

ARTIFICIAL INTELLIGENCE

AREA MAPPING FOR SPY ROBOTS

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ABSTRACT

Spy robots, today are an intricate part of espionage. Provided with sonar sensing devices and artificial intelligence programs, they are used to explore uncharted territories. They are capable of and can be used for mapping unknown areas from definitely spaced rooms to entire terrains on a matter of minutes. These bots use microprocessors that store A.I. programs that spring to control on the encounter of obstacles since it is a necessity to be able to avoid obstacles to map an area on its own. Compared to 1980's technology, when these robots were first developed, today's bots have digital servos mounted onto their motherboard for accurate and faster transmission. The memory of the bot is adaptively designed to be able to receive and transmit data as quickly as possible. Many A.I. programs have been written and executed in ways that, till date stand fool proof in escaping obstacles to map given areas. The first of its kind and the best developed are described below. The first is that in which the sonar ranging devices of the bot solve the farthest distance that can be measured from the bot and moves in that direction. This method is slower, but capable of, efficiently, area mapping a real time battlefield, mountain terrain, etc. Where the obstacles are randomly placed. The second method mentioned is to explore limited areas like enemy head quarters, map out building lay outs, etc., that can be classified as under mazes. As the bot moves, it moves along the largest distance it can measure without having to encounter obstacles (like walls mainly) and trace its path and map the area as it does so. This is faster than other methods, but cannot tackle rough environments like the first method. Both these methods are discussed in detail.

INTRODUCTION

1. AI FOR EXPLORATION

Behavior based control is a robot control technique inspired directly by insects.

Although having very small brain capacities as compared with the robots' super fast micro-controllers, they manage to find food, escape predators and work defenses against them, adapt themselves to all kinds of terrains, react with adept reflexes to all sorts of conditions, natural and otherwise.

Even in 1980's robots couldn't handle unstructured environments without having to completely lose control or becoming excessively overwhelmed and therefore unsure of what action to execute.

Back then bot programs on obstacle avoiding were limited to turning away from the obstacle and continue moving in that direction. Today, they can be used to remove or eliminate the obstacle (in case of bigger/powerful bots) in their path (based on the size of the obstacle). At the same time the obstacle avoiding capabilities remain intact.

2.DIFFERENT TYPES OF WALKING GAITS:

There are different types of gaits for Robots , but wave gait and tripod gait are the two types of gaits that are mostly used for the spy robots. so let use discuss about them now.

2.1 WAVE GAIT:

This can be used for all mechanical walking robots with a minimum of six legs. The wave gait is stable and is capable of low velocities. The pods of the bot move in a fish-swimming fashion; which means that 2 legs on the same side of the body and the ones directly opposite to them point the same direction. This type of walking sequence is capable of executing one task at any given time*; i.e. *it, unlike the tripod gait cannot handle motion and angular movement at the same time. The wave gait is also an efficient mode of robot transport. Drawbacks are that the

body/chassis of the bot requires extra weights at the pod-ends to maintain stability. This takes up more power. Also the velocities are lesser compared to the tripod gait, because they r incapable of handling more than 1 command at a time and also their excess weight gives them a drag.

2.1. TRIPOD GAIT

This is used in hexapod bots only. With the tripod gait, the legs are divided into two sets of 3 pods. The first set consists of 1st and the 3rd leg on the right and the 2nd leg on the left. The second set consists of the 1st and the 3rd leg on the left and the 2nd leg on the right. At any command of action, one of these sets is in motion (all 3 pods of the set acting simultaneously).

In this the sequences are programmed so the bot moves faster and can also execute forward and reverse motion while turning left or right. They are considered more efficient and faster than the wave gait bots.

3. INSECTRONICS' MICROPROCESSORS AND MEMORY MANAGEMENT

For this we can use a microchip of RISC development called 'programmable interface controller (PIC). PIC=>it is known as Harvard architecture. The chip preference is generally PIC-16F84-MCU for small robots; has 2 types of memories. First memory to store the program and the second to store data. (Like a computer that has a hard-disk to store the program and the RAM to run the program and to store the data.) Computers use what is called the Van Neumann architecture. The advantage of the Harvard architecture over the Van Neumann architecture because the Harvard version can fetch instructions for the CPU and the RAM can be made to handle the instructions simultaneously. This speeds up the execution time and the reaction time. Clock speeds are comparatively higher than computers.

4. DIGITAL SERVO FOR ANGULAR DISPLACEMENT

There are techniques for monitoring a terrain without physical contact. But only a part of the immediate surroundings can be expressed by orientation in angular degrees. Older technology depended on mechanical links, gear tracer motors, etc. for signal transmission. So

Angle-indicating systems are subject to inaccuracies caused by servo wear, gear train friction and mechanical hysteresis. In order to avoid this, we, today, use digital servos, mounted on the chassis right behind the sonar device to transmit signals.

4.1. EXPLORATION WITH OBSTACLE AVOIDANCE

Logical truth table to an AI control program for an insectronic on detecting an obstacle and provide feedback (through LED's) so as to determine the bot's action (without having to see its surroundings directly). This kind of application is generally used in spy robots where the environment/terrain of the bot's work is either undefined or unknown.

<u>LEFT</u>	<u>RIGHT</u>	<u>OBSTACLE LOCATION</u>	<u>BEHAVIOUR (FEED-BACK)</u>
			<u>(LEFT*2+RIGHT)</u>

0	0	none detected	0
0	1	obstacle towards the right	1
1	0	obstacle towards the left	2
1	1	obstacle directly ahead	3

BEHAVIOUR VALUE

COURSE OF ACTION

0

Continue moving front

1

Stop: turn left continue moving front

2

Stop: turn right Continue moving front

3

Stop: back away, randomly turn right or left and Continue moving front.

5. HOW TO AREA MAP ?

In previous cases, the bot just avoided the obstacles it encountered based on immediate feedback from the sonar sensors. It made its way through obstacles but didn't have any internal representation of the environment it is in. This is an important aspect of robots as it is essential and basic in espionage. In case the robot did not have this capability, they'd just keep blindly walking their way close to objects until their sensors detected it and signaled that a response was needed. If this drawback can be overcome, the bot can map the area around itself and store the results in its second memory. This is an effective way of keeping the robot from bumping into things and also gives a clear cut idea to the robot as to where to walk in order to come across as less number of obstacles as possible. The SRF04 sonar sensor used for its compactness has a detection cone of 30degrees approximately. To map its surroundings, the robot takes measurements of its distance from obstacles at 180 degrees arc to the front, turns left and undertakes the same and then turns to the right (of the front) and takes the distance measurements and stores all 3 sets of readings in its second memory. The 180-degree zones are divided into 11 parts, which means each segment has 18 degrees. Accurate measurements can, however, be taken over 20 degrees each time a reading is taken. The advantage of this technique is that when the sensor takes 180 degrees measurements in each direction there are large areas of overlapping, angularly, so no area is left unknown or classified as under "dead zone" which cannot be overlooked in the process of mapping an unknown territory.

5.1. AI PROGRAMS FOR AREA MAPPING

To keep track of the immediate surroundings of the bot, the program made with 'obstacle avoidance' as its prime objective, which comprises of inventing a matrix that illustrates the distances measured between the sonar sensing device and the obstacle over a 180-degree angle.

Pos [12] (say) is a one dimension array that states the distances detected to be 'obstacle-free' over 11 positions named 0-12 that the bot records while covering an angular displacement of 18-degrees at a time over a total of 180-degrees. The data/readings are stored by writing in, an algorithm that executes the following steps. First reading is taken at angle 0-degrees and the maximum distance the sonar ranging device can measure without having to encounter any obstacle is stored as Pos[0]. The second reading is then taken at an 18-degree position and the distance value is stored as Pos[1]. This way the robot continues until the reading Pos [12] is recorded and stored in the microprocessor's second memory. The control then jumps into the execution of the next program, which would be the one that decides the best direction for the bot, move in. The program is a very simple sort program that compares the values stored in the array Pos [12] and determines the greatest value of them all. The value is then stored in the memory as the "best position ", that is to say, the direction or the position in which the bot should be oriented in order to encounter least number of obstacles over a larger linear distance. Then on the execution of the next program, the bot moves in the direction of the "best position". Experimentally, as well when such an insectronic was left on its own in an unknown territory full of randomly placed obstacles, the program with the above-described characteristics withstands the need for an extension in it or a substitute program instead.

Another program in this field has been created just to be able to determine whether the bot needs to turn right or left so as to encounter lesser obstacles. When the sonar-sensing device records the distance data, an average is first taken over an angle of 90 degrees i.e. over 5 consecutive angular displacement readings. The average procedure is also undertaken in the angular displacement of the second set of 90-deg i.e. from 90-180 deg. Both the averages are compared to see which of them is greater and then the bot embarks on that direction. Yet another method of area mapping is described below. This method however does not involve very complex methods as would be in real time spy robots with excessively added features, but

is as practical and easy to program. Gyroscopes direct the bot and keep it informed about which way is north. In unknown territories like mazes, etc., the robot needs to find its shortest way out of the maze, in order to get out of it in the shortest possible time. It is very easy for a control system to figure this out from an over-head point of view. But through the sonars of a bot, it is as difficult as it gets.

Consider an easy maze, for starters, a room spacing with an entrance and an exit, with walls as obstacles. Using the wall following method, the control commands the robot to take randomly, either the right or the left hand sidewall and follow it till the “FINISH” is encountered. With this method the bot may sometimes find itself caught in dead ends, but it will never go back to paths it has already tried. This method is used primarily for “instinctive” method of tackling unprecedented environments. This method is also the faster than any other, developed in maze solving, as of now. With this method there is a huge underlying advantage which is that the robot control creates the area map not on the basis of the use of its sonar sensing devices, but is capable of creating a topology of its environment and the maze being solved by tracing its path from the “START” to the “FINISH”. This method is further faster as it starts off from the “START” of the maze right away and goes solving through it, saving time as compared to sonar-sensing-devices-method. Consider a maze sequence; the content of the program with the above algorithm must have the following steps.

1. If there is no wall on the right hand side of the robot, then turn it to its right hand side.
2. If there is no wall in front of the bot, move it one cell forward.
3. If steps 1 and 2 are not executed or cannot be executed because of lack of the satisfying condition, turn the bot to the left.
4. Continue the steps 1, 2 and 3 until bot reaches the destination, and then stop.
5. When the bot encounters dead ends, it backtracks its way out of it by following the wall sequence and takes another path form a result of executing the above algorithm.

6. APPLICATIONS

Robots with these technologies are commercially made for espionage. They are sent on missions over enemy territory to map it. They only find significant applications in the military. They may be land bound but they are efficient and can reach up to 60 mph depending on the structural-make of different bots. They use a voltage ranging from 9 volts – 30 volts (Li or Si battery), voltages, again depending on the necessities of the bot and the accessories added on as extra features.

Aerial spy machines like planes and other aircrafts are easily detected in radars primarily because they exhibit thermal emission on account of the power that they consume not only to pull off the ground but to stay there, as well coupled with highly sensitive ranging devices, infrared cameras, and otherwise. The bot, here can cover area and map it at relatively lower speeds, but since it uses up less power, it emits so less heat that it can be, on the thermal sensors mistaken to be an animal or a shrub. In real time military warfare, these spy bots are used to find out strategies employed by the enemy, in their territories, as well as explore an uncharted territory for landslides or un-up-with-holding terrains and enemy-lain mines.

7. Conclusions:

- Analyzed the efficiency of various walking gaits , wave gaits are slow but extremely stable.
- Tripods gaits are both faster and dynamically stable.
- Usage of robots in warfare and other charted areas
- Usage of digital servos for faster and accurate transmission in the robots
- Usage of Harvard architecture in robots.

7. REFERENCES:

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