MOM Project Proposal

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SAM Course 2023/2024
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***Abstract*:**

We propose a novel microrobot designed for collective task execution in swarm robotics. This microrobot harnesses a vibration-driven mechanism for movement, eschewing traditional wheels for a more versatile approach. A simple power source coupled with an efficient control system provides responsiveness to environmental cues. The design emphasizes modularity and scalability, enabling these microrobots to adapt to varied tasks within a swarm framework.

Keywords:

MOM – MOdular Microrobot, IR – Infrared (sensors and emitters), Vibrators – devices which, when powered, vibrate, Logic IC – simple integrated circuit made from logic gates, NMOS/PMOS transistors – n /p - channel transistors

I. Introduction

We're building a super simple microrobot that doesn't need wheels or a brainy microcontroller. It's powered by just a coin battery and gets around with a couple of tiny buzzers controlled by basic transistor logic. With four sets of IR sensors to see where it's going, this little bot can dodge obstacles and hang out with other bots without any crashes. It's our take on keeping robot design straightforward, cheap, and perfect for swarming together in big groups.

II. General concept

This microrobot is designed to be straightforward and functional: it's powered by a single 3V battery and moves without wheels. The design is split into three main parts for clarity:

A. Supply

The robot's operations are powered by a basic 3V battery located at its base. This battery provides the necessary power for both the control and movement mechanisms.

B. Control

The robot is directed by a simple control system using NMOS transistors. These transistors act as switches in response to signals from infrared sensors. The sensors are responsible for detecting obstacles in the robot's path, allowing for immediate reaction to the surrounding environment.

C. Actuators

Movement is created by vibration motors. When activated, these motors cause the robot to move by generating vibrations. Through different activation patterns of these motors, the robot can either rotate or move straight, which allows it to navigate on a flat surface.

III. Design

The design of our microrobot is modular, centred around a combination of Printed Circuit Boards (PCBs) that serve specific functions. Here's how it's put together:

- The Main PCB acts as the robot's framework, providing structural support and housing the electronic components. It's here that the battery connectors, motor controllers, and logic circuitry reside, creating a centralized hub for the robot's operations.

- The Sensor PCBs which reside on the sides of the robot hold the infrared emitter and detector pairs responsible for the robot's environmental awareness. Being placed at strategic points around the robot's body, these sensors detect obstacles and trigger the control system to act accordingly, ensuring smooth navigation and interaction with the surroundings.

- Finally, the Actuator PCB contains the 2 vibrating motors that generate the movement. These motors are activated by the control signals from the Main PCB, causing vibrations in the 2 front legs that propel the robot. The design allows for quick changes to the motor configuration, adapting the robot's movement to different scenarios. The reason why we chose to have only the 2 front legs moving is for robot stability and ease of movement control.

IV. Control modularity

The modularity of control in our microrobot is defined by a logical system that orchestrates movement through vibrational actuation, facilitated by the front legs. This is achieved using two Solarbotics VPM2 Vibrating Motors placed strategically to control the frontal bidirectional movement. The rear legs remain static, providing stability to the robot's structure.

Upon detecting an obstacle with the IR sensors, the logic circuit—comprised of NMOS and PMOS transistors—commands the appropriate vibrator to cease, causing the robot to pivot away from the obstacle. This selective deactivation is governed by basic if-then logic: if an object is detected on the left, then the left vibrator stops, prompting a rightward turn, and vice versa. If the robot approaches another from the swarm, both vibrators may temporarily halt, allowing the robot to pause and reorient its path.

This system operates on simple principles derived from the IR sensors' datasheets. The IR emitters project an infrared beam; when reflected by an object, the corresponding IR detector triggers a control response. The vibrators' operational parameters, such as amplitude and frequency of vibration, are set within the safe operating limits indicated by the Solarbotics VPM2 specifications. The battery provides a steady voltage that ensures consistent performance, with the logic circuitry modulating this power to achieve the desired motion.

Movement equations, while elementary, take into account the force of vibration F_V related to the motor's amplitude A and frequency *f*, balanced against the robot's mass *m* to calculate the acceleration *a* it experiences. These can be simplified as:

$$F_V = A * f$$
$$a = F_v / m$$

Here, F_v is kept within a threshold to prevent the robot from tipping over, ensuring reliable navigation as it interacts with its environment and other robots.

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