition



(a) Start of Growing a Region



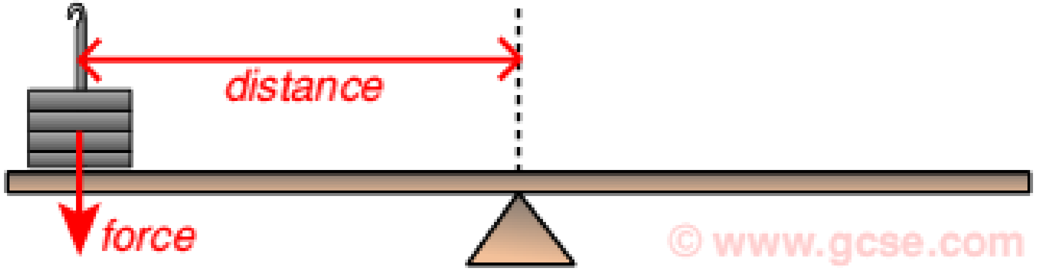
(b) Growing Process After a Few Iterations

Boundary / Region

- The boundary base approach depend of information achi eved from boundary pixel only. But region base approac h retrieve information from both boundary and internal p ixel.

Moment(cont.)

- **A moment is defined as a force multiplied by the perpendicular distance from the line of action of the force to the pivot**



Moment

Moment = Force x Distance

The math of moments

- In pure math, the n^{th} order moment about the point c is d efined as:

- $\mu_n = \int_{-\infty}^{+\infty} (x-c)^n f(x) dx$

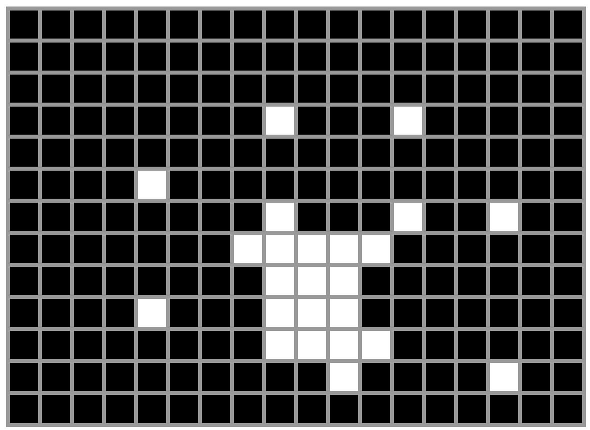
- We’re interested in images – they have two dimensions. So we need two independent variables. So the formula b ecomes:

- $\mu_{mn} = \iint (x - c_x)^m (y - c_y)^n f(x, y)\,dxdy$

- The Moment of an M X N image f(x,y) can be defined a s
- $m_{pq} = \sum_{x=0}^{x=M-1} \sum_{y=0}^{y=N-1} (x)^p (y)^q f(x,y)$

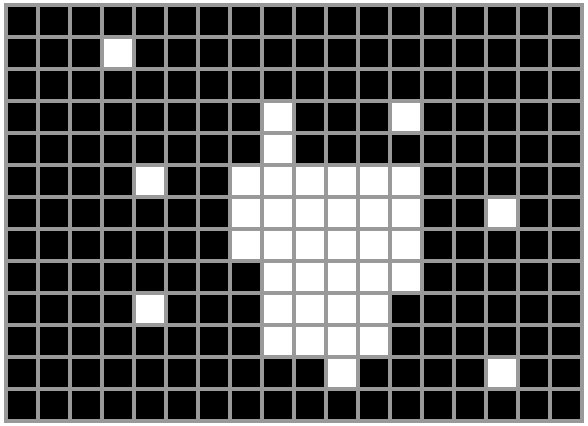
Calculating area

- $m_{00} = \sum_{x=0}^{x=M-1} \sum_{y=0}^{y=N-1} (x)^0 (y)^0 f(x,y)$
- $m_{00} = \sum_{x=0}^{x=M-1} \sum_{y=0}^{y=N-1} f(x,y)$



Centroid

- Centroid=$(\frac{m_{10}}{m_{00}},\frac{m_{01}}{m_{00}})$
- Consider the m_{10} first moment:
- $Sum_{x=} \sum\sum xf(x,y)$
- Centroid=$(\frac{sum_x}{m_{00}},\frac{sum_y}{m_{00}})$



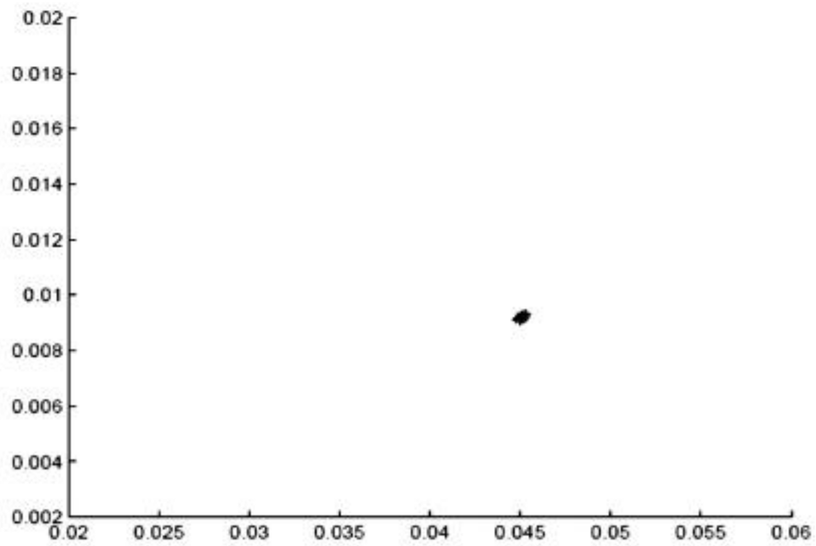
Translation invariance

- $\mu_{pq} = \iint (x - \bar{x})^p (y - \bar{y})^q f(x, y)\, dx\, dy$
- Where
- $\bar{x} = \frac{m_{10}}{m_{00}}$
- $\bar{y} = \frac{m_{01}}{m_{00}}$

Translation invariance(Cont.)





Scale invariance

- f'(x,y): new image scaled by λ
- $f'(x,y) = f(\frac{x}{\lambda}, \frac{y}{\lambda})$
- Varible Transformation
- $x' = \frac{x}{\lambda}$ $y' = \frac{y}{\lambda}$ $dx = \lambda dx'$ $dy = \lambda dy'$

Scale invariance(Cont..)

- $\mu'_{pq} = \iint (x)^p (y)^q f(\frac{x}{\lambda}, \frac{y}{\lambda}) dxdy$

$$= \iint (\lambda x')^p (\lambda y')^q f(x', y') \lambda^2 dx'dy'$$

$$= \lambda^p \lambda^q \lambda^2 \iint (x')^p (y')^q f(x', y') dx'dy'$$

$$= \lambda^{(p+q+2)} \mu_{pq}$$

Scale invariance(Cont..)

- Concept: Set total area to 1
- $\mu'_{00} = \lambda^2 \mu_{00} = 1$
- $\lambda = \frac{1}{\sqrt{\mu_{00}}} = \mu_{00}^{-\frac{1}{2}}$
- Scaling invariant modes:
- $\eta_{pq} = \frac{\mu_{pq}}{\mu_{00}^{\gamma}}, where\ \gamma = \frac{p+q+2}{2}$

Moment Invariants

- The seven moment invariants are defined in terms of nor malized central moment of order 3.
- $M1 = (\eta 20 + \eta 02)$
- $M2 = (\eta 20 - \eta 02)^2 + (4\,\eta 11)^2$
- $M3 = (\eta 30 - 3\eta 12)^2 + (3\eta 21 - \eta 03)^2$
- $M4 = (\eta 30 + \eta 12)^2 + (\eta 21 + \eta 03)^2$
- $M5 = (\eta 30 - 3\eta 12)(\eta 30 + \eta 12)[(\eta 30 + \eta 12)^2 - 3(\eta 21 + \eta 03)^2] +$
- $3(\eta 21 - \eta 03)(\eta 21 + \eta 03)[3(\eta 30 + \eta 12)^2 - (\eta 21 + \eta 03)^2](6)$
- $M6 = (\eta 20 + \eta 02)[(\eta 30 + \eta 12)^2 - (\eta 21 + \eta 03)^2] + 4\,\eta 11\,(\eta 30 +$
- $\eta 12)^2 (\eta 21 + \eta 03)^2$
- $M7 = 3(\eta 21 - \eta 03)(\eta 30 + \eta 12)[(\eta 30 + \eta 12)^2 - 3(\eta 21 + \eta 03)^2] -$
- $[3(\eta 30 + \eta 12)^2 - (\eta 21 + \eta 03)^2]$

The Proposed Approach

- Representation of objects in real scenes

  Representation is 2D gray function
- Preprocessing of Images

  Image normalized to 256 X 256 pixel
- Feature Vector Calculation

  We use the set of moment invariants for computing feature vecto rs
- Classification
  - Calculated feature vectors are supplied into linear support vect or machine (SVM).

Result

Comparison with other methods

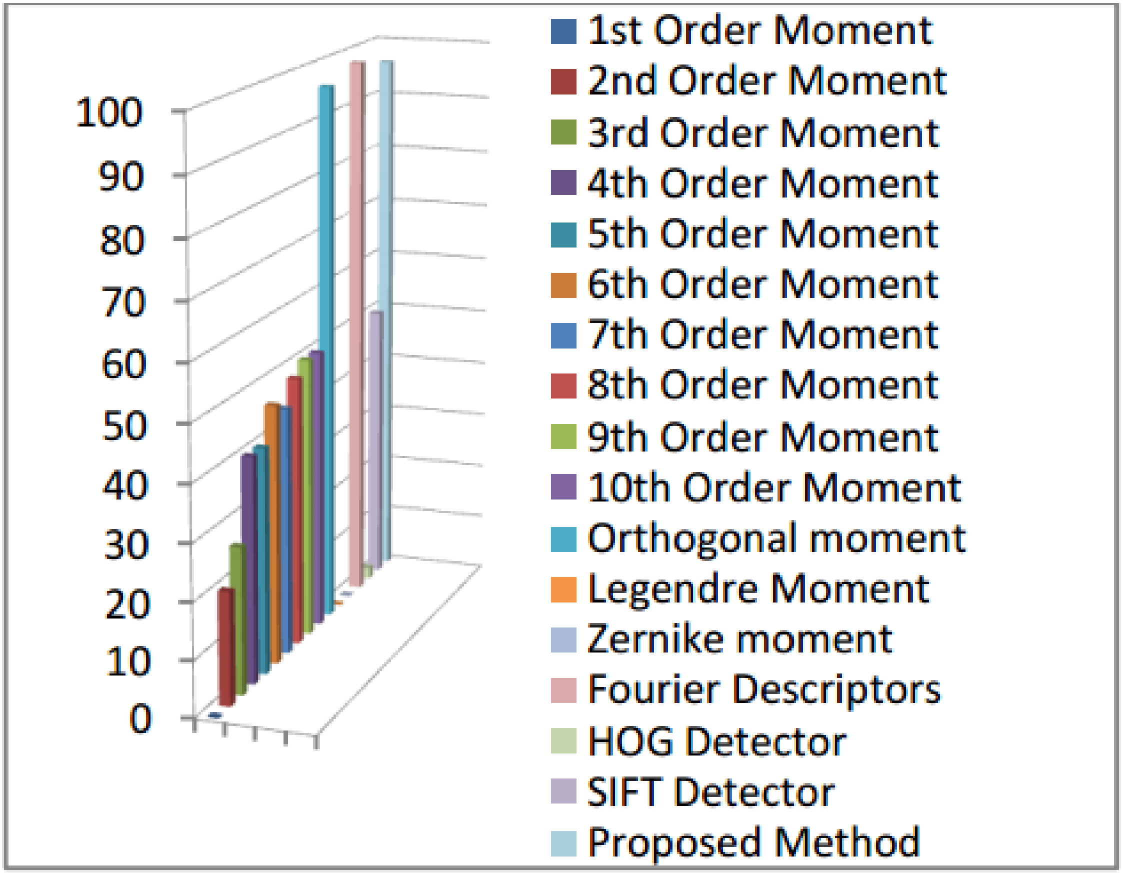


Figure 3. Accuracy of positive images for different methods (in %)

Comparison with other methods

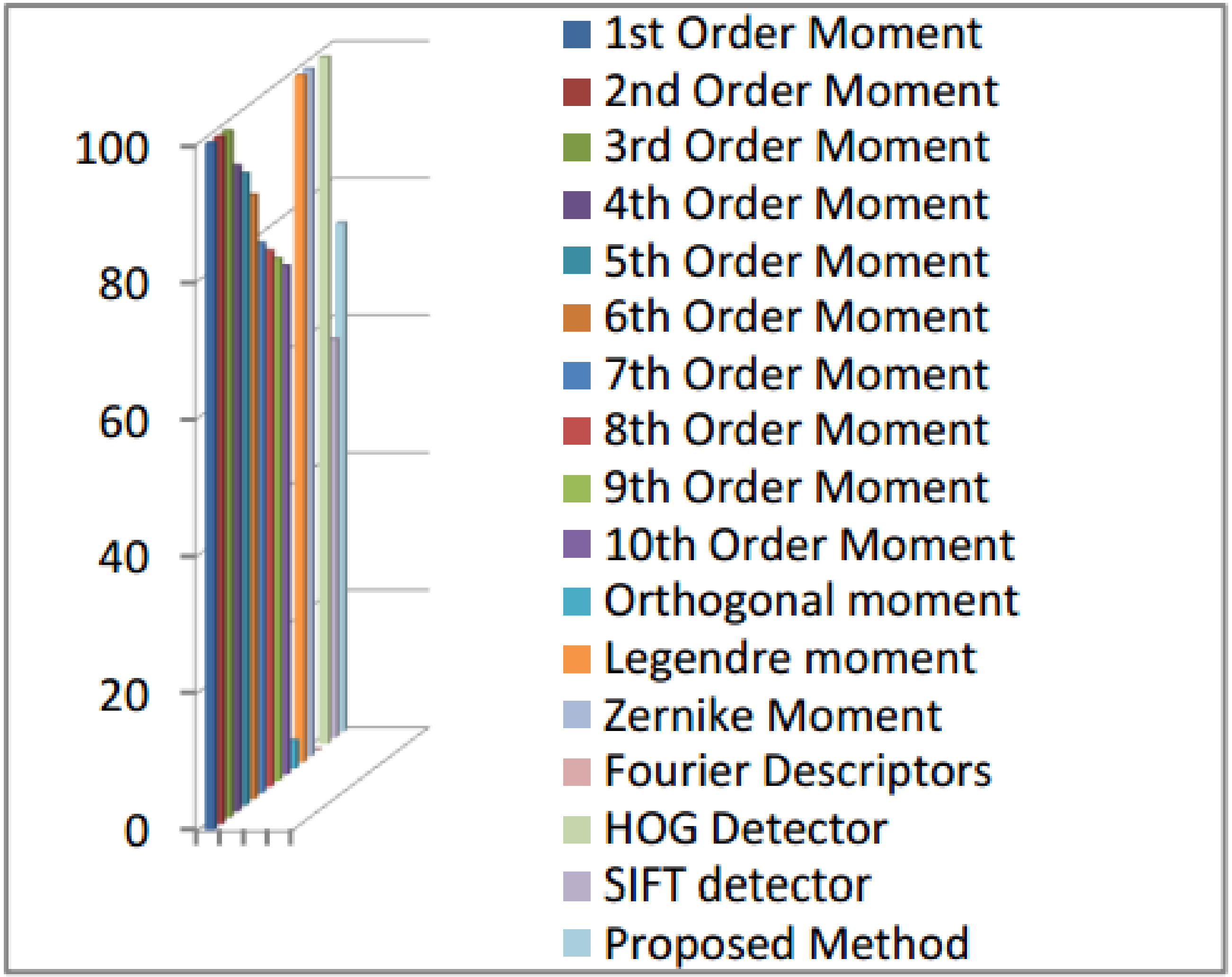


Figure 4. Accuracy of negative images for different methods (in %)

Comparison with other methods

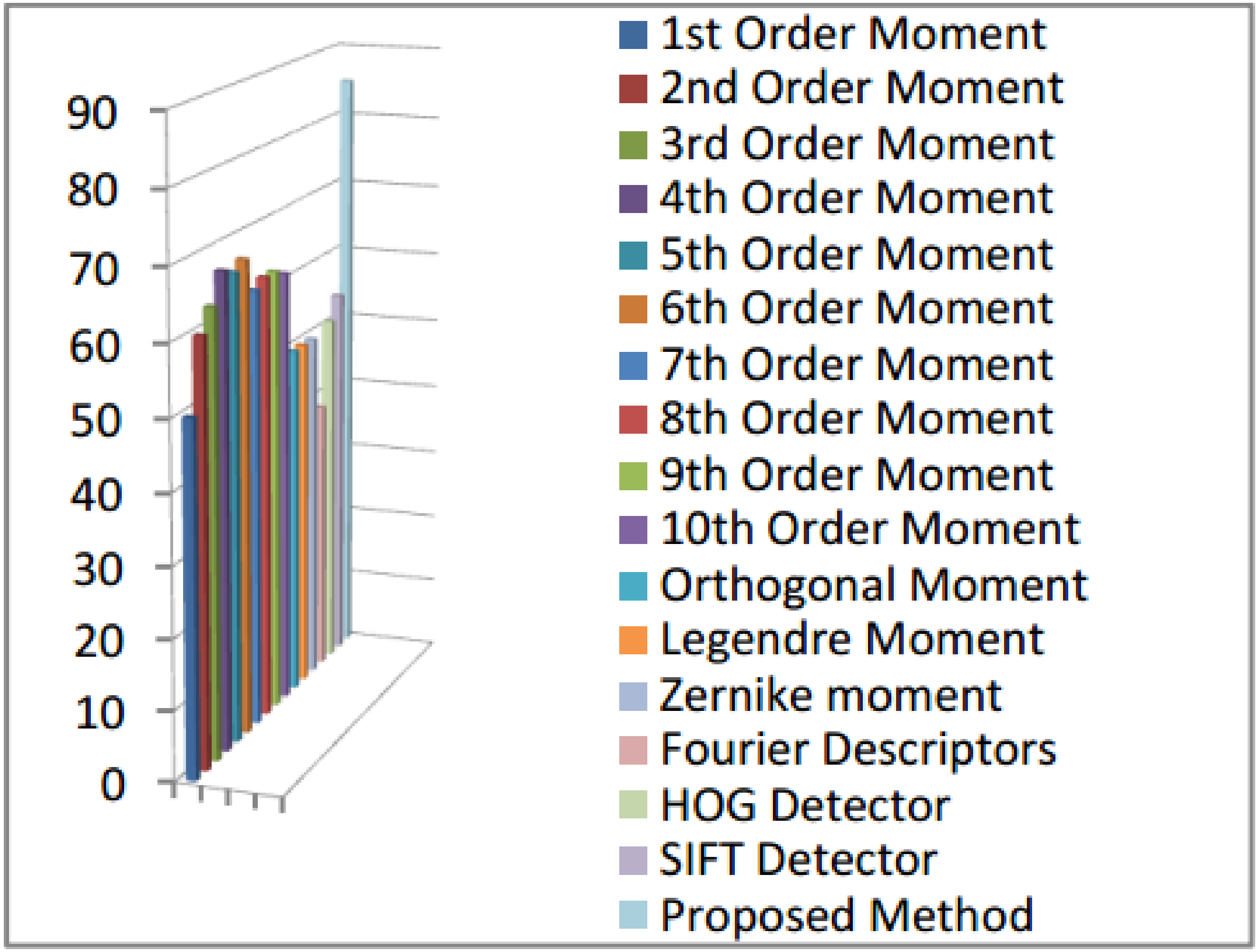


Figure 5. Average accuracy of images for different methods (in %)

Comparison with other methods

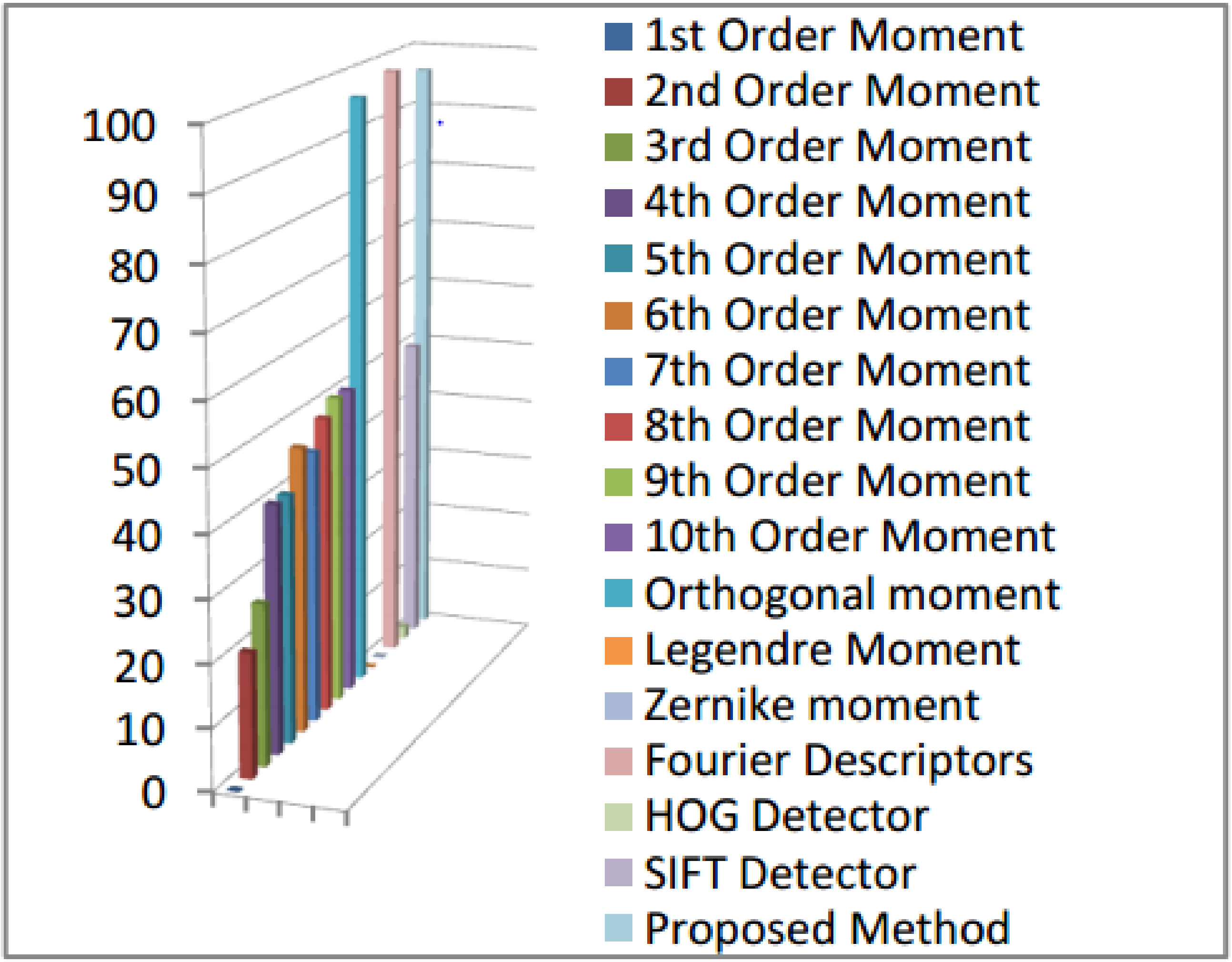


Figure 6. Recall value of different methods

Comparison with other methods

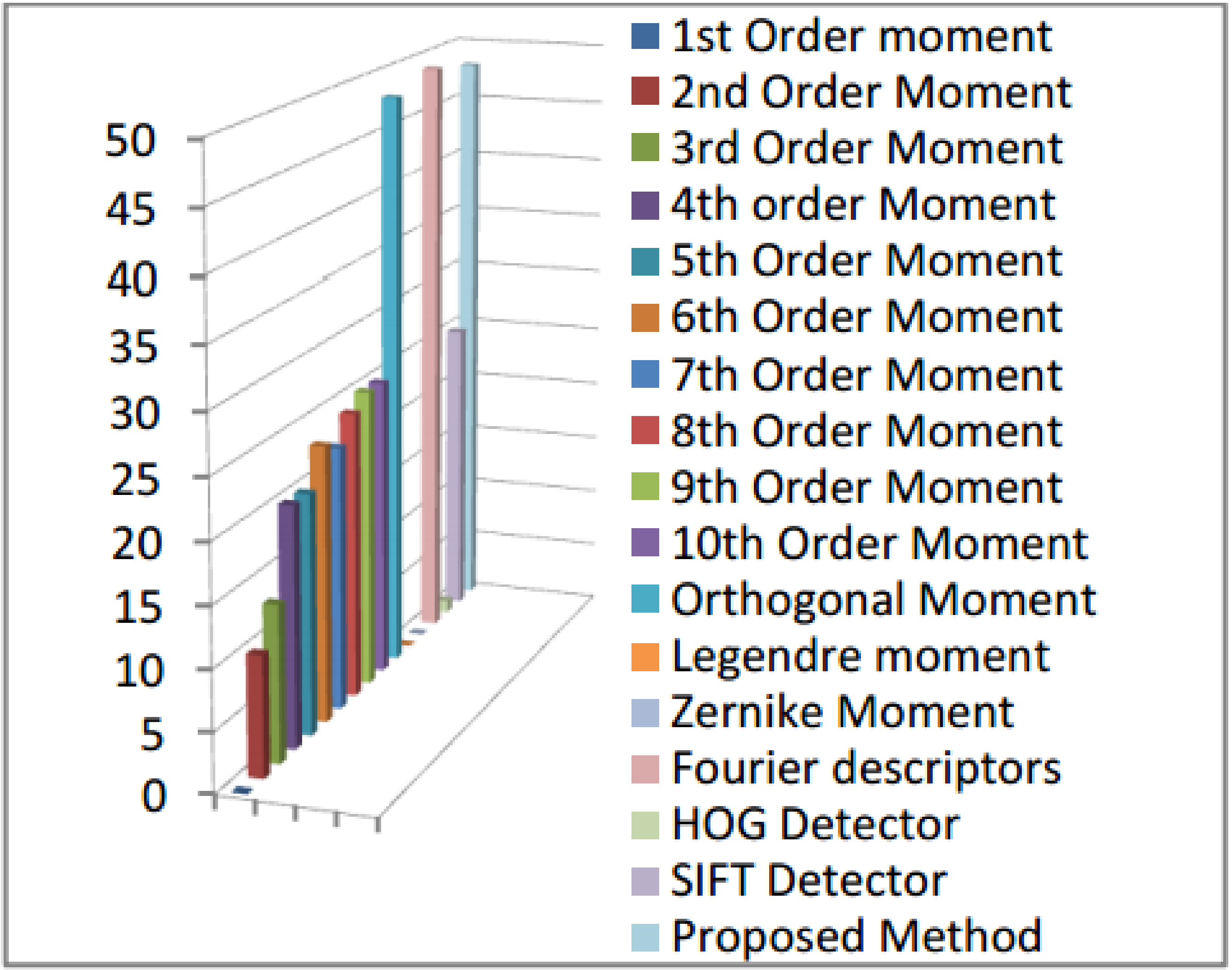


Figure 7. Precision value of different methods

Comparison with other methods

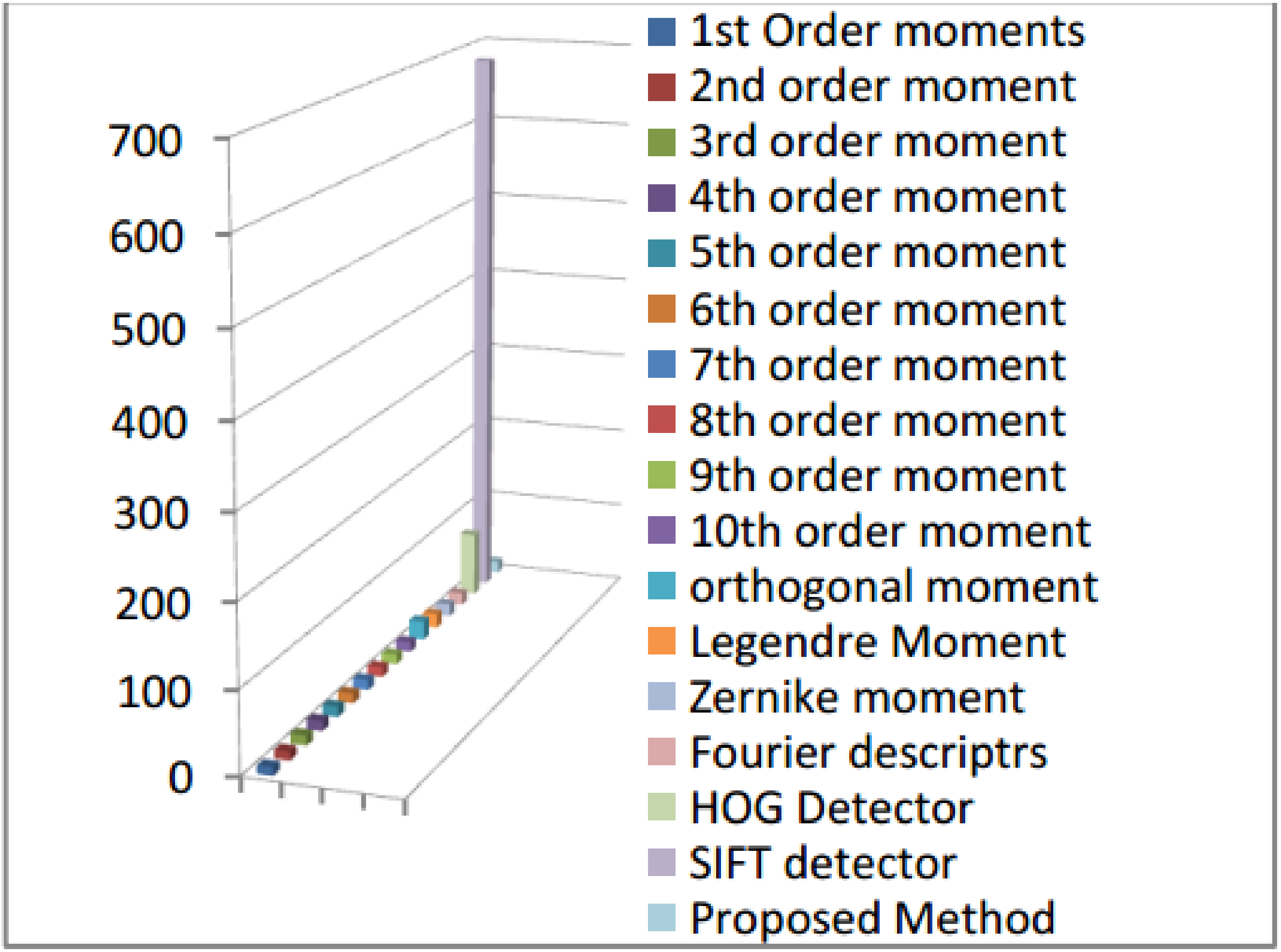


Figure 8. Efficiency of different methods (in seconds)

Measures for different recognition methods

Methods	Pos Acc	Neg Acc	Avg Acc	R	P	E
1^{st} Order Moment	0	100	50	0	0	10.19
2^{nd} Order Moment	20	100	60	20	10	10.61
3^{rd} Order Moment	26	100	63	26	13	11.90
4^{th} Order Moment	40	94	67	40	20	12.21
5^{th} Order Moment	40	92	66	40	20	12.59
6^{th} Order Moment	46	88	67	46	23	11.95
7^{th} Order Moment	44	80	62	44	22	12.27
8^{th} Order Moment	48	78	63	48	24	11.99
9^{th} Order Moment	50	76	63	50	25	11.90
10^{th} Order Moment	50	74	62	50	25	12.22
Orthogonal Moment	96	4	50	96	48	23.29
Legendre Moment	0	100	50	0	0	17.54
Zernike Moment	0	100	50	0	0	14.91
Fourier Descriptors	98	0	39	98	49	14.72
HOG Detector	2	100	51	2	1	78.9
SIFT Detector	50	58	54	50	25	72.4
Proposed Method	96	74	85	96	48	14.14

Conclusion

- This paper describe the development and demonstration of a new moment invariant approach for object recogniti on in real world. The invariance nature of moment invari ants against linear transformation made it suitable for rec ognition of object of different pose and appearances. It a chieved an average accuracy of 85% which is better then other methods.

Thank you all