

① Bhat, S.G.: Simulation of crab movement on computer.

② Ravi, T. Reddy: Papier Mache

③ Shastri Ramamurthy B.G.: CD Rom technology and its activity in Design activity

④ K. Puhzhen di: Study & simulation in Robotic finger movement

⑤ Anil K. Gupta: Tea in I.I.T. - a case for Cafeteria.

⑥ Prasad Boradkar: Significance of space & time in music.

⑦ (Miss) Rashmi Gothi: Study of columns in Hindu architecture

⑧ Umesh Kulkarni: Humour in Product Design.

⑨ J. Bhaskar: Design of parameters of visual grammar with ref. to business management.

⑩ G.A. Shah: Developing visualization through games and puzzles

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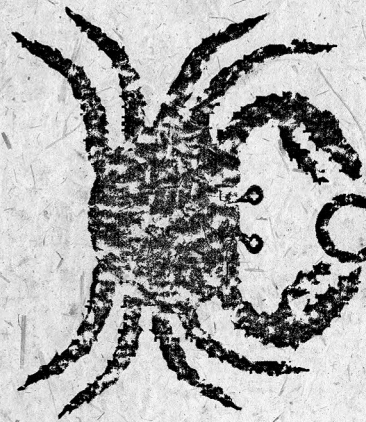
ONLY

⑪ Vinayak Nabar: Exploration of form using coconut shell.

⑫ N. Prasad: Meaning in product.

⑬ Madhuri Vetsa (Miss): Thinking process & its relation to visualization and form generation

SPECIAL PROJECT REPORT



SIMULATION OF
CRAB MOVEMENT
ON COMPUTER

BY

SURESH G. BHAT

IDC

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SIMULATION OF CRAB MOVEMENT ON COMPUTER

A SPECIAL PROJECT REPORT

BY

SURESH G. BHAT

GUIDE:

PROF. A.G. RAO

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INDUSTRIAL DESIGN CENTRE
INDIAN INSTITUTE OF TECHNOLOGY
BOMBAY.



« APPROVAL SHEET »

The Special Project entitled

Simulation of Crab Movement on a Computer

by

SURESH G. BHAT

is approved for the partial fulfilment of
the requirements for the Master of Design
degree in Industrial Design.

Guide : *A.G. Rao*
28/4/89.

Prof.A.G.RAO.





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I wish to extend my gratitude to my guide Prof. A.G.Rao, to whom I am greatly indebted for his invaluable guidance through the project and his understanding and advice, which has helped me learn to deal with seemingly impossible situations and not be crabby about them.

I would also like to thank Prof. Ravi Poovaiah for his valuable suggestions and help in dealing with a stubborn computer.

I would especially like to thank my friend Dipankar Goswamy for his 'fifteen minutes' of intensive training in computer animation which is the main reason for this project to contain any at all. Another friend who helped clear a clogged brain and proceed with the task, Vinayak Nabar also deserves to be thanked.

7th April 1989
IDC

Suresh G. Bhat





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INTRODUCTION





« MOVEMENT AND ITS PERCEPTION »

What is movement and how does one perceive it? One generally defines movement as a change in position. This however, in itself is an incomplete definition, though the other part is generally implied in it. Movement (of an object) is a change in (its) position *with a change in time*. We generally perceive movement thorough our visual receptors. The other sensory modes can also help in perception of movement by receiving relevant stimuli which are then properly interpreted by the brain.

Visual perception which is the major mode of observing movement, itself is possible only if there is relative movement between the object and the eyes. Even when we view stationary objects, the eyes vibrate so as to shift the image in order to receive the necessary stimulus. It is the brain that then decodes the visual message to form an image. Movement of any object may therefore be easily perceived.

Visual perception is essentially an educated reaction of the brain. In addition to the basic





image formation by virtue of optical stimulus, the significance of the image is obtained only through acquired pattern recognition and association, as a result of continuous training during the growth of an individual. Thus identification of color, texture, tone and size, depth / distance, direction are attributes of a trained brain.





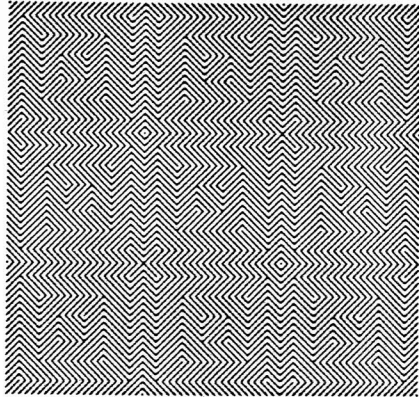
« INTRICACIES OF VISUAL PERCEPTION OF MOVEMENT »

A strictly scientific definition of motion would be - the displacement of one object relative to other objects. But this does not clarify our perception of motion, for which object is displaced and which serves as the frame of reference is an arbitrary choice. Visually perceived however motion has no such relative aspect and is an attribute of the moving object for in this case the observer is personally the frame of reference.

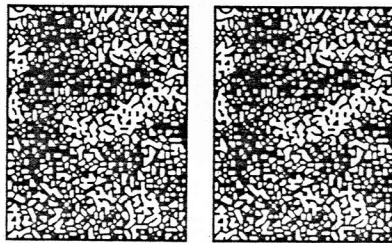
It is, however, possible to create illusions of movement quite contrary to the reality. A simple experience that most of us would have had is while sitting in a waiting train staring out at an adjacent moving train we sense a movement of our own train, if only momentarily until the conditioned brain reaction takes over.

When two or more objects of different areas on the same plane are viewed, each appears to move towards or away from the others. This is known as induced movement.





- a moiré pattern



- a stereoscopic image



Optical illusion is another topic which has been researched extensively. Illusion of movement can also be created by these methods. Geometric patterns that seem to constantly vibrate are termed *moiré patterns* and this is achieved by causing the viewer to repeatedly shift the focal point slightly within the pattern frame. Different patterns can cause a multitude of such illusions.

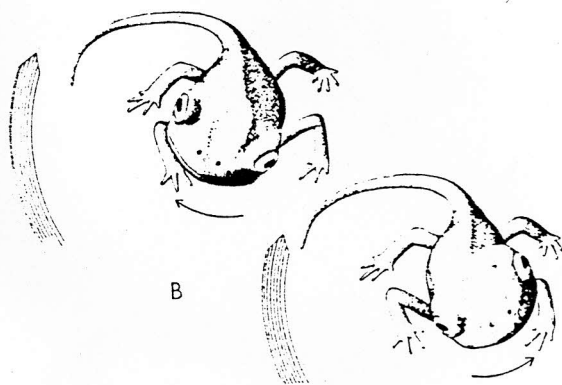
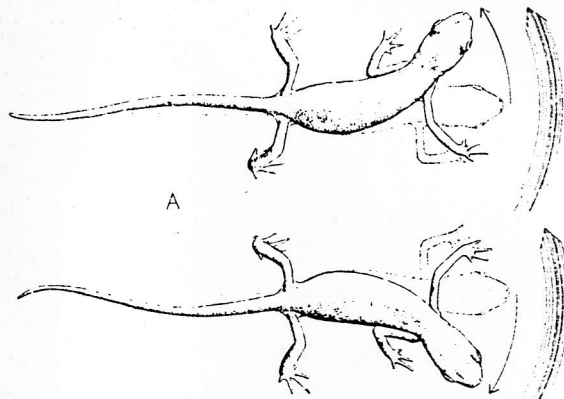
Another interesting phenomenon is *Stereoscopic vision*, where two identical textured fields are placed beside each other and when viewed through into the distance until their images merge, various regions in this merged field either advance or recede to give a three dimensional image.

Such are the various features of visual perception that would not only interest a scientist researching the visual perception, but would also open up great possibilities for a designer who wishes to create certain visual effects to be used in products, sign boards, posters etc.



RESEARCH





« TECHNIQUES OF REPRESENTING MOTION PICTORIALY »

◇ TEXT BOOK METHODS

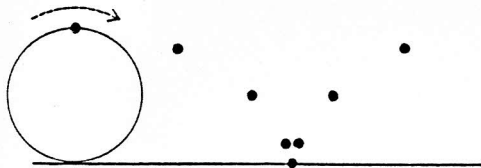
◇ *End Shadow Method* -

Used where it is sufficient to convey an idea of the nature of motion. The initial position of the object is illustrated with normal lines, while the extreme position after the movement is the viewer to assume the nature of the movement in between these two positions.

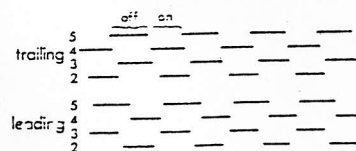
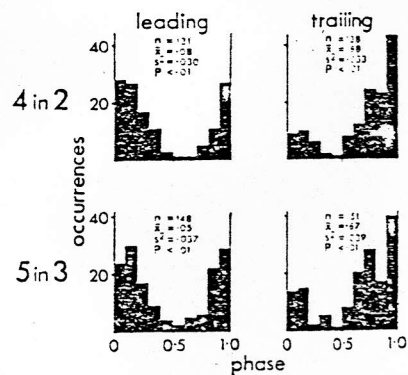
◇ *Extreme Stops Method* -

Used where only the change in position is to be depicted. Both initial and final positions of the moving object are shown. In this case the nature of motion is irrelevant and may again be imagined by the viewer. It is sufficient to convey to the viewer the change in position.





Walking in the Crab



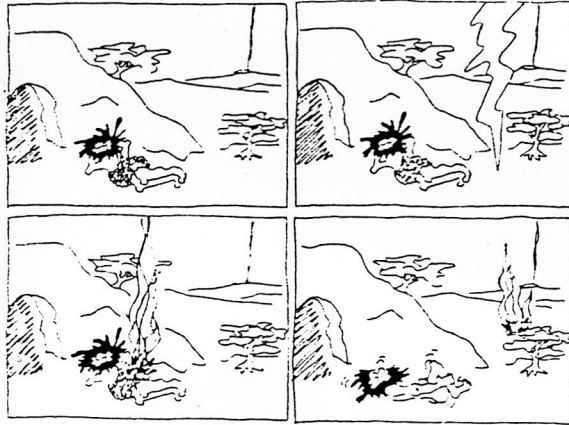
◇ Path Trace Method -

Used where the trajectory of the moving object is to be indicated. The object itself is of no significance and if at all shown it may be done so in dotted lines or faint tones.

◇ Graphical Methods -

Used when the exact sequence of motion is to be noted. This method too may be used to record the motion of any object whatever and it can do little to help visualize the object in motion.





◇ COMIC STRIP METHODS

◇ *Successive Panels Method* -

Here a constant background is used as a reference and the moving object is shown in the different key positions. Alternatively the object is shown within a totally different background, indicating that movement has taken place.

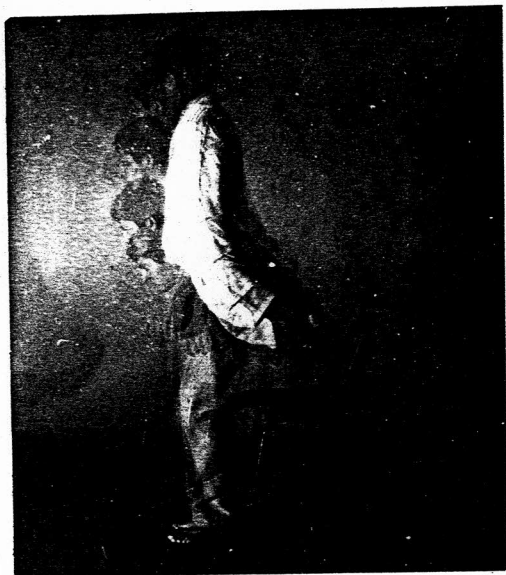
◇ *Trailing Frames Method* -

Several frames are overlapped and the moving object is shown normally in its most recent position, while all other positions during the movement are shown in more faded tones.

◇ *Trailing Path Method* -

The path through which the object moves is shown as a blur, fading with time. It creates an image of the object having moved, creating a wake behind itself.





◇ PHOTOGRAPHIC METHODS

◇ *Lazy Shutter* -

By using a slow shutter speed while photographing a moving object, it is possible to get a trailing image of the object.

◇ *Panning Method* -

By moving the camera itself, following the moving object to photograph it, an image is obtained with the background blurred.

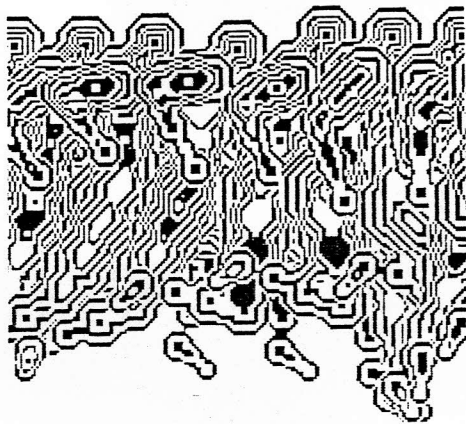
◇ *Multiple Exposure Method* -

The same frame is exposed to the moving object several times with the same background to obtain several images of the object in various positions. This sort of an image is known as a *flutter* or sometimes a *strobe*, for this effect can be obtained using a stroboscopic light source and a single exposure.

◇ *Time Lapse Photography* -

Extremely slow movements can be photographed by this method by exposing at regular intervals and when viewed, the whole motion appears to be speeded up.





◇ ANIMATION TECHNIQUES

These techniques make use of persistence of vision to give an effect of continuous movement by exposing twenty four or more frames per second.

◇ *Flip Books* -

Successive pictures are illustrated on different sheets of paper, which is then bound into a little book, which when flipped through creates an illusion of movement.

◇ *Animation Films* -

Objects - constructed by drawing, puppets or any other possible means - in successive positions are photographed / filmed and projected to be viewed like normal films.

◇ *Computer Animation* -

Computers are used not only in direct animation, but also to add animated sequences to motion pictures. Advanced software such as scanning and digitization has been developed that helps in animation.



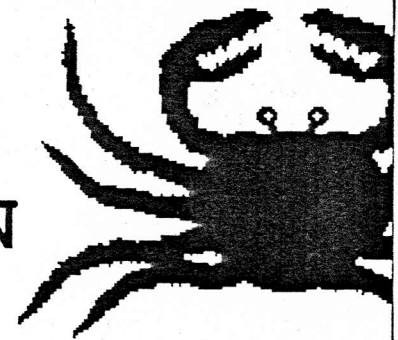


◇ **MOTION PICTURE METHODS**

Motion picture photography is an extensively developed field where real life action is filmed and projected to be viewed on a screen.



EXPLORATION





« THE PROJECT »

This project aims at opening an area where there are possibilities of developing interesting images of movement. The intention of the project is to study various images of movement and to develop a new imagery. In this era of computer animation, an attempt is to be made at developing a methodology for animation which can not only be used on a computer but also in conventional animation. The possibility of using the developed images in still illustrations is also to be considered. The use of this method for recording movement is to be tried out too.

The main tool therefore to be used was a computer animation programme and as an example, it was required to animate the movement of a crab. Among the various tools and techniques that exist for recording movement, computer animation is relatively new compared to cartoon animation, which is the one that has been exploited most, not only by animators, but also by millions of viewers.





« THE DEVELOPMENT »

The first inspiration was drawn from the cartoon shown alongside. The crab could leave behind footprints too, to serve as a score in order to keep track of its movement and record it.

What sort of foot prints would a crab leave behind? It was decided that instead of actual footprints, the crab would leave static images (body prints) of itself. This same technique could be applied to other moving objects too. The problem that arises now would be that the image would be indistinguishable from other crabs. This would only create confusion.

To overcome this it was decided that static images of only the important parts directly involved in the movement would be retained. In the case of a crab these are the images of its legs. It can be made more interesting by having the 'footprints' to fade out with time.

The most interesting possibility is that whatever the moving object, it would have a unique imagery of its own, and this opens up a multitude of possibilities for further exploration.



Now how would one distinguish different situations? At this stage it was decided that language could be used as a guide-line to base the animation on. Various kinds of movements and different situations as expressed through language can be explored and an imagery for each can be drawn up.

After studying the various lingual expressions of movement, they were classified as follows, with reference to:

◇ *The Viewer* -

- | | |
|--------------|------------------|
| † Sideways | ~ Left / Right |
| † Vertically | ~ Up / Down |
| † Distance | ~ Towards / Away |
| † Rotational | |





◇ *A Reference Object* ~

- † Around
- † Above / Below
- † Through
- † Into / From

~ these would depend on the nature of the object- whether it is an obstacle or a receptacle.

◇ *The Moving Object Itself* ~

- † Change in overall body position
- † Change in part position
- † Change in body shape

◇ *Type of Movement* ~

- † Sliding / Rolling / Creeping / Gliding
- † Walking / Running / Galloping / Leaping / Somersaulting





◇ *Nature of Movement* -

- † Speed Fast / Slow
- † Uniform / Accelerating
- † Continuous / Jerky

◇ *Surrounding Medium* -

- † Water
- † Ground
- † Air
- † Space
- † Time

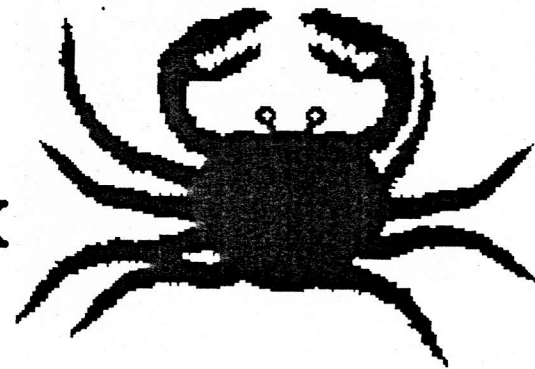
◇ *Agent Causing Movement* -

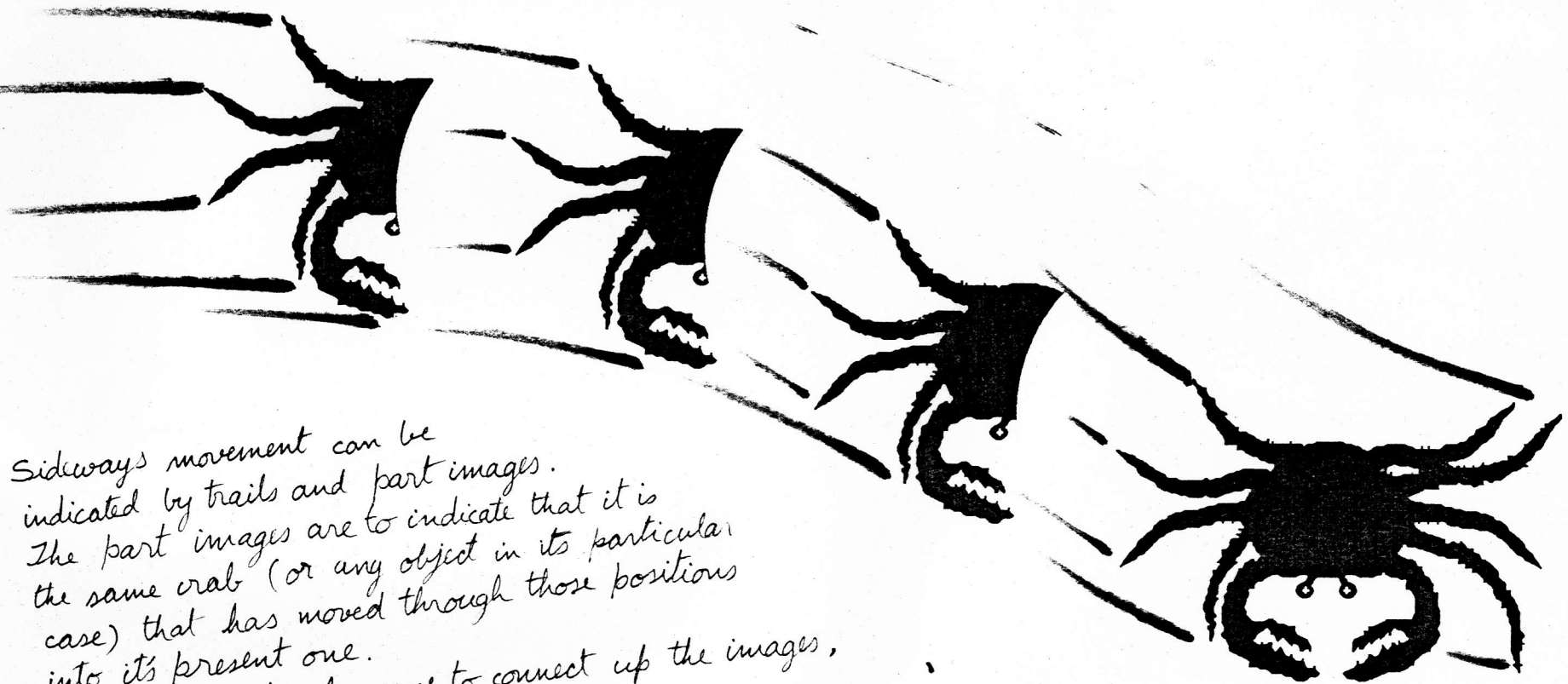
- † Voluntary
- † Forced

These have been visually explored on paper as illustrated in the following pages and then implemented on a computer animation programme, to animate the crab movement.

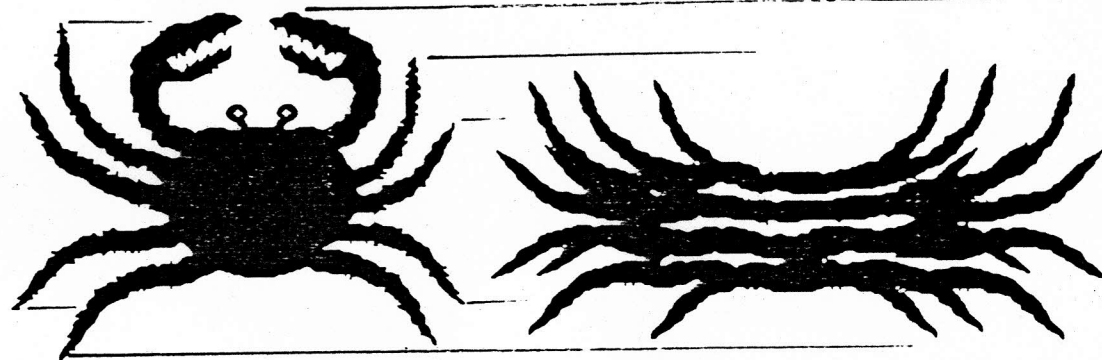


APPENDIX





Sideways movement can be indicated by trails and part images. The part images are to indicate that it is the same crab (or any object in its particular case) that has moved through those positions into its present one. The trails not only serve to connect up the images, but also help picture the path taken. The quality of the trail lines could be varied to indicate the nature of motion. The static images could be faded with time or flickered where the medium of presentation permits it (as in computer animation). In a computer animation sequence, whole images could be used too with cyclic flickering.



Static images of the main parts involved in the movement are retained in key positions.

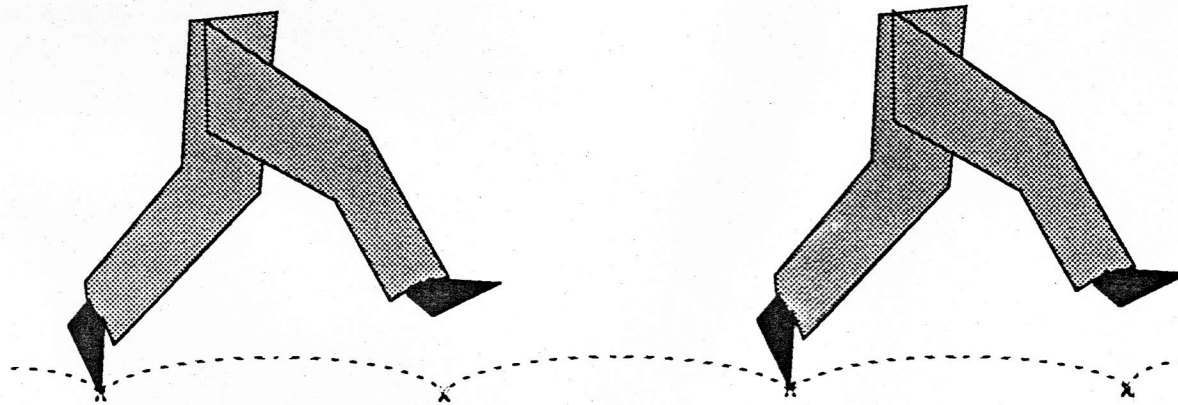
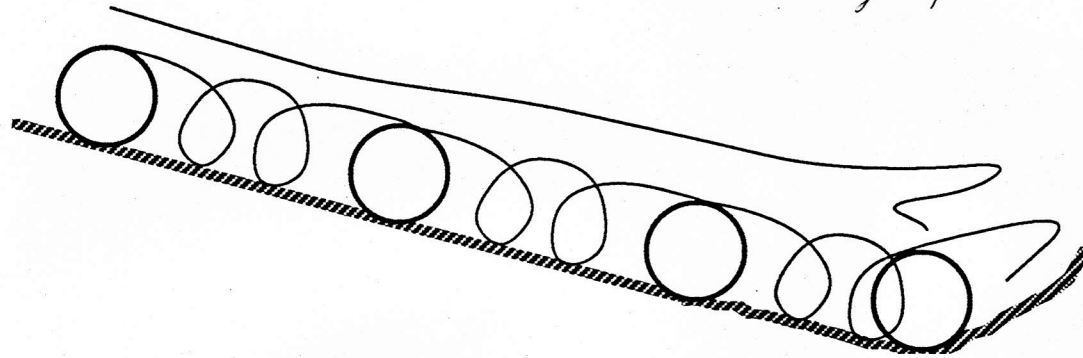
This opens up a new dimension in the imagery of movement, both animated and static.

The image is totally dependant on the moving object and the nature of its motion, and hence every object would have a unique image of its own.

This gives an interesting area for exploration.

In addition to static images, path lines may be used to indicate the nature of movement where necessary.

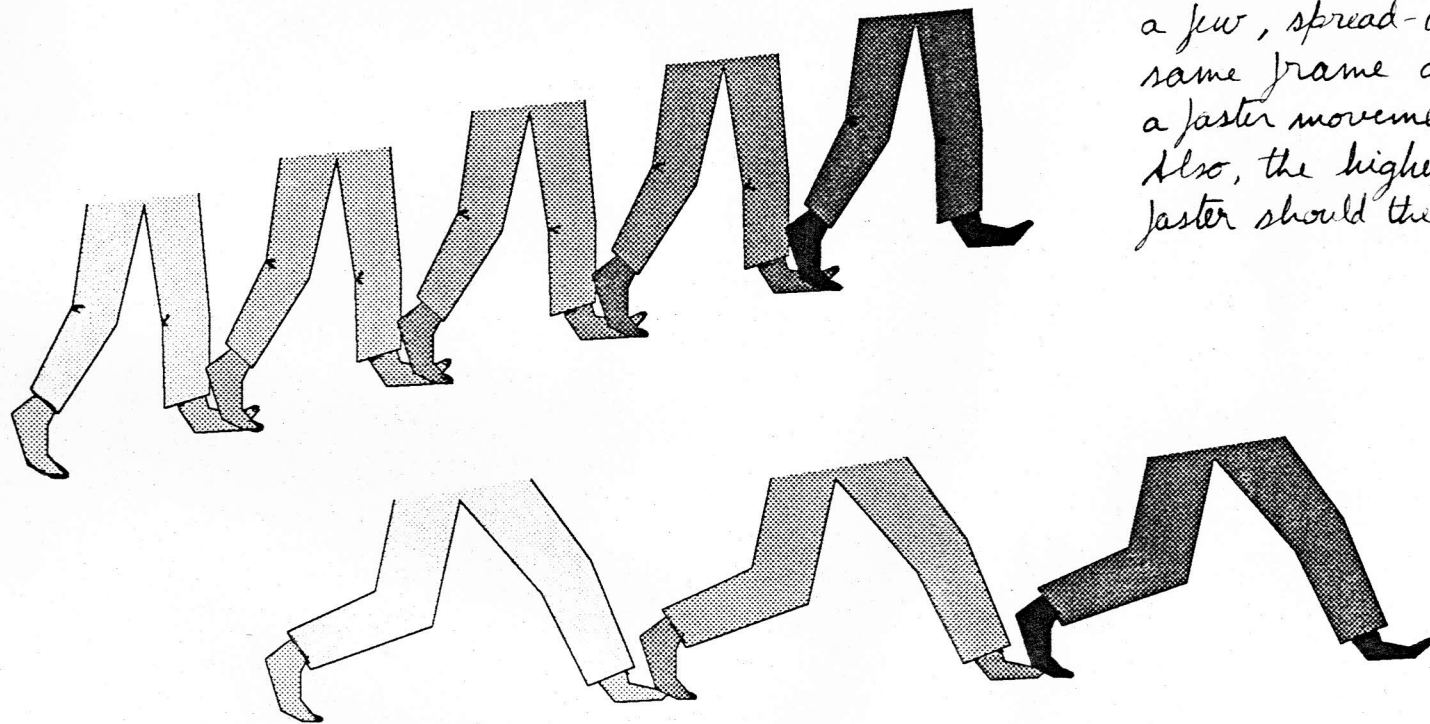
Here the continuous spiralling line indicates 'rolling', while the dotted line is used to evoke an image of 'creeping'.



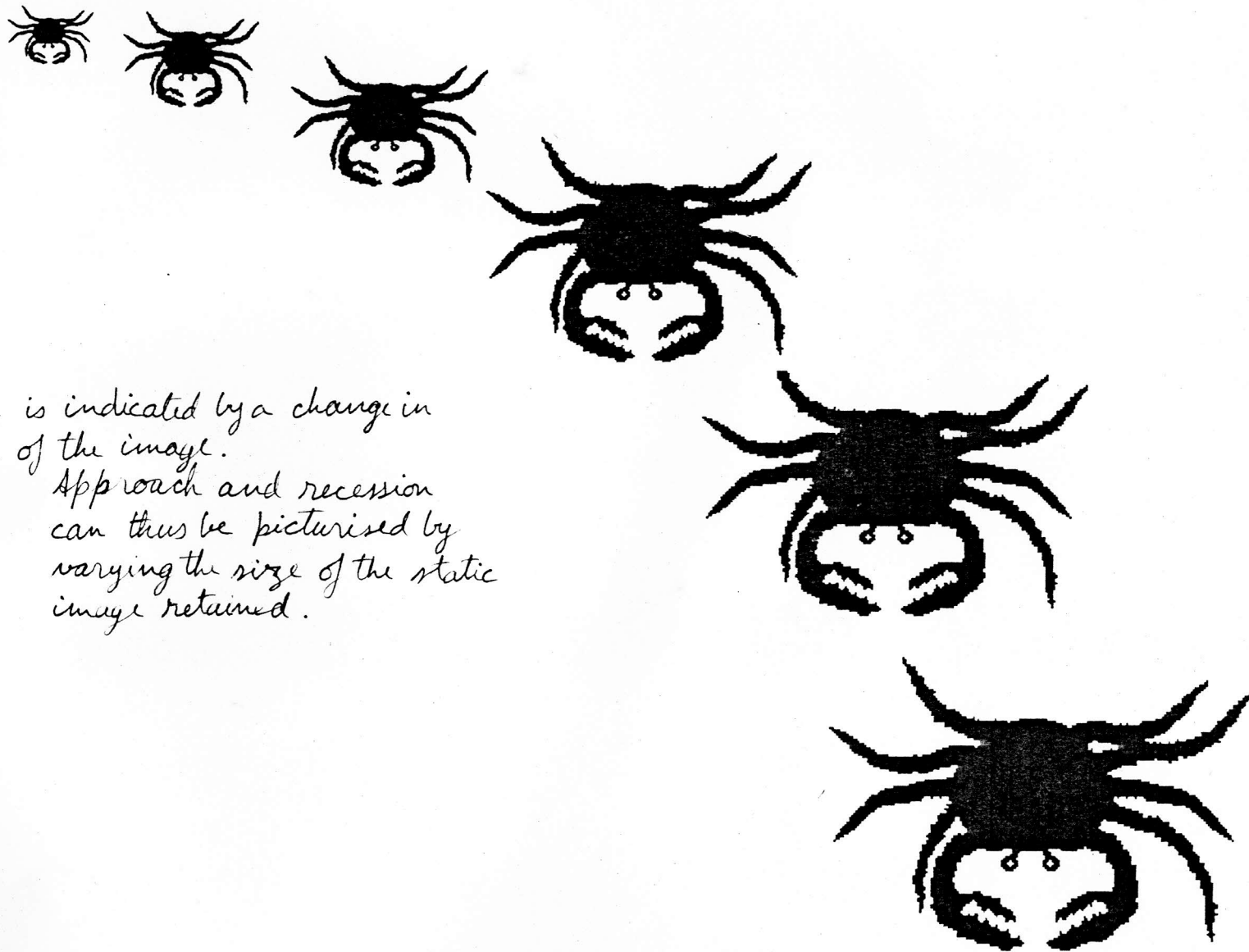


ghost images are another sort that could be used to indicate previous positions, as do part images and fading images.

The number and spread of the static images would be indicative of the speed of movement.



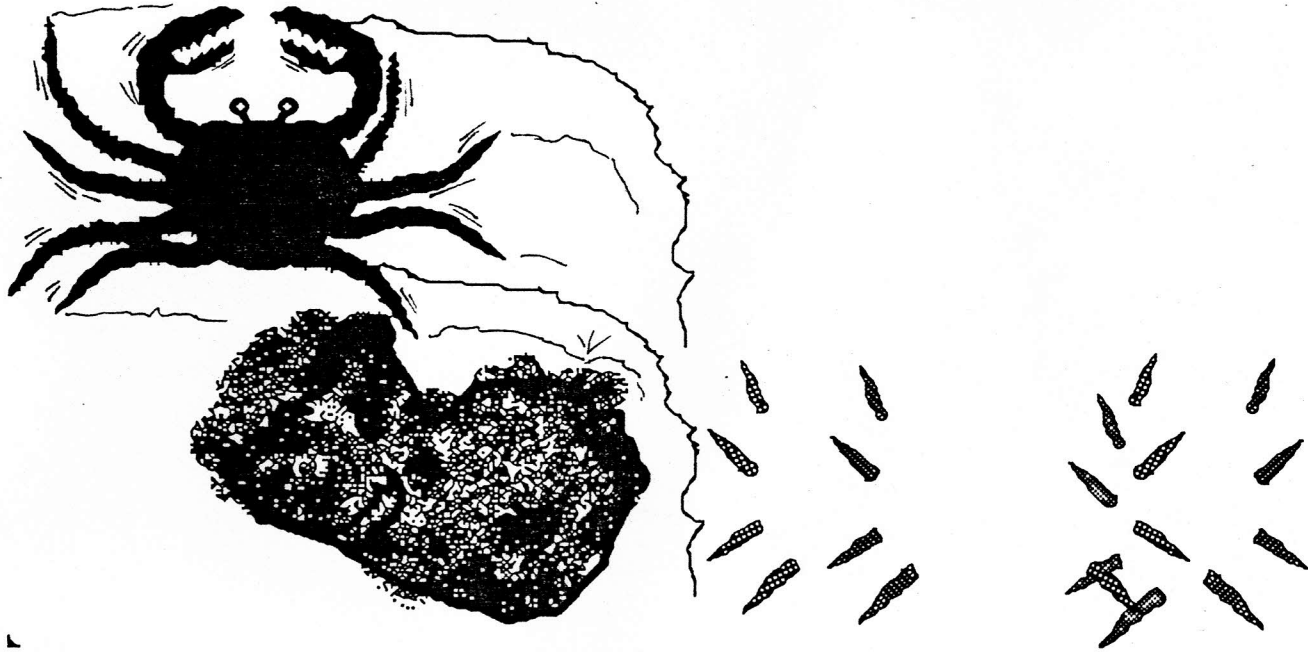
Many, clustered images would depict a slow deliberating walk, whereas a few, spread-out images in the same frame area would represent a faster movement. Also, the higher the speed, the faster should the fade out of the image be.



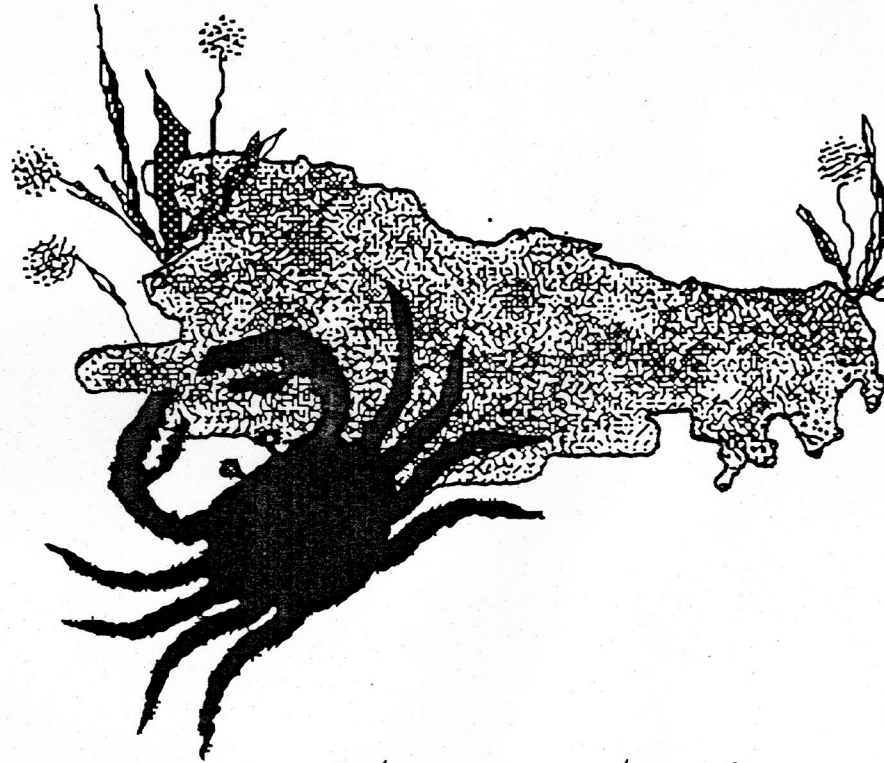
Depth is indicated by a change in size of the image.

Approach and recession can thus be pictured by varying the size of the static image retained.

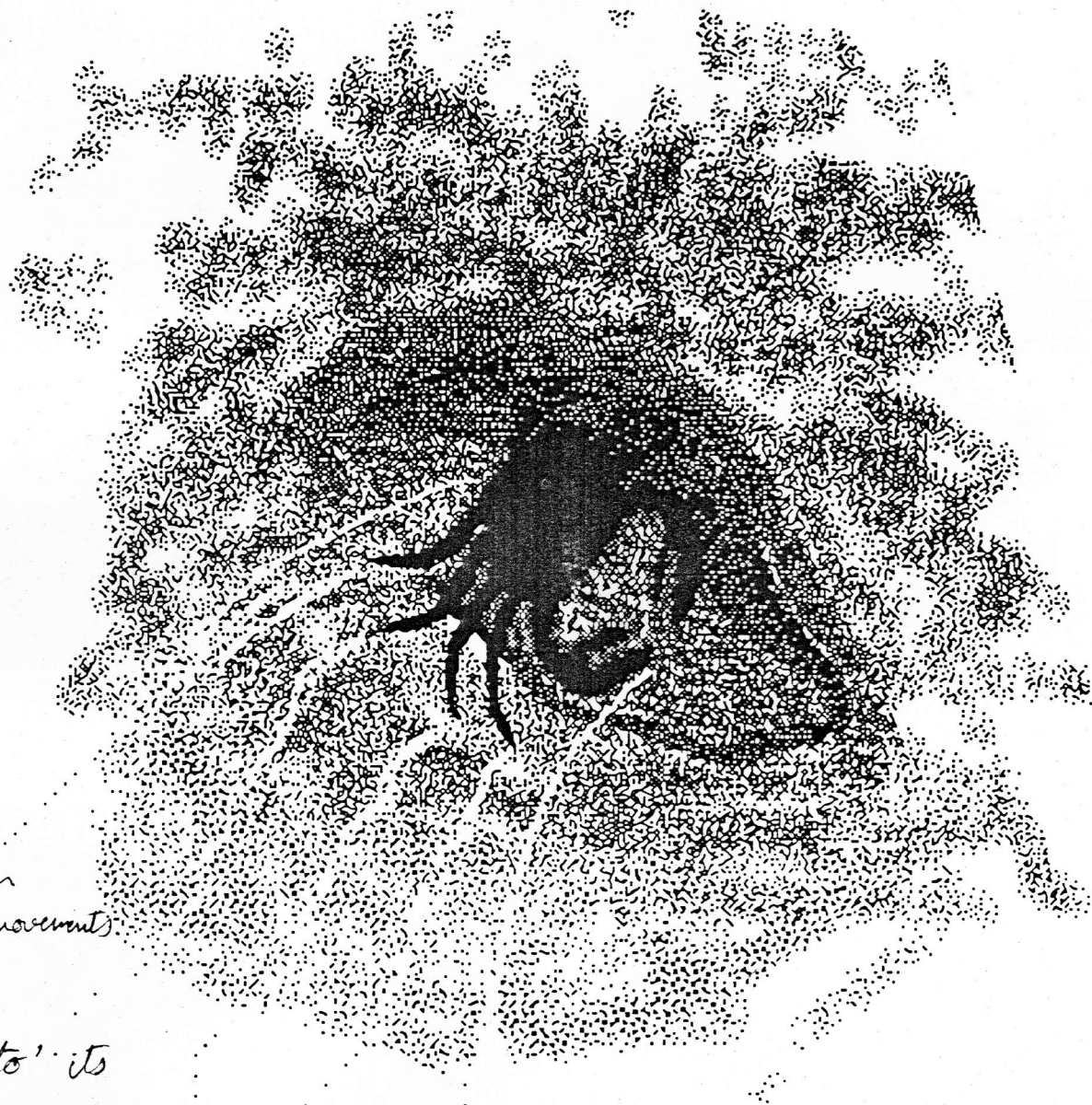
Fading static images of the end segments
of the legs have been used here to form
an image of the crab movement.



The unsteady trail lines conjure up
the image of a jerky walk around
an obstacle in the path.



Expressions such as 'going over', going under, going through are also explored for visual portrayals.



Part of the image
maybe made to
vanish and appear
to display certain movements

A crab 'getting into' its
burrow.

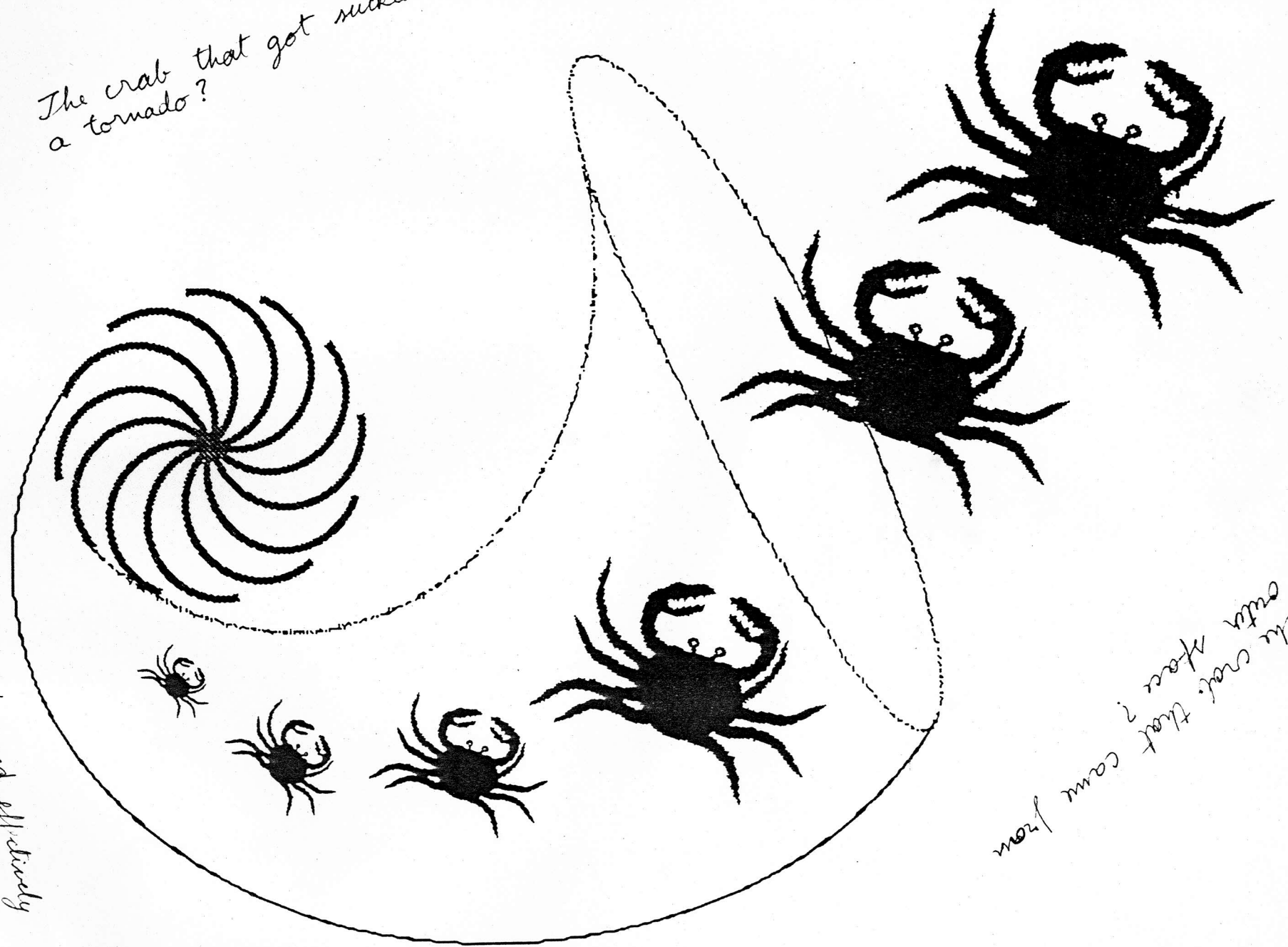
The crab that mistook an
earthworm burrow to
be his own —

Bodily distortions
such as this one are
another means that can
be used to create desired visual
effects to convey the intention
of certain movements.



The crab that got sucked into
a tornado?

The background too could be used effectively
for causing desired visual effect.



The crab that came from
outer space?

