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Subminiature Surveillance Robots for Social Safety

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Abstract: A portable subminiature surveillance robot for social safety is composed of mechanical parts, control parts and interface modules. The robot is able to jump and move on the flat or rough grounds such as a gravelly road, with various interface modules and different functions. It can be used to guard, patrol, search and detect in small, limited or dangerous areas where people or big robots cannot enter. It is also able to be controlled remotely. This study intends to detail the development of each component of the robot, and to look into the future plan and its expected effects.

1. INTRODUCTION

A portable sub-miniature surveillance robot for social safety has cylindrical body and driving wheels made of shock-absorbing materials. The robot body is 11cm in diameter and roughly 20cm long, and the wheel is 15cm in diameter. Inside the body there are mechanical elements such as three small DC motors, a clutch and brakes for moving and jumping. Also a camera, controllers and different kinds of sensors are equipped inside.

2. MECHANICAL DESIGN

See Figure 1 for the mechanism of the robot, and Table 1 for the detailed specification. The robot moves using two wheels, uses clutches to keep spring compressed and then jumps by releasing the compression in an instant. Two of three DC motors control the wheels and the other controls the spring compression.

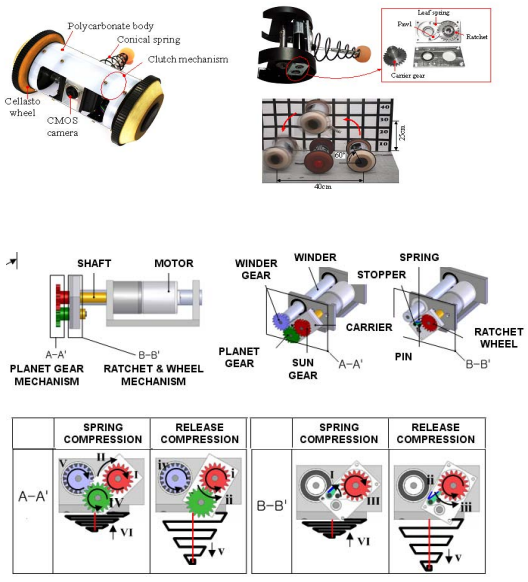

Figure 1. The robot mechanism

Table 1. Specification of the robot

Parameter	Rating
Length and Diameter	- Body: length 20cm, diameter 11cm - Wheel: diameter 15cm
Weight	- 1.5kg
Speed	- 0.5m/s (at flat ground) - 0.2m/s (at rough ground)
Maximum jump height	- 10cm(developed) - 30cm(in the future)
Interface module	- Gas detector - Radioactivity detector - Temperature and humidity detector - Laser pointer, Laser gun

Figure 2 is the modeling of the jump mechanism of the robot. The height of jump is related to the spring constant. To jump higher, it is necessary to make a spring stronger and its compression distance longer. A conical type of the spring can satisfy these conditions.

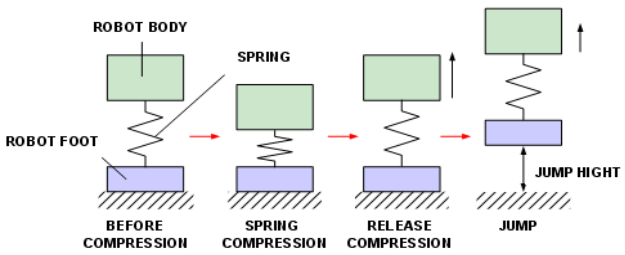

Figure 2. The modeling of jump mechanism

Figure 3 shows the spring deformations comparing a general spring with a conical spring. Under the same load in certain periods, the deformation of a conical spring is larger than a general one. In order to jump higher, a conical spring is proper. In this study, we developed the jump and clutch mechanism using a conical spring for the robot.

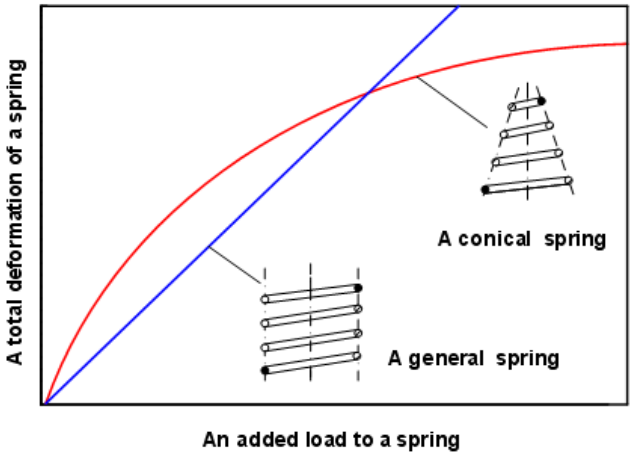

Figure 3. The spring deformations based on an added load

3. DESIGN OF CONTROL

Figure 4 shows the block diagram of the robot controller. The main CPU is 16-bit DSP processor and H-Bridge DC motor driver unit is included. The main CPU controls the speed and position of DC motors by applying PWM signals. The robot controller has various sensor interface units to detect obstacles and control the attitude of the robot when it moves and jumps. Two ultrasonic sensors are used to detect obstacles on both sides at the distance of 10m ahead, and PSD(Position Sensing Device) to sense objects at the close distance of about 30cm. Additionally, a photo-sensor is used to control the attitude of the robot when it falls after jumping. Using these sensors, we developed the algorithms for its movement and jumping.

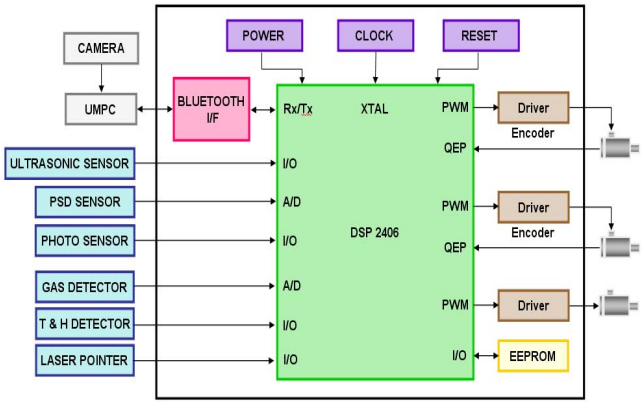

Figure 4. The control block diagram

For the remote control of this portable sub-miniature surveillance robot, bluetooth communications are used. The robot is equipped with the camera which is able to survey an area of interest and send their images and data. Furthermore, many kinds of sensor modules such as gas detector or radioactive detector and the laser gun were developed for the various applications of the robot.

4. CONCLUSIONS

In the next step, the mechanical parts of the robot will be made smaller and lighter to throw easily, and the shock-absorbing mechanism developed to resist the shocks when the robot jumps and falls. Ultimately, the whole performance of jumping mechanism will be enhanced so that the robot can jump up to 30cm above the ground. With its surveillance camera, the robot can identify and track some objects, recognize its own position, and plan the moving paths based upon the surroundings. It can also be controlled remotely with joysticks and HMD (Head Mounted Display).

The sub-miniature surveillance robot for social safety will replace the human inspections in dangerous areas, such as gas or radioactive contamination areas or fire places. And it will contribute to secure the safety of workers, such as a police-man, a security guard or a fireman, exposed to dangerous environments. These days, our industry conditions of semiconductors, displays and mobile telecommunication units are going down, so new fields of industry driving the next generation markets are needed urgently. This robot will prompt the technological development in the intelligent robot area and make the robot market more active.

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