New Photogrammetric Instrumentation for Use In Medical Applications

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ABSTRACT

Photogrammetric measurements involving medical applications can be of X-ray, Ultrasound, or standard photographic material. In many cases, Imagery has to be enhanced before it can be photogrammetrically reduced. This paper will discuss the development of new instrumentation that can enhance and measure any form of imagery.

INTRODUCTION

In medicine, photogrammetric techniques have been used for some time. Basically photogrammetry requires imagery in some form or another, from which reliable measurements can be made. The instruements and equipment that are employed vary greatly, depending on the specific problem, and the data to be acquired for diagnostic purposes. The various forms of imagery that are produced are X-ray, Ultrasound, CT scans etc. including standard photographic material. Existing photogrammetric instruments have the ability to measure most forms of imagery, but with certain limitations, such as:

1) Lack of capability to provide image enhancement.

2) Measurements are made manually.

3) Skill level of the operator.

4) Limited interfacing capabilities to imaging equipment.

These limitations can be overcome by the new Pass 2000 (Photogrammetric Automatic Scanning) system, developed through a joint effort by Perkin-Elmer and R.P.I..(Robertson,Wyatt 1984), (Robertson,Miles 1984),(Robertson,1986).

The system has the following capabilities:

1) To measure targeted images from any photographic medium automatically, and with high speed.

2) Offers optional capabilities of enhancement and measurement automatically or manually.

3) Provide computer capability that can handle large data sets with speed, and capabilities for realtime applications.

4) Provide output that can be compatable with most imaging systems.

The PASS 2000 system incorporates the Perkin-Elmer PDS Microdensitometer which is certainly not a new instruement. The PDS Micro-D is recongnized throughtout the world for its accuracy and resolution. The PDS Micro-D has been installed in over 14 countries, and is well known in the health field. The Pass 2000 has additional expansion capabilities, including peripheral devices, dual detector assemblies such as

a CCD, and PMT(photomultiplier tube), and photogrammetric application software. This concept is new for photogrammetric applications in the medical field. (Figure 1)

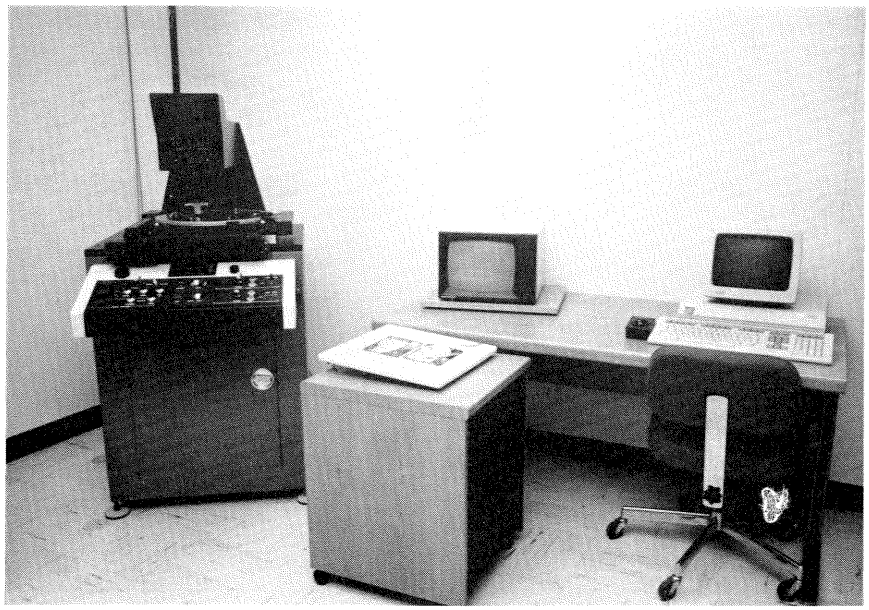

Figure 1 PASS 2000 SYSTEM

SUMMARY OF APPLICATIONS

At R.P.I. we have been involved in research and development in medical applications since 1980. During our various studies in Ultrasound for example, we had placed our intial emphasis on accurate measurements from Ultrasonic images (Figure 2). Presently the emphasis of research is on improving resolution, and enhancing the information already from the Ultrasound image (Robertson,Miles 1984). For an example, before a radiologist is able to make a correct diagnosis, the viewing monitor and the photographic hard copy must present an image of optimum quality. Unfortunately, this is not always true. Figure 3 illustrates a dental X-Ray enhanced by image processing. The system offers an optional capability of photographic playback directly on the stage. This opens a new area of study, rather than measuring the enhanced hard copy version of the image, measurements can be made automatically while the image is in a numerical form in real time.

Presently R.P.I. is involved in a joint pilot project with a Canadian Cancer Institute. Studies involving enhancement of mamographic images and measuring surface topology of radiotherapy patients, including the use of photogrammetry in Tissue Compensator design are being undertaken. Mammographic screening is used for the early detection of breast cancer. Enhancement of mammographic images could help in the differentiation of benign lesions from malignant lesions. Figures 4 and 5 show a mammographic image.

One current project is to develop an efficient procedure to measure the surface topography of the radiotherapy patient in the treatment position (for cases where CT scans are impractical). The technique used was to project a grid pattern onto a mannequin, and then photographed it with reflective control targets. The Rasterstereography approach has been used for some time (Renner,O'Conner,Amtey,

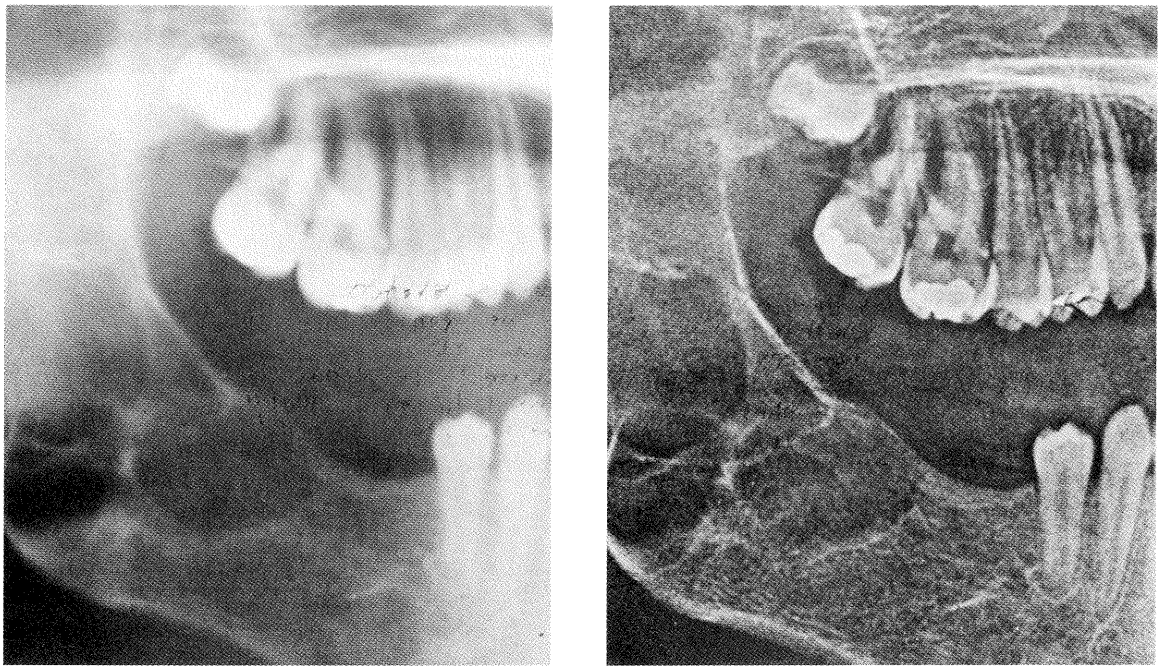

Figure 3 Enhanced Dental X-Ray

1977),(Forbin,Hierholzer,1981). Two tests were made, one using a real time approach, and the other using a photographic method (Figure 6). For the real time test a projector was used to project a grid pattern onto the subject, a CCD camera with a frame grabber was used to capture the image at a rate of 30 frames per second. For the second test a photograph was taken of the subject with the projected grid, and later measured on the PASS 2000 system. The system has the capability to scan and measure automatically all grid intersections. The tests were successful, although the intial control values used for this test was not very accurate.

Figure 2 Ultrasound Image

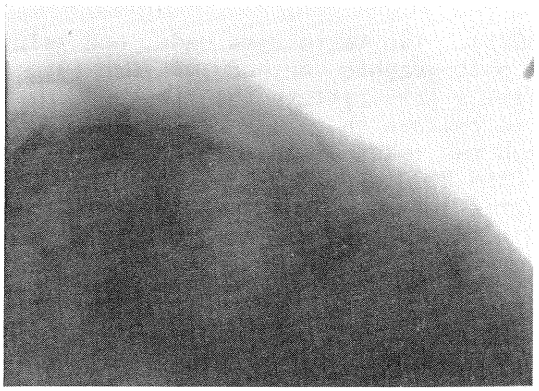

Figure 4 Mammographic Image

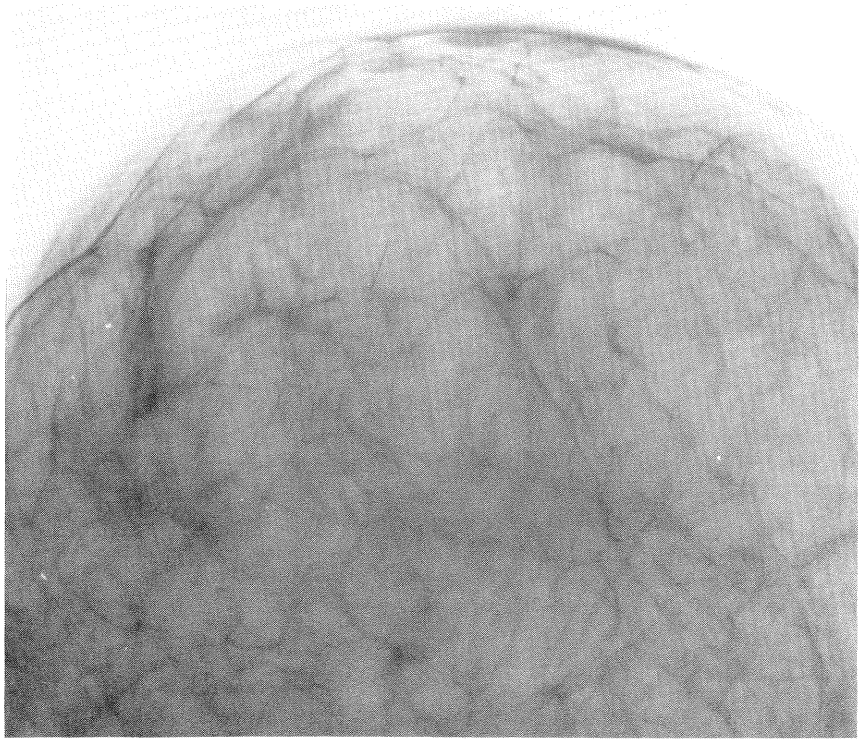

Figure 5 Enhanced Mammographic Image

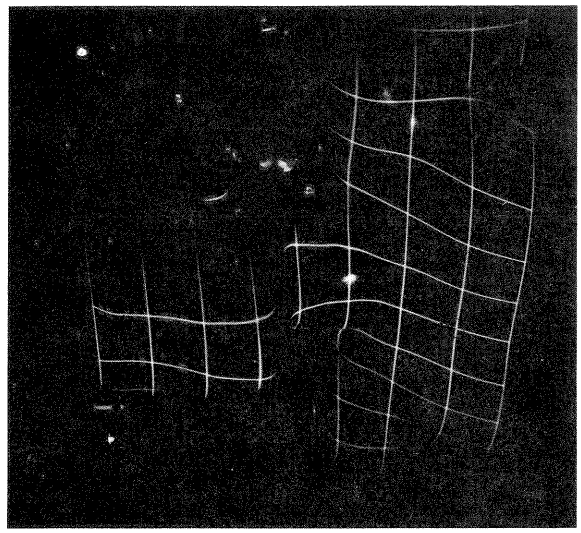

Figure 6 Rasterstereograph

CONCLUSIONS

The PASS 2000 system capabilities of automated measurement and enhancement offers a new photogrammetric approach to medical measurement problems.

ACKNOWLEDGMENTS

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