First IEEE Computer Society
International Conference on

Medical Computer Science/ Computational Medicine

1982

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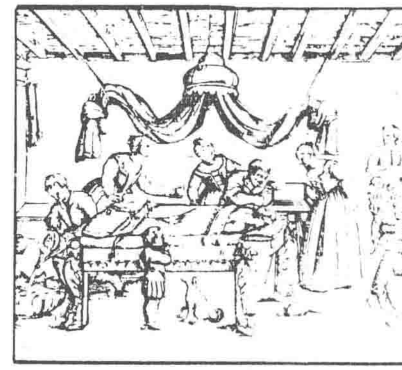

PROCEEDINGS

MEDCOMP '82

FIRST IEEE COMPUTER SOCIETY INTERNATIONAL CONFERENCE ON MEDICAL COMPUTER SCIENCE/COMPUTATIONAL MEDICINE

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Preface

In this, our first International Conference on Computational Medicine and Medical Computer Science, we recognize the synergistic relationship existing between computers, computing, and the medical professions. The "man-machine" adversarial roles of yesteryear have now been replaced with ever-increasing innovations and applications of this important tool to improvements in our quality of life.

To the medical profession, the increasing usefulness of computers in all aspects of medicine is still evolving while, at the same time, revolutionizing nearly every aspect of the field—from pre-medical education to complex analyses and diagnostics to sorting through thousands of tests and samples in search of elusive cures still to be found. This is an exciting time for all of us, and as the use of computers pervades our daily lives, the distinctions between computer scientists, biomedical engineers, and medical professionals will become all the more clouded. The transdisciplinary approach to solving our mutual problems and to transferring knowledge and technical information provides all of us with unlimited opportunities to embrace and learn about the latest developments. This applies not only to our own particular fields but also to the fields of others whose activities may one day help each of us professionally and, ultimately, society.

I think it is particularly significant to note that, based on the more than 120 presentations scheduled, MEDCOMP 82 has accomplished its goal of being transdisciplinary and transnational. We are indebted to our distinguished keynote speakers, William Rial, William Raub, and Francois Gremy, for their participation in assuring the success of MEDCOMP.

I'd like to thank all those on the Organizing and Program Committees without whose help and volunteer efforts, MEDCOMP 82 would not have been possible. And finally, a special thanks to our presenters, whose high quality papers and presentations are the criteria on which the ultimate success of this MEDCOMP and others in the future will be judged.

Judith M.S. Prewitt, Ph.D.
General Chairman

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Session 1.1: Microcomputers and Their Impact

A MICROCOMPUTER-BASED SYSTEM FOR THE AUTOMATED FORMATION OF ARTIFICIAL BIOMEMBRANES*

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Abstract

This paper presents a method for automating the technique of artificial biomembrane formation that has been widely used by investigators in biophysical research. Currently, this is implemented by a manually controlled syringe movement that elevates the water level in the membrane-forming chamber. This technique is automated by a low cost microcomputer system that is interfaced to a electromechanical system. The system "learns" the proper movements by monitoring the human expert and saves the data associated with the process in its memory. The system then "executes" the learned movements to create the same process as the human expert. Also, the system monitors certain parameters in the execution mode to adapt itself to the current conditions. This technique shows the possibility of establishing elaborate control laws in a microprocessor-based control process by means of an initial phase of interaction with a human expert.

Introduction

The interfacial technique of artificial biomembrane formation developed by Montal and Mueller[1] has been widely used by investigators in biophysical research. The method consists of juxtaposition of two lipo-protein monolayers, which are preformed at the air-water interface, and is implemented by a manually controlled syringe movement that elevates the water level in the membrane-forming chamber. Successful execution of this technique requires long periods of training of the operator. Automation of this technique with a conventional electro-mechanical servo mechanism would not be feasible because of the elaborate control law involved in human artistic expertise. In this report, we present a microprocessor-based control system for the automation of this technique. In addition to input from a sensor to form a closed-loop control, the control law for the movement of the syringe is established by recording actual syringe movements implemented by a well-trained human expert.

The system consists of a microcomputer and a fluid-delivering mechanical system (a specifically configured syringe system). The two subsystems are connected via a stepper motor for output remote control and a position encoding potentiometer that inputs the syringe displacement to the microcomputer. This system can be run in two modes. In the "learning" mode, data associated with syringe movement generated by a human expert are collected and stored in memory and/or in mass storage devices. In the "execution" mode, this movement is duplicated to the finest detail through remote controlled syringe movement by invoking the stored data as the prescribed control law. In the latter mode, a closed-loop control is also established by input from a remote sensor that monitors the membrane resistance. Through pre-determined criteria, the input data enable the processor to abort an unsuccessful trial and to reset the system both mechanically and electrically. Furthermore, a set of data collected by multiple runs in the "learning" mode can be individually evaluated in terms of probability of success through this closed-loop control.

An 8-bit microcomputer system serves as the data collection unit, as well as the motion controller. The first task, the data collection in the "learning" mode, is accomplished through a 12 bit analog-to-digital converter attached to a 16 channel analog multiplexer. The syringe is mechanically coupled to a multi-turn precision potentiometer, which converts the displacement to a potential difference, as the human expert moves the syringe. This potential difference is periodically sampled, and the data are stored in the 32K byte memory of the microcomputer and/or mini-disk storage system.

The second task, the motion control in the "execution" mode, involves the reproduction of the movement of the syringe by use of the collected data. The syringe is coupled to a stepper motor, which is driven by the micro-computer. Under the software control, the collected data associated with the human-generated movement is transformed into stepwise movement, which is a close approximation of the original.

The system is connected to a CRT terminal with a keyboard which enables the operator to give the necessary commands to the system for different tasks, or to interrupt the ongoing

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