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A Novel Architecture for Path Planning of Mobile Robots

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Abstract - This paper discusses a new motion planning algorithm for multiple robots which can plan trajectories in real time and can be implemented in the physical world. Formation of networks between the robots and establishing a communication link is more important for the planning process. Each robot using its own motion planner and based on the current world model, constructs a collision free trajectory. Employing priority systems helps the robots to act spontaneously when a problem is encountered. Based on the priorities, a robot plans its path. A robot with low priority has to re-plan its path allowing the robot with high priority to continue along its path. In robot control an important aspect that one needs to consider is its sensing capability. If the sensor is good and reliable then the robot works efficiently. Motion sensors are used in security industry as simple and general motion detectors that do not discriminate on the type of motion but just generate an alarm based on motion that crosses some predetermined threshold regardless of the type of the object.

Keywords - collision free trajectory, motion detectors, motion sensors, planning process, priority systems

I. INTRODUCTION

Autonomous robots have seen waste acceptance in the modern world. Autonomous robots are seen to be used for carrying out programmed and repetitious tasks. As the machines successfully do these tasks, naturally lead to the question “what they can do more”. With the aid of robots, the tedious jobs like assembling parts in a factory can be automated efficiently avoiding the manual labor and increasing the speed of operation. Besides this unnecessary movements can be avoided and the assembling or (any other job) can be made truly efficient and fast. This is the main advantage of employing automated robots, which include path planning. Path-planning can be considered as the process of navigating a mobile robot around a configured space, which has a number of obstacles in it that have to be avoided.

In order to achieve these tasks, autonomous robots have to be intelligent and should decide their own action. When the autonomous robot decides its action, it is necessary to plan optimally depending on their tasks. More, it is necessary to plan a collision free path minimizing a cost such as time, energy and distance. When an autonomous robot moves from a point to a target point in its given environment, it is necessary to plan an optimal or feasible path avoiding obstacles in its way and answer to some criterion of autonomy requirements such as : thermal, energy, time, and safety for example. Therefore, the major main work for path planning for autonomous mobile robot is to search a collision free path.

Motion planning is one of the important tasks in intelligent control of an autonomous mobile robot. It is often decomposed into path planning and trajectory planning. Path planning is to generate a collision free path in an environment with obstacles and optimize it with respect to some criterions. Trajectory planning is to schedule the movement of a mobile robot along the planned path. Several approaches have been proposed to address the problem of motion planning of a mobile robot. If the environment is a known static terrain and it generates a path in advance it said to be off-line algorithm. It is said to be on-line if it is capable of producing a new path in response to environmental changes.

Mobile robots are likely to play an important role in the lives of humans in the future. To efficiently perform tasks, the capability of simultaneous localization and mapping (SLAM) is often necessary for mobile robots. This paper involves a prototype to implement SLAM.

II. SIMULTANEOUS LOCALIZATION AND MAPPING

Simultaneous Localization and Mapping (SLAM) is an important component of fully autonomous robotic systems. It refers to a solution which allows a robot starting within an unknown location in an unknown environment to traverse the area and incrementally get a better bearing of its location and build a map of the surrounding environment. Any approach to master the SLAM problem can be decomposed into two aspects: handling of map features (extraction from sensor data and matching against the (partially) existing map) and handling of uncertainty. This problem is accounted and is described using the operational diagram as shown in Fig. 1.

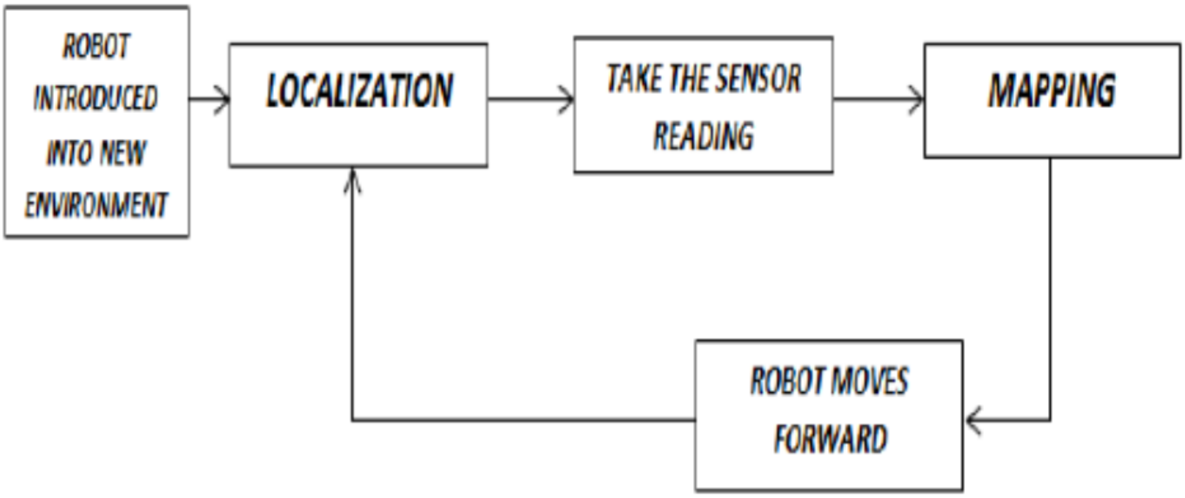

Fig. 1. Operational Diagram

The SlamBOT is first introduced into the environment which is to be mapped. The SlamBOT locates itself in the environment. Then it starts mapping its surroundings. The sonar sensor transmits ultrasonic waves and receives the waves reflected back from the objects or obstacles. These readings are received in the analog form. They are converted to digital signals by using an analog to digital converter. The digital values are mapped by using software that can generate graphics and thus the map of the environment is generated. Once the map from one position of the SlamBOT is generated, the bot moves to its next position and once it reaches this, the whole process of localization and mapping is repeated. Thus the entire environment is mapped while keeping track of the SlamBOT's location in the map.

III. HARDWARE ARCHITECTURE

Hardware employed at the transmitter side is shown in Fig 2. The sonar sensor whose values are taken in through the serial port is connected to the I/O pin with UART function. Servo motorand DC motors are connected to I/O pins of the MSP430. Data from Sonar is digitized and transmitted using the Zigbee module.

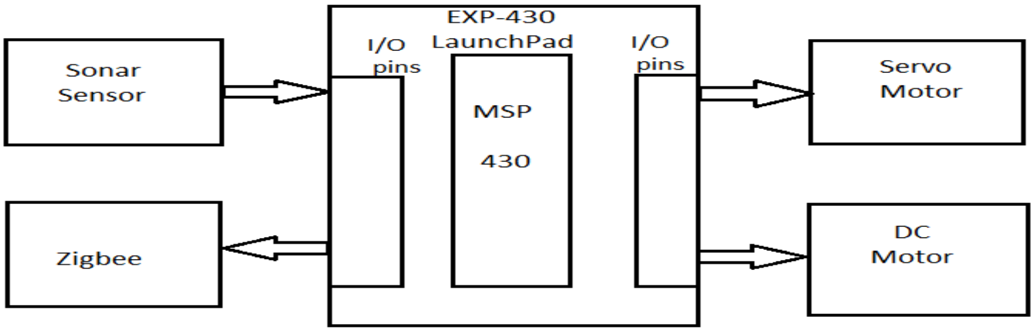

Fig.2: Transmitter side

At the receiver, data transmitted by the Zigbee transmitter is received by the Zigbee receiver. This data is transmitted serial through UART to a computer system. The data received is plotted using the processing software. This is shown in the Fig 3.

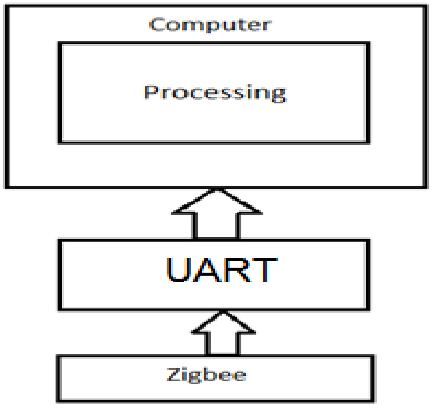

Fig. 3: Receiver side

PCB's are used to mechanically support and electrically connect Electrical components using conductive pathways, tracks or signal traces etched from copper sheets laminated onto a non-conductive substrate.

IV. FIRMWARE IMPLEMENTATION

Following is the algorithm of the main program and subroutines required for the acquisition of sonar values and control of the movement of robot and servo motor. The servo motor takes 180-degree sweeps in forward and reverse directions in steps of 5-degree. For every 5-degrees, the sonar values are taken through serial port and digitized and transmitted through the ZigBee transmitter. Then the dc motor rotates for 2 seconds which moves the robot forward and then the servo motor takes the next sweep.

Main program algorithm:

Step 1: Start
Step 2: Make all the global variable declarations.
Step 3: Initialize ADC with reference voltage of 2.5V
Step 4: Initialize UART with pins 1.1 and 1.2 as Rx and Tx respectively.
Step 5: Set PWM period = 1000 and initialize timer.
Step 6: Initialise other registers present in the MSP430 microcontroller.

Step 7: Begin servo motor sweep of 180 degree in forward and backward directions.
Step 8: Move the robot forward with the help of dc motor.
Step 9: Stop.

Servomotor subroutine algorithm:

Step 1: Pin 1.6 to which servo is connected is initialized as output pin.
Step 2: The duty cycle is set by using the TCA0CCR0 andTCA0CCR1.
Step 3:Clock speed of 1Mhz frequency is selected.
Step 4: At initial position of servomotor, enable ADC10 sampling and conversion. Check if sensor reading is available. No, then go to step 6. Else continue.
Step 5: Receive the sensor value and send the same serially.
Step 6: Rotate the servomotor by 5 degrees.
Step 7: Repeat steps 4 to 6 from current servo position.
Step 8: Continue same procedure for 36 values in one direction
Step 9: Then reverse direction of rotation of servo motor and rotate motor the first time by 2.5 degrees.
Step 10: Take the next 36 values in the present direction
Step 11: Return to main program.

DC motor subroutine algorithm:

Step 1: Initialize pins 3,4,5,7 as output pins.
Step 2: Wait for completion of servomotor control subroutine
Step 3: Make DC motor rotate for 2seconds.
Step 4: Return to main program

V.EXPERIMENTAL SETUP AND RESULT

For demonstrating simultaneous localization and mapping, an indoor environment is set up as shown in the fig 4. There are 3 boxes as the obstacles and placed in the line of sight of the sonar sensor at random distances which is not less than 50cm and not more than 4m.

Fig 4: Experimental setup

Then the robot starts taking the first sweep and after two sweeps, the robot moves a few steps forward and takes the next sweep. The map of the same is plotted using processing and updated when the robot moves forward.

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