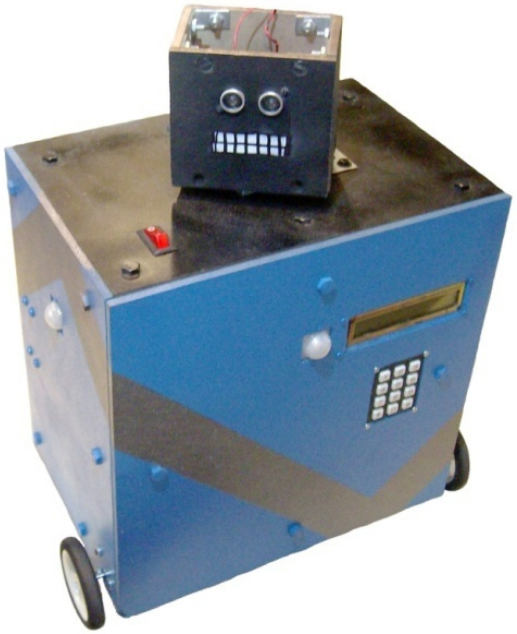
Build instructions for Searching Security Robot



The Searching Security Robot was designed as part of a mechatronics course at Colorado State University. The project requirements for the university were intentionally left open ended to encourage creative designs.

Our group decided to design a robot that would simulate human security for homes, businesses or other buildings. The robot consists of two major components, the body and the head. The body is the larger, lower portion of the robot mounted onto three wheels. The body has a keypad and LCD screen that allow the user to select the settings for the robot. Also mounted to the body are four infrared sensors used to sense for motion in 360 degrees. The second, smaller component, the head, is mounted on the top of the body and is controlled by a high-precision stepper motor. Mounted inside the head of the robot is an ultrasonic range finder, disguised as the robot's eyes. The purpose of the head is to allow the robot to easily detect nearby objects so the robot can modify its course before it comes into contact with walls or other obstacles.

The robot serves two major functions. The first, more complex function, is the "Roam Mode." In this mode, the robot will begin by moving forward on its three wheels, two of which are controlled by motors geared to deliver high torque and steady, precise motion. While the robot is moving forward, the head is constantly turning from left to right. The ultrasonic range finder is reporting the distance of any obstacle it sees, in any direction, to map its surroundings. Any time the robot decides that an object is too close by, it will determine the location of the object by reading the position of the precise stepper motor, and turn away from it. The algorithm that is used allows the robot to maneuver down hallways or aisles and even turn corners without appearing confused.

The second function is simple, yet necessary for the robot to deserve the title "Security Robot." In the "Sense Mode," the robot is stationary. The robot takes a short while (about 7 seconds) to calibrate its extremely sensitive infrared motion sensors and get them accustomed to the surroundings. After that, the robot remains still and is constantly searching for any motion within 360 degree's of its position. Even the slightest motion can be detected from dozens of feet away. If motion is detected, the area is unsecure and the robot will sound its alarm.

The robot uses menu-driven navigation, controlled by a keypad and LCD screen, to select one of three modes. The mode of the robot and menu navigation instructions will always be displayed. The first mode is "Roam Mode," and the second mode is "Sense Mode," both as previously described. The third mode is "Alternate Mode" where the robot will begin with roaming, and stop intermittently to sense for motion. This is the most useful mode, as it is the closest the robot can be to simulating actual human security. The Searching Security Robot will find new, random places to search for motion periodically, making it capable of patrolling an entire building, one section at a time. For larger buildings, multiple Searching Security Robots may be used because the robots will avoid each other, just as they do walls and other obstacles, and the robots will not sense each other as motion because they emit no infrared signal.

The “brains” of the robot are contained in the programming of five small and efficient PIC microcontrollers.

1) **The Master PIC** - The keypad output communicates directly with the Master PIC. The Master PIC communicates directly via either input or output signals with all other PICs.

2) **The Stepper Motor PIC** - This microcontroller is solely responsible for incrementing and decrementing the position of the motor that controls the head of the robot. The motor’s current position is constantly updated and sent to the Master PIC in order to accurately map the angle of the robots surroundings.
3) **The Ultrasonic Range Finder PIC** - This PIC controls and communicates the input of the ultrasonic range finder. It senses the distance of its surroundings 20 times per second, and reports the data back to the Master PIC. If an object is too close to the robot, a signal will be sent to the Drive Motor PIC indicating that the robot should turn.
4) **The Drive Motor PIC** – The Drive Motor PIC controls the steering of the wheels. It receives information from the Master PIC about when to turn and in which direction. Otherwise, the motors will continue moving forward.
5) **The Motion and Alarm PIC** - The fifth and final PIC microcontroller serves two purposes. First, it is used to sense for unexpected motion. After motion is detected, it creates software-generated audio output in the form of siren sounds.

All wiring and communication between the PIC microcontrollers is hidden inside the aesthetically pleasing body and head. This makes for an appealing, simple, user friendly device that serves a very practical purpose for homes and buildings of all types. This is an effective prototype that can increase the level of confidence of home or business security in the same way that a car alarm does for a car. In some situations, such a robot can substitute human security guards. It could also be an addition to a more passive security system such as video surveillance.