Menu-Driven Control of the MiniMover-5 Robot

Zhongming Liang
Purdue University Fort Wayne

Abstract

The paper discusses a utility program developed by the author for the MiniMover-5 robot system. The program provides menu-driven control of the robot and allows students to easily work with robot positions. The paper also includes an example of using the utility program for a project, in which two MiniMover-5 robots were controlled with their interface units receiving inputs from sensors at a conveyor.

The MiniMover-5 Robot System

This paper discusses a significant improvement in the robotics lab for course CIMT 365 Robotics Applications. It is a junior-level course in the curriculum of the ABET accredited MET program in the manufacturing technology department of Purdue University Fort Wayne. The three-credit course has two-hour lecture and three-hour lab in each of the fifteen weeks in a semester. Students in the MET program take a series of courses in computer programming and automatic control including:

- CS (Computer Science) 114 Structured Microcomputer Programming
- CS 210 Computer Programming Fundamentals
- EET (Electrical Engineering Technology) 211 Electrical Machines and Controls
- CIMT (Computer Integrated Manufacturing Technology) 345 Computer Numerical Control
- CIMT 365 Robotics Applications
- CIMT 384 Instrumentation and Automatic Control

The laboratory for course Robotics Applications has five Apple-PC controlled MiniMover-5 educational robots, one Esched Robotec Scorbot ER-III educational robot, and three Mitsubishi Movemaster RV-M1 industrial robots.

The MiniMover-5 robot is valuable for teaching fundamentals of robotics, which has been noted by many educators. For example, Douglas Malcolm, Jr., James Fuller and Phillip McKerrow discussed the planetary bevel gear system of the robot mechanical gripper. Phillip McKerrow also discussed the controller and the kinematics of the robot. Ray Asfahl discussed the gripping force sensing, the keyboard control, and program control of the robot. [1,2,3,4] From an educational point of view, the robot system also demonstrates the disadvantage of the open-loop control and the necessity of an established hard home, in comparison with other robot systems in the lab.

This robot system has support for ARMBASIC, an extension of Applesoft BASIC with six additional commands dedicated for robot control. Although a robot user is given great flexibility in controlling the robot within his/her programming capability, writing an ARMBASIC program from scratch for a robot application project often means a large amount of programming work for a student, especially on an Apple II personal computer.

About one year ago, menu-driven utility programs in C were written by the author and two students for control of the Mitsubishi Movemaster robot.[5] As a continued development, a utility program was recently written in ARMBASIC for manipulating positions of the MiniMover-5 robot. The utility program has been successfully used in a proj ect that had two MiniMover-5 robots linked with a belt conveyor in an automation cell.

The Menu-Driven Utility Program

Teaching, examining, editing, and saving robot positions are among basic functions of a robot system. The menu-driven utility program to be discussed here was written for easier implementation of these functions on the MiniMover-5 robot system.

The ARMBASIC program, named TEACH, is explained in the following.

- Initializations
    - Reading an existing robot position data file
        - A list of the available files on the disk is displayed on the screen.
        - Prompting for a file name. The user can enter either the name of an existing position file or the name of a position file to be created.
        - If the user indicates that the file exists.
            - Each line of a position file containing a position number and the step counts of the six motors is read. The six motor step counts are stored in matrix PS in the row whose number is equal to the position number.
            - Since the maximum number of positions is set to be 99, number 100 in the file states its end.
    - Activating the computer control of the robot.
    - Asking the user to manually move the robot to a "home" position and closing the gripper. The MiniMover-5 robot does not have a hard home. A home position needs to be defined by a user and used consistently for repeatability of robot positions.
    - Resetting the internal step counters for the six stepping motors.
- Presenting a menu.

  1. Go to existing position
  2. Teach new position
  3. Exit

- Menu item 1 (Go to existing position).
    - Prompting for the position number of the destination.
    - Moving the robot to the desired position based on the incremental step counts of the six motors.
    - Setting the end position of the last move as the beginning position of the next move.
    - Renumbering the robot position if so desired.
        - Prompting for the new position number.
        - Moving the motor step counts to the new row of matrix PS.

- Prompting for the position number of the next destination, or returning to the menu.

. Menu item 2 (Teach new position),

  . The user manually moves the robot to a desired position,

  . Prompting for a position number of the new position.

  . Storing the motor step counts in the corresponding row of matrix PS.

  . Having the user teach another position, or returning to the menu.

. Menu item 3 (Exit).

- If the user desires,
  - The contents of matrix PS are saved in a position file.
  - A special line is placed last to indicate the end of the file.

  . If the user desires,

    . Returning the robot to the home position.

As can be seen from the above discussion, the utility program helps a user with the following:

- Examining positions.

. Teaching new positions in relation with existing positions.

- Modifying positions by replacing existing positions with new positions

. Renumbering positions.

. Saving and retrieving positions.

The development of a robot application project substantially benefited from the utility program, as will be seen in the next section.

Project of Two MiniMover-5 Robots

The interface between the MiniMover-5 robot and external sensors developed by the author and a student a couple of years before[6] was used in this project. As shown in Figure 1, an electrical belt conveyor was placed between two MiniMover-5 robots. At each end of the conveyor, there was a unit of an infrared light emitter-detector pair as a proximity sensor connected to a MiniMover-5 robot. The left MiniMover-5 robot picked an object from the storage area and placed it on the conveyor. In case that the previously placed object had not been moved forward by the conveyor, the robot would wait until the space would become available. When an object on the conveyor reached the right end, the sensor detected its presence and the robot picked it up and placed it in the shipping area. The project is considered interesting and educational because of the use of the simple educational MiniMover-5 robots.

The positions for the MiniMover-5 robots were developed with the utility program TEACH.BAS discussed in the previous section. As an example, the computer program for the left robot does the following:

. Reading in robot positions from the data file to matrix AS.

. Asking the user to manually move the robot to the home position and closing the gripper.

- Resetting the internal motor step counters.

. Moving the robot from position O to position 1.

. Opening the robot gripper.

. Continuing in the following loop for I = 1 to 6, assuming the robot picks six objects in a cycle.

- Checking input from the infrared light detector at the left end of the conveyor and making sure that the space is available for loading.

  . Moving the robot to positions (2*1) and (2*1+ 1).

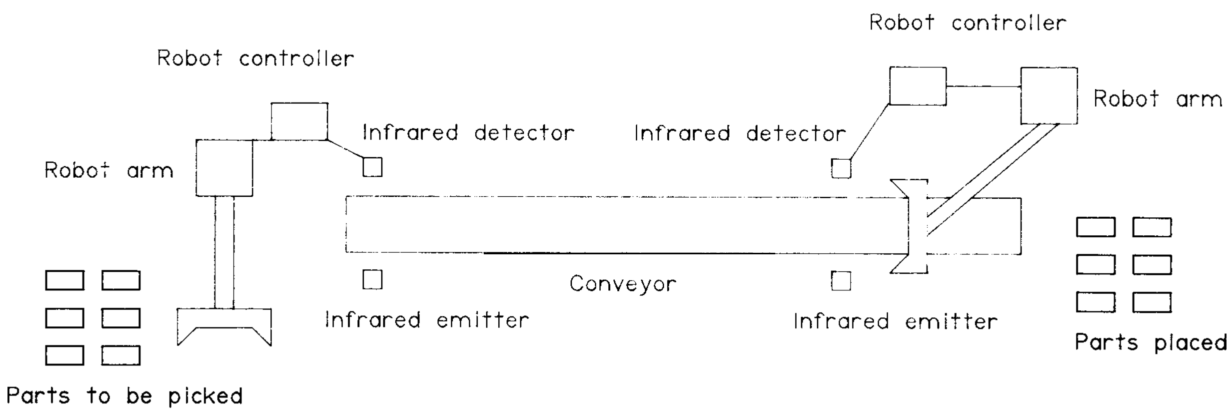

Fig. 1 The project setup

. Closing the gripper to pick anobject.
. Moving the robot to positions 14,15, and 16.
• Opening thegripper torelease the object.
• Moving the robot to positions 15and 1.

. Returning the robot to the home position and closing the gripper.

It can seen that the program is rather compact due to well-ordered positions developed with the utility program TEACH.

Conclusions

A menu-driven utility program TEACH.BAS for position development of the MiniMover-5 robot has been introduced. As an example of applications of the utility program, a project of two MiniMover-5 robots linked together by a conveyor has been discussed. The program and the project give students knowledge and experience with manipulating robot positions in applications of robotics.

As we have seen earlier, the MiniMover-5 robot has been discussed in a number of college textbooks on robotics because of its popularity and many excellent design features. Although the robot does have some limitations such as its low accuracy due to the open-loop control, a combination of the MiniMover-5 robot and some other more accurate robots for the robotics course has proven excellent. For the last a few years, the author has been working on better and better use of the MiniMover-5 robots.

The current paper addresses exploring the maximum potentials of existing equipment for teaching in laboratories. The menu-driven utility program TEACH has two contributions to teaching: (1) It makes positions of the MiniMover-5 robot much more manageable and the robot much more applicable; (2) Its program code demonstrates to students how user-written programs can expand the functionality of an existing system.

References

1. Malcolm, Jr., D. R., *Robotics: An Introduction,* 2nd edition, PWS-Kent, Boston, MA, 1988, p. 276.
2. Fuller, J. L., *Robotics: Introduction, Programming, and Projects,* Macmillan Publishing Company, New York, NY, 1991, p. 53.
3. McKerrow, P. J., *Introduction to Robotics,* Addison-Wesley Publishing Company, Sydney, Australia, 1991, pp. 89,211-212,215-217.
4. As fahl, C. R., *Robots and Manufacturing Automation,* 2nd edition, John Wiley& Sons, Inc., New York, NY, 1992, pp. 159, 199,203.
5. Liang, Z., "Menu-Driven Programs for Mitsubishi Movemaster Robots," *1995 ASEE Annual Conference Proceedings,* pp. 297-300.
6. Liang, Z., "An Interesting Experiment with a Simple Educational Robot," 1994 *ASEE Annual Conference Proceedings,* pp. 2062-2066.
7. *MiniMover-5® Robotics Reference and Applications Manual,* Microbot, Inc., 1982.

ZHONGMING (WILSON) LIANG
graduated from South-China Univ of Science & Technology in 1966. He earned an MS degree from Huazhong Univ of Science & Technology in 1981 and an ME degree from the City College of New York in 1982. He made very good progress toward his Ph.D. degree at Stevens Institute of Technology from 1983 to 1987. He was with a company as a design engineer for ten years and is a registered professional engineer in Indiana.