

Ergopedia, Inc.

October 12, 2004

Status report on SBIR Phase I project

Project Title: Lab-Science Through Distance Learning: Certification for In-Service Teachers

CFDA#: 84.305S

Institute of Education Sciences, Priority 2

Summary

The objective of phase one research was to produce a prototype learning system including a small programmable MEbot a DVD-based set of lessons, and a set of printed notes. The project required both hardware and software development as well as audio and video production. The first milestones involve hardware and software and have been met. A prototype robot has been constructed and is in the final stages of debugging. 40 completed circuit boards have been purchased. The first version of the handheld software has also been written. The goal for the next milestone (second report) is to complete the DVD lessons to accompany the MEbot and set up the field test and evaluation. The field test itself and evaluation will be the subject of our third and final report.

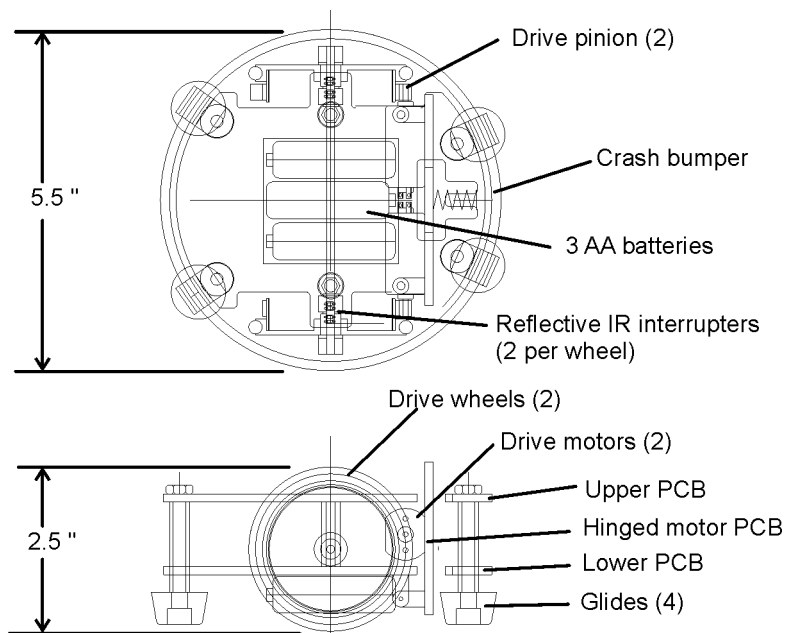
Project Milestones

We are on schedule for meeting our timeline as the hardware has been designed and parts for 40 units have been procured. The milestones for the project are listed below.

Date	Hardware/Software	Curriculum	Field Testing
August 2004	Finalize hardware design and order prototype boards. Begin PALM software development.	None	Identify districts. Create HSB documents (application form etc.)
September 2004	Procure components and assemble 40 boards.	Select appropriate lessons to fit the hardware capabilities.	Collect application forms from participants.
October, 2004	Debug hardware, both electronic and mechanical	Review 8 projected lessons with 4 additional potential lessons.	None
November 2004	Test complete robot with phase 1 software.	Script the first 4 lessons. Shoot and edit 1 DVD disc (4 lessons)	Hold initial meetings with participant teams
December 2004	Final assembly of 24 robots. Procure 24 Palms for field test.	Shoot the remaining 8 DVD sequences	Begin field test before Christmas if materials are ready.
January 2005	Evaluate design	Evaluate feedback	Complete field test and analyze data
February 2005	Prepare Phase II schematic designs	Evaluate feedback and prepare phase II plan	Evaluate feedback and prepare phase II plan

Hardware - Mechanical

The diagram below shows a cross section through the MEbot. To minimize costs all of the custom machining was designed into the three circuit boards and the wheels. All other components are off the shelf hardware. Parts sufficient to manufacture 40 units have been procured and assembly is taking place during November. We are currently debugging the drive electronics feedback control circuits.



Prototype #6, complete except for motors

Hardware - Electronics

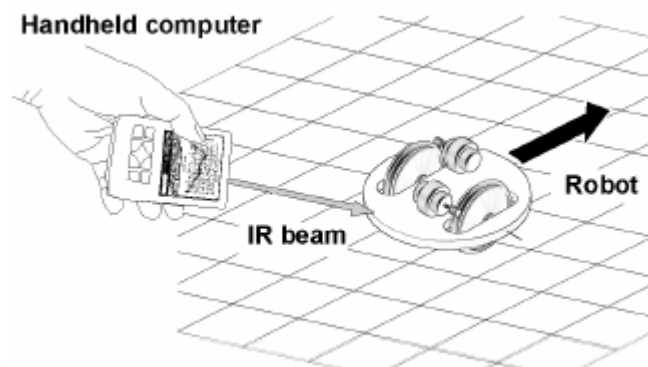
As a system, the electrical and electronic design of the MEbot for version 1 is complete and we are in the final stages of debugging the hardware and microcontroller software. The drive motors cost \$0.85 in quantity and have achieved the design speed of 0.5 m/sec. Our technique of pulse-width modulation low-cost, CMOS H-bridge IC's for speed control has been tested and is working. The reflective optical sensors are also working.

Power: 3 - 4 AA batteries,

Communications: IRDA and serial.

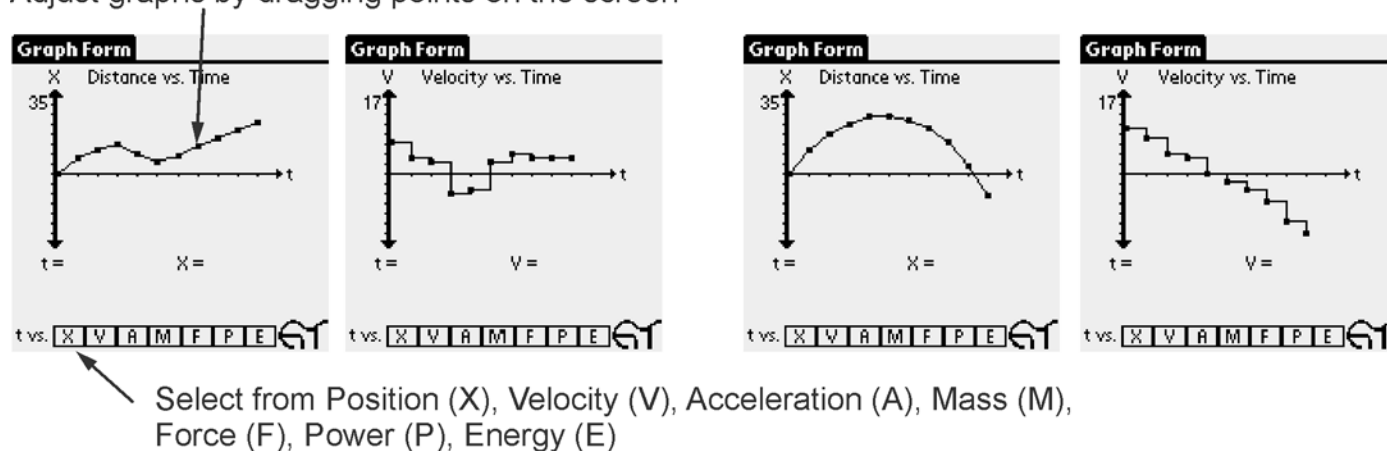
Software

The control and data acquisition for MEbot are done with a hand held computer running Palm OS. The hand held device communicates with the robot via the infrared port. The schematic below illustrates the concept.



We have developed the first version of the software That allows the user to play with graphs of position, speed, acceleration, etc. Changes on any one graph immediately calculate and update the others. For the field test we will limit the software to 1-D motion since curves and vectors are beyond the scope of the introductory lessons. The diagrams below show some actual screen shots of the software running on a Palm IIIxe handheld computer.

Adjust graphs by dragging points on the screen



Curriculum

The objective of phase one research is to evaluate the technology for its effectiveness in training teachers in physics. We have selected for areas for the field test and 8 hands on activities using the handheld computer and the robot. We have not filmed any of these lessons yet and plan to do so as soon as the final capabilities of the robot and software have been confirmed. Five of the 12 lessons are described below so you may get a feel for how the pedagogical strategy works.

Lesson 1: Graphs of distance and time, part 1. The teacher creates a distance vs. time graph on the handheld computer and has the robot move as prescribed by the graph. The goal is to build graphing interpretation skills.

Lesson 2: Graphs of distance and time, part 2. The teacher observes a pre-set distance vs. time graph on the handheld computer and must move the robot by hand to re-create the graph on the computer. The robot transmits its actual movement back to the computer so the teacher can compare what they did with what the graph asked them to do. Teachers may repeat the motion until the 2 graphs match.

Lesson 3: Speed and distance, part 1. The teacher draws a speed vs. time graph on the hand held computer. The robot executes the speed vs. timing graph allowing about teacher to see the relationship between the graph and the actual motion.

Lesson 4: Speed and distance, part 2. The teacher is given a position vs. time graph and must create a speed vs. time graph which results in the position graph they were given.

Lesson 5: Speed and distance, part 3. The teacher isn't given a speed vs. timing graph on the handheld computer and must move the robot by hand to re-create the graph on the computer. The robot transmits its actual movement back to the computer so the teacher can compare what they did with what the graph asked them to do. Teachers may repeat the motion until the 2 graphs match.

Field Testing

The field test calls for 24 teachers to evaluate for lessons each using pre- and post tests to measure knowledge gained in each lesson. Because we will be collecting personal performance data, we were required to comply with human subjects in research protocols. We have completed and it received a federal wide assurance number (FWA#). We wrote and submitted a research protocol to an institutional review board (IRB#) and

have received approval for our research study. We have completed all documents required by the IRB, including the application form teachers must complete, and other documentation and disclosure.

Two meetings have been held with the teachers from the Andover public schools. More than 20 teachers have expressed interest and 8 have completed application forms so far. Unfortunately, the science supervisor for the Austin Texas school district resigned this past summer and has not been replaced. That makes the Austin Texas site unavailable. We have identified another site in Illinois and several others in Massachusetts. We will get a final commitment from another site by mid December.

Problems and Resolutions

At this time we do not see any barriers to completing the work as planned. However, a few changes have been made.

The Human Subjects compliance was not anticipated in the original proposal. Completing the necessary protocols caused us to scale back some of the field test activities in order to ensure complete disclosure and risk minimization. We had planned to do 12 lessons for each participant and we will only do 4 lessons per participant so we can randomize which lessons each participant is given.

We need to replace the Austin site for field testing. We have identified three potential sites in MA and one in Illinois which have the right combination of new or student teachers, and enthusiastic management support.

We will not have the 2-D vector version of the software complete by January so all field tests will be done with 1-D experiments. This poses no problem because pedagogically we planned to start with 1-D anyways.

Budget

The project is on budget (Table 1) and expenditures to date have been for mechanical and electronic components for the Mebot. Some preliminary filming has also taken place and we have selected DVD StudioPro 3 and Final Cut Express as the software platforms for the DVD production phase of the project.

Table 1: Expenditures to Date

SBIR Budget	Budget	Actual to Date	Description
Salary	\$ 55,500.00	\$ 16,844.95	Hsu and Chaniotakis
Benefits	\$ 5,000.00	\$ 1,700.00	Hsu and Chaniotakis
Travel	\$ 1,500.00	\$ -	
Equipment	\$ 3,000.00	\$ 1,750.00	SMT rework tools
Supplies	\$ 10,000.00	\$ 8,465.05	Mebot components
Contractual	\$ 13,000.00	\$ 4,240.00	Programming
Other			
Subtotal to Date	\$ 88,000.00	\$ 33,000.00	
Indirect costs	\$ -		
Training stipends	\$ 12,000.00	\$ -	
Total to Date	\$ 100,000.00	\$ 33,000.00	