

**“BIO-MORPHIC EXPLORERS”
A NEW PARADIGM IN MOBILITY**

JPL

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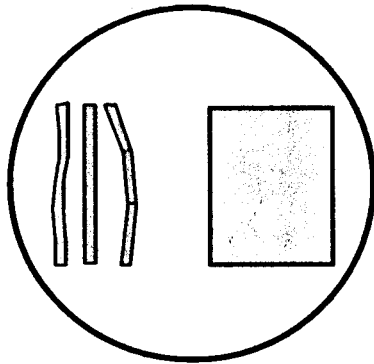
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CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA 91109**

CONCEPT

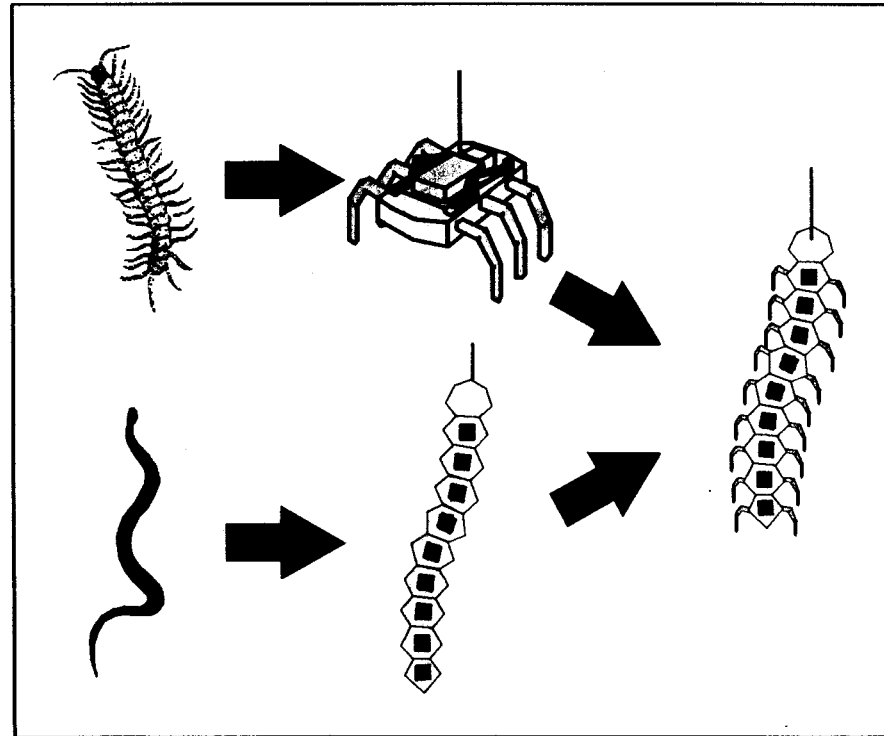
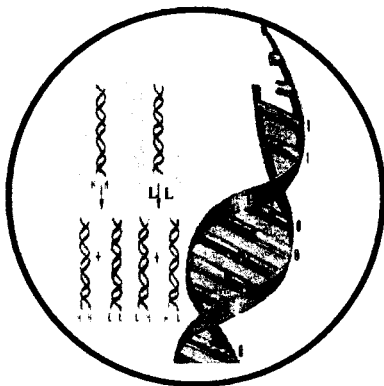
BIO-MORPHIC EXPLORERS

- **BIO-MORPHIC EXPLORERS: A UNIQUE COMBINATION OF DIRECT-DRIVEN MOBILITY DESIGNED USING ADVANCED FLEXIBLE ACTUATORS and THEIR CONTROL BY ADAPTIVE, FAULT TOLERANT BIOMORPHIC ALGORITHMS TO AUTONOMOUSLY MATCH WITH THE CHANGING AMBIENT/TERRAIN CONDITIONS.**

FLEXIBLE ACTUATORS

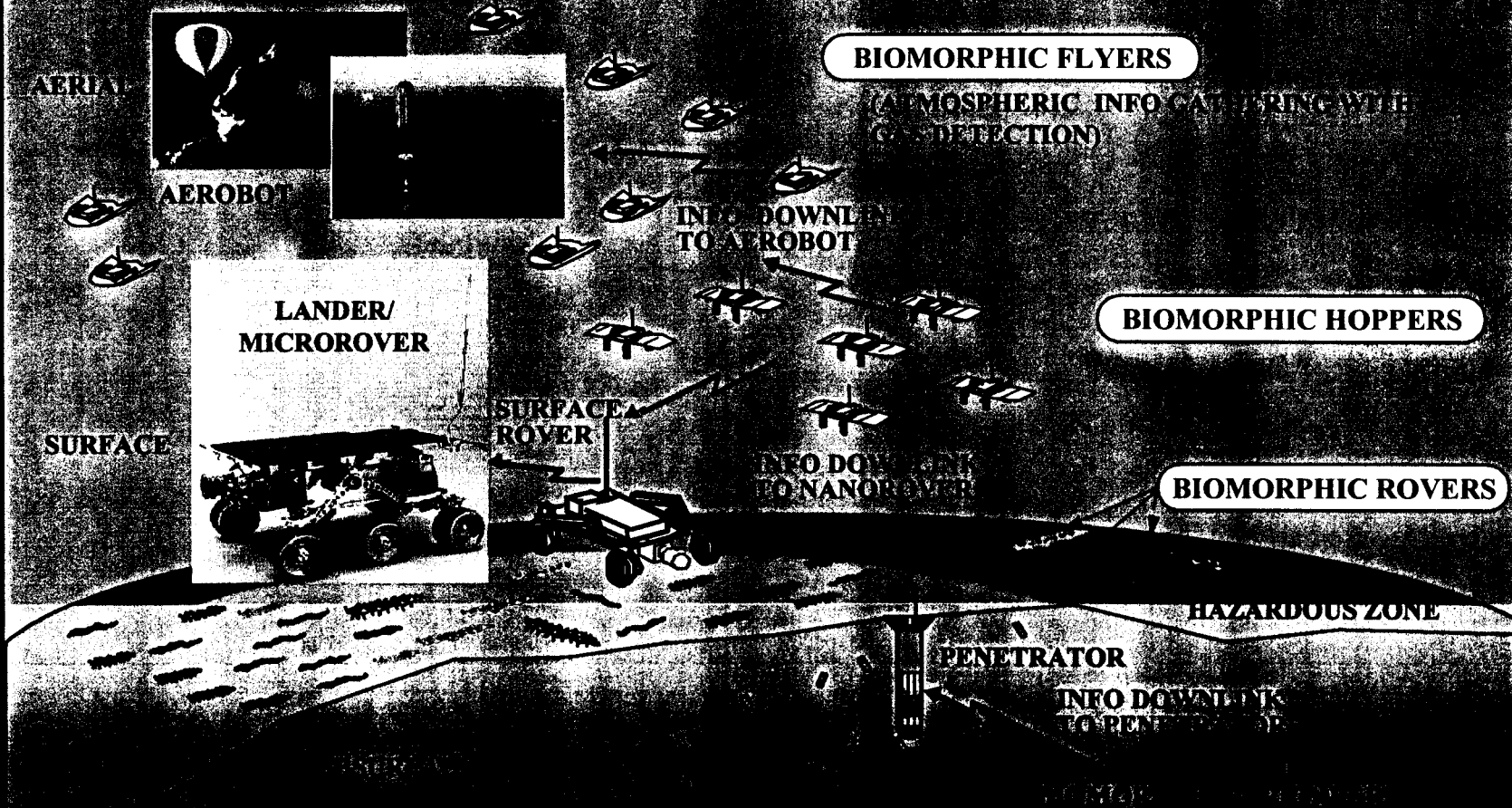


BIOMORPHIC CONTROL



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POTENTIAL COMPREHENSIVE EXPLORATION SCENARIO



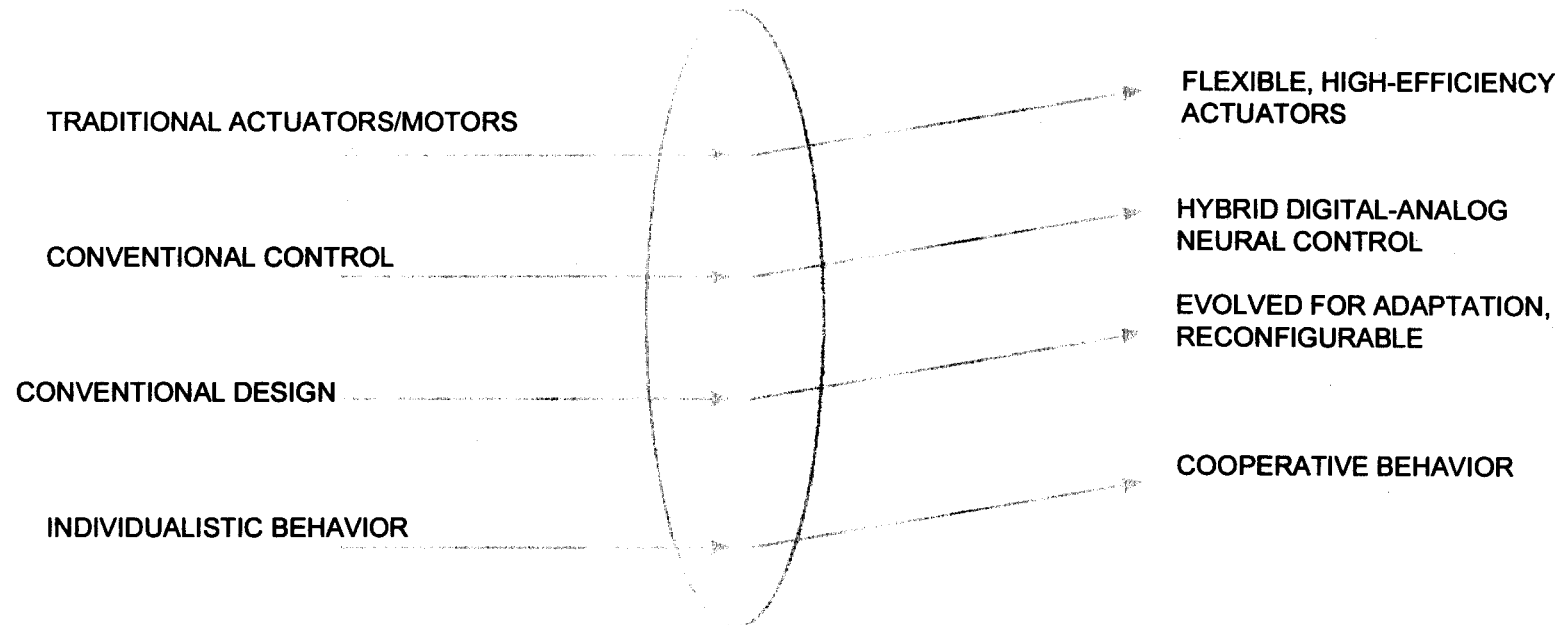
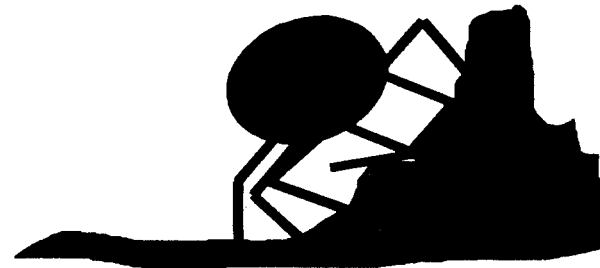
HEIRARCHICAL ORGANIZATION OF LANDER, ROVER(S), PENETRATOR(S) AND A MULTITUDE OF INEXPENSIVE MICROEXPLORERS WOULD ALLOW COMPREHENSIVE EXPLORATION AT A LOWER COST

MOTIVATION: PARADIGM SHIFT FOR ENHANCED SCIENCE RETURN

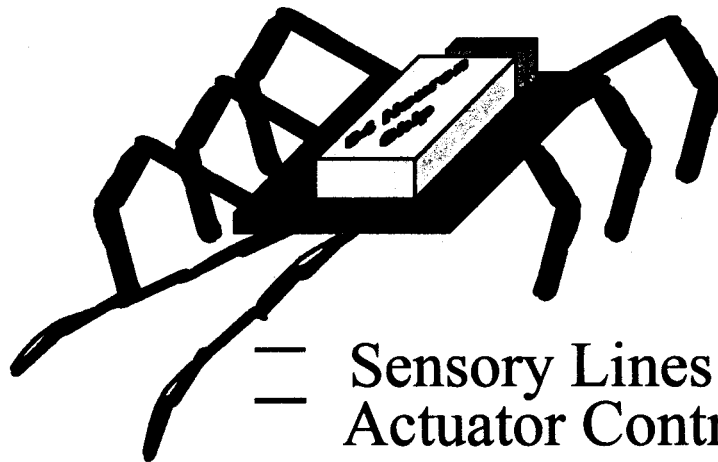
CURRENT ROVERS



BIOMORPHIC MICROEXPLORERS

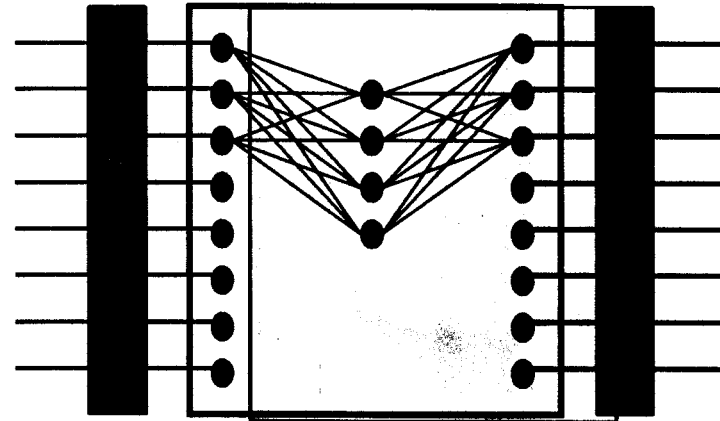


Neurally-controlled Biomorphic Explorer



— Sensory Lines
— Actuator Controls

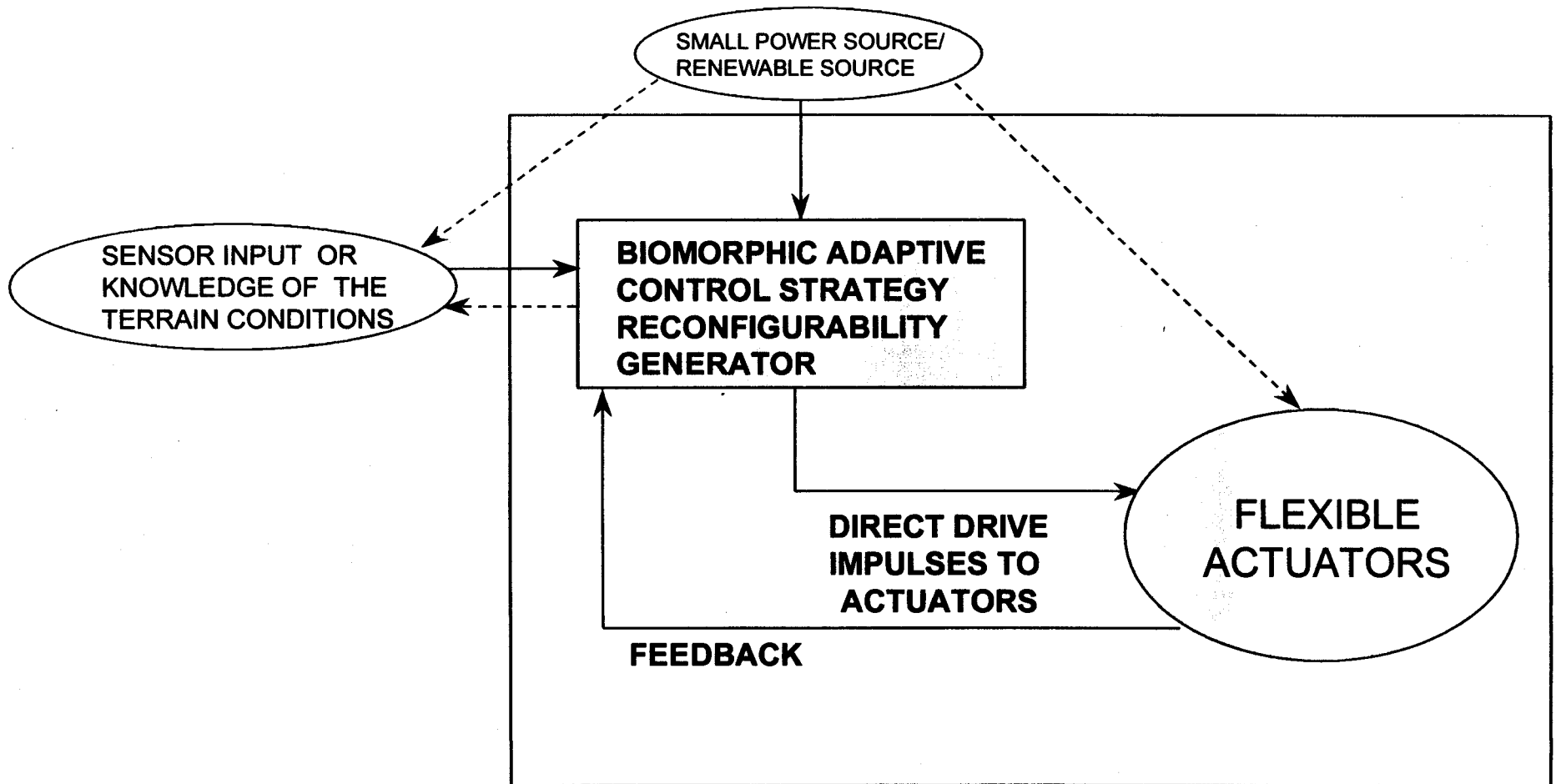
Neural connections mapped on 64 Neural Network (NN) Chip



JPL's 64 NN chip Characteristics:

- Low Weight (5g)
- Small Size (1cm x 1cm)
- Low Power (12mW)
- High Speed (~250nsec)
- Programmable Neural Network Architecture

BIO-MORPHIC EXPLORER SCHEMATIC



EARTHWORM LIKE BURROWING ROBOT

THE JOINTED PLATES BUCKLE OUTWARDS WHEN THE CENTER ACTUATOR IS SHORTENED, ENABLING THE ROBOT WORM TO ANCHOR WHILE THE FRONT END ADVANCES

THE JOINTED PLATES LAY FLAT WHEN THE CENTER ACTUATOR IS ELONGATED, STREAMLINING THE ROBOT WORM SO THAT IT CAN MORE EASILY PENETRATE SOIL

MODIFIED TIP CAN BE MADE TO:

- ① SHARPEN THE END
- ② COLLECT SAMPLES
- ③ SENSE

LITTLE SPIKES ON THE PLATES PROVIDE FURTHER TRACTION ONLY WHEN THE PLATES ARE IN THE BUCKLED POSITION

MOTION COULD BE MADE BI-DIRECTIONAL BY CHANGING SEQUENCE OF SEGMENT SHORTENING AND ELONGATION BY ACTUATORS

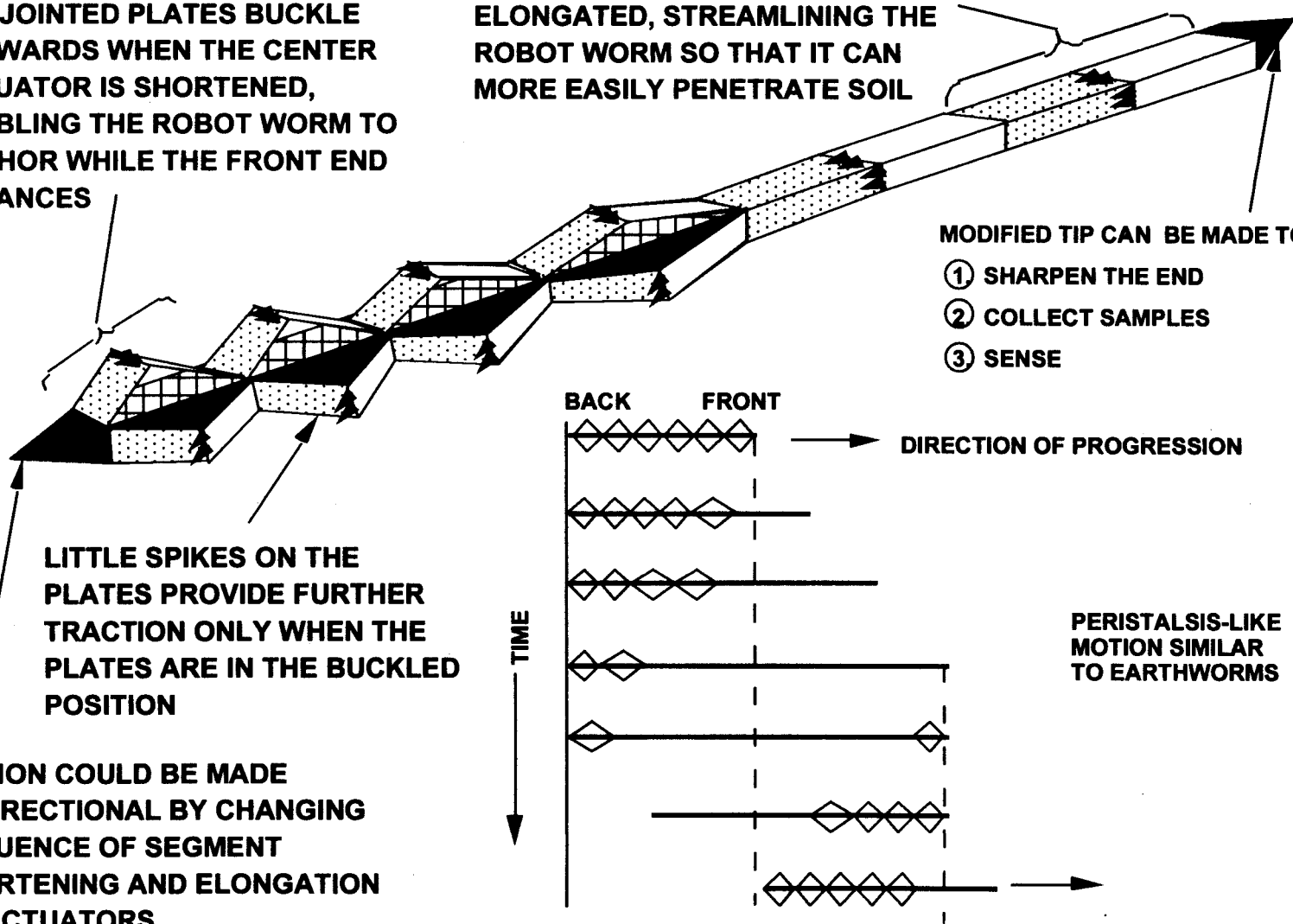


Figure 1

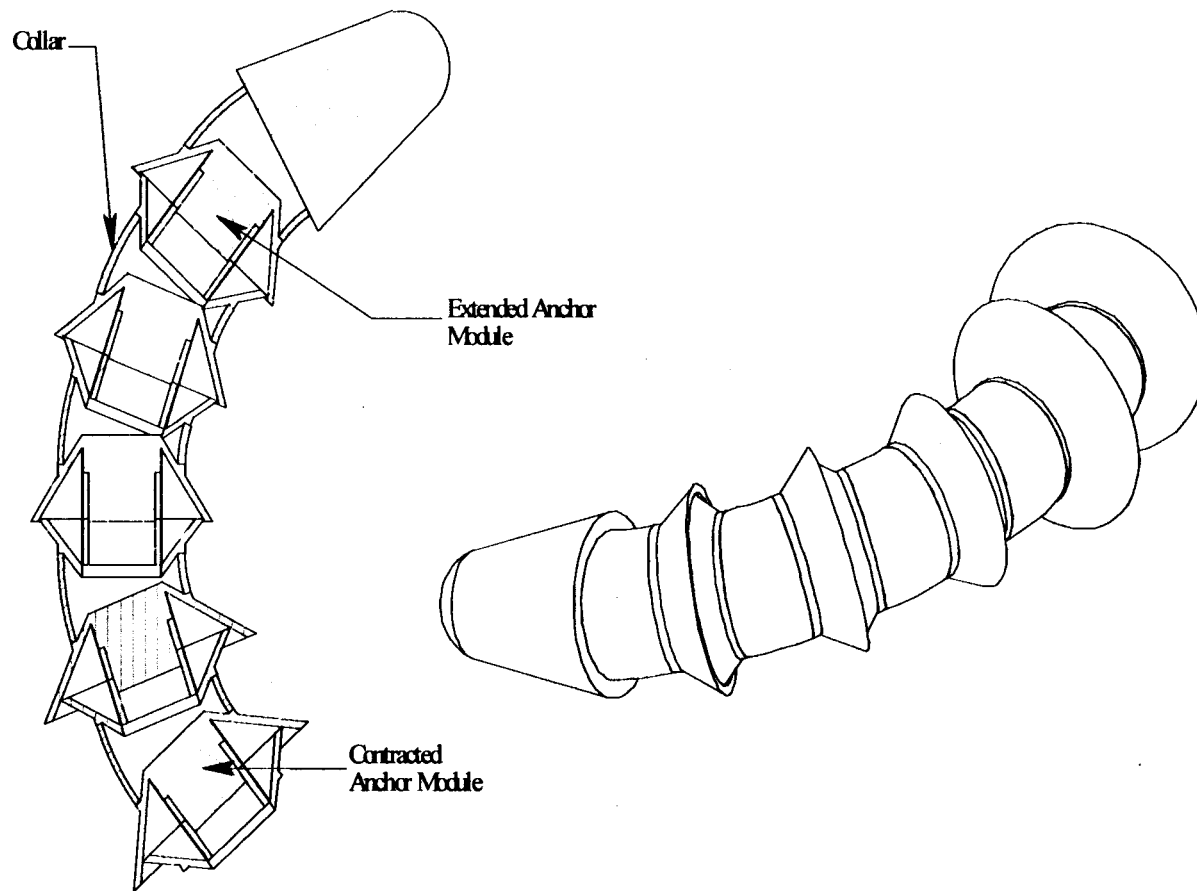


Figure 2

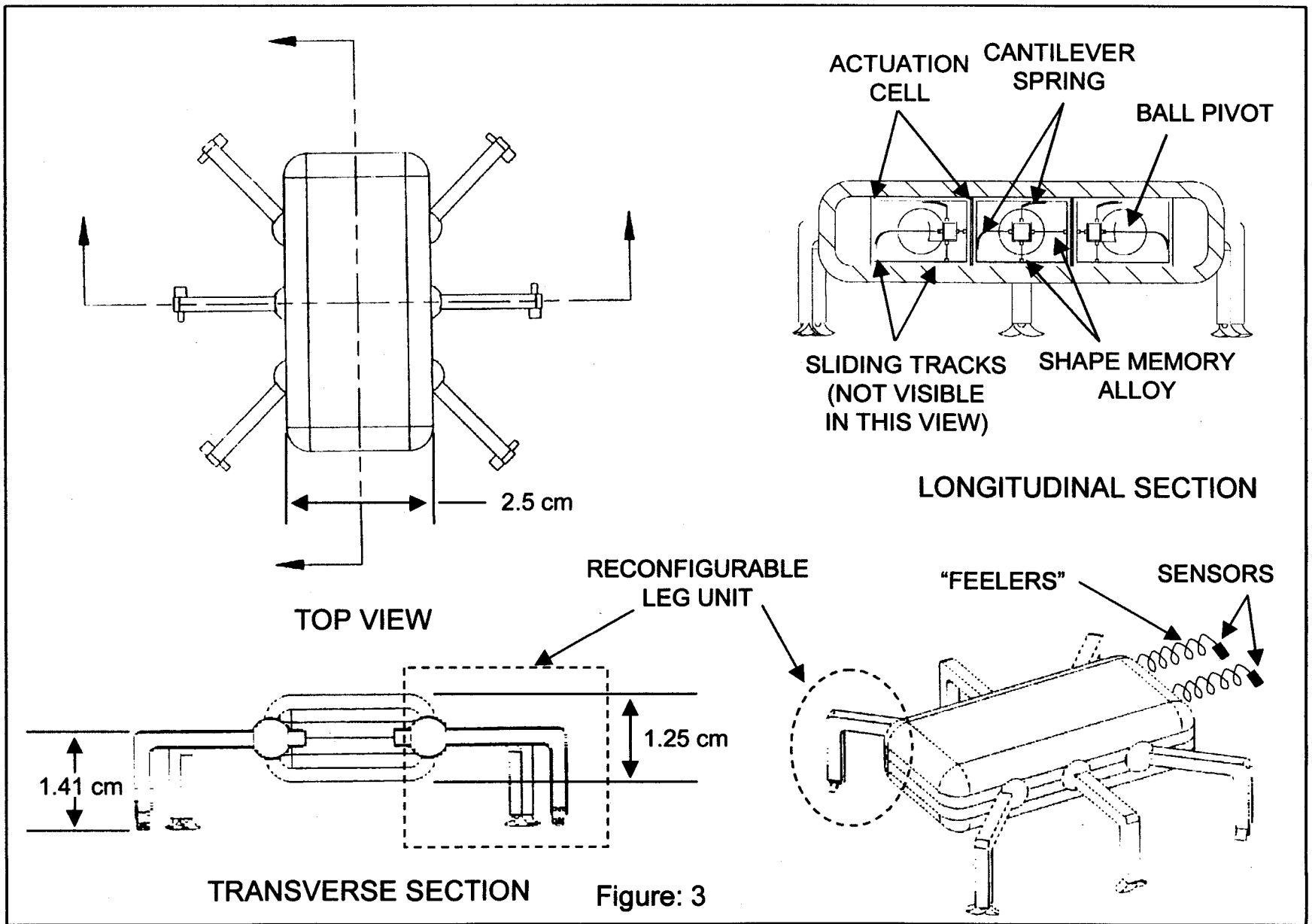


Figure: 3

RECONFIGURABLE FOOT/LEG OF BIOMORPHIC EXPLORER

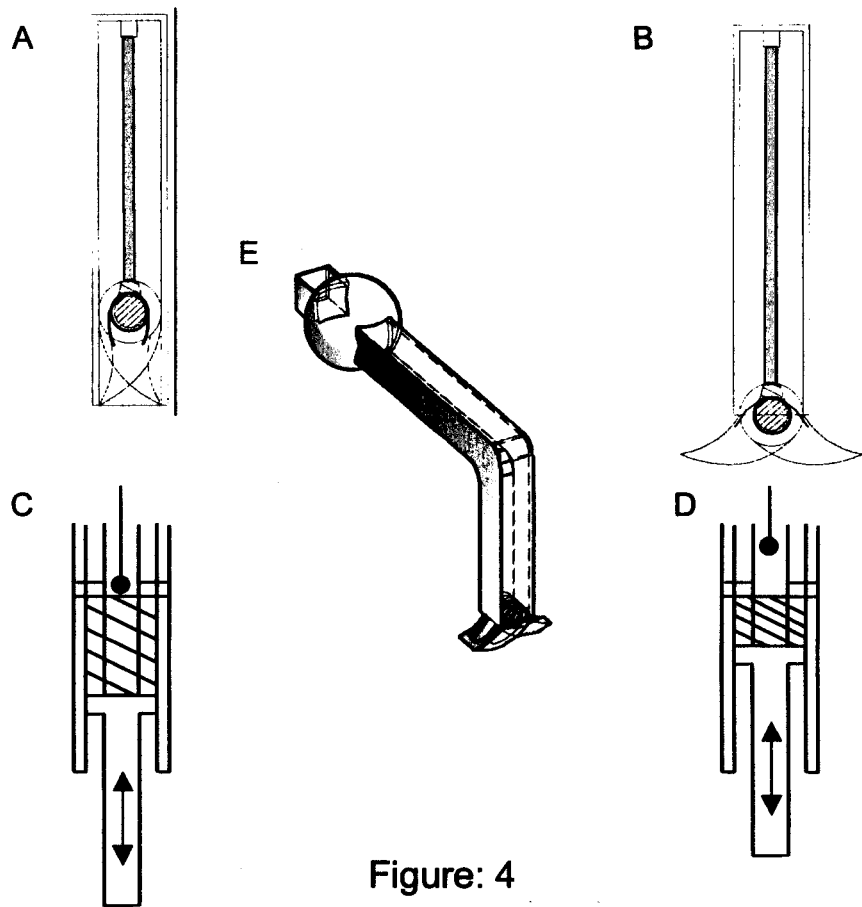


Figure: 4

ADVANCED MOBILITY FOR BIO-MORPHIC EXPLORERS

