



Integrated Multi purpose Underwater Station

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Abstract

An in-situ data acquisition and seabed sampling system is proposed to be designed and assembled. The system would collect data from a multitude of sensors and samples such as seabed core, pore water and water sample just above and below the seabed. In addition a 35 mm still photo underwater camera system would be integrated to take time series photographs of the seabed before, during normal operation and sampling. A control hardware/software module built around a microprocessor would oversee the system operation and built in system tests. The built in tests would check subsystems including electronic subassemblies for proper performance. Data collected would be stored in memory for retrieval by a personal computer. It is also proposed to provide an acoustic link for real time control and data verification in future.

The proposed system is divided in three phases for assembling and field testing. Only electronic design aspects required for Phase I are discussed here but the full system would have considerable number of mechanical subassemblies.

Introduction

In general data collected in the vertical column of the ocean excludes the very close seabed sections. It is difficult to collect the very close sea bottom data as disturbance occurs during the collection process itself. When collected, few parameters such as current speed, pressure, temperature etc., are usually addressed. Geological sample collection is done independently. Generally the surface sample gets disturbed and in many cases it is possible to collect only one type of sample at a time. These samplers include sediment corers, grabs etc. For undisturbed surface sample these methods are not very attractive.

To overcome this limitation a new system design is proposed and is currently under assembly. The system when fully designed, assembled and tested would be capable of collecting vertical water column data, such as pressure and temperature, top sediment core, pore water content of sediment, water sample a few feet above the seabed along with still photographs of the seabed prior and after the sampling operations. This would enable to gauge any ecological disturbances during the operations.

Table 1 : General Plan of System Integration.

Phase I

Tasks - Sub assemblies to be integrated.

- 1) Seabed Photography.
- 2) Roll, Pitch, Compass, Temperature, Pressure.
- 3) Sediment Core.
- 4) In situ porewater.
- 5) Near bottom water sample.

Phase II.

Phase I :

- 1) Turbidity.
- 2) Oxygen Measurement.
- 3) Sediment Strength Measurement.

Phase III.

Phase I + Phase II :

- 1) Acoustic Modem Link.
- 2) Other optional sensors and subassemblies required.

TABLE 2. : SENSOR SPECIFICATIONS

- 1) GENERAL SPECIFICATIONS :
 - a) Depth of Operation : 6000 meters
 - b) Operating time (Phase I) : 4 / 5 days max.
 - c) Data storage medium : RAM memory
 - d) Operating Power : 24 V, 12 A hr.
- 2) SENSOR SPECIFICATIONS :
 - 2.1) Tilt Sensors :
 - a) Range : $\pm 30^\circ$
 - b) Linearity : $\pm 0.2^\circ$ (0-10)
2 (10 - 30)
 - c) Threshold and Resolution : 0.01
 - d) Response Time : 0.3 sec
 - 2.2) Compass :
 - a) Range : 360°
 - b) Accuracy : $\pm 5^\circ$
 - c) Resolution : 0.35°
 - d) Allowed tilt : 12° (Horizontal)
 - 2.3) Altimeter : Benthos Model 2110
 - a) Frequency : 100 KHz
 - b) Accuracy : 0.1 Meter
 - c) Resolution : 0.1 Meter
 - d) Repetition Rate : 0.5sec fastest.
 - 2.4) Temperature : Thermistor Fenwal GB 32 JM 19
 - a) Range : $- 2.5^\circ$ to -35°C
 - b) Accuracy : 0.05°C
 - c) Resolution : 0.1 % of range
 - d) Response Time : 12 sec
 - 2.5) Pressure : Encardio Rite
 - a) Range : 0 to 2000 meter
 - b) Non linearity, Hysterisis : $\pm 0.25\%$ FS
 - c) Repeatability : $\pm 0.1\%$ FS
 - d) Non linearity, Hysterisis and Creep : $\pm 0.3\%$ FS
- 3) BENTHOS STILL CAMERA SYSTEM :
 - a) Camera Model 372, 800 shots per loading.
 - b) Flash Model 383, 400 J, 3 sec cycling time
 - c) Power supply, Ni-Cad, 24 V
 - d) Operating Depth, 10,000 meters
 - e) Operating mode, electronically triggered by the microprocessor controller.

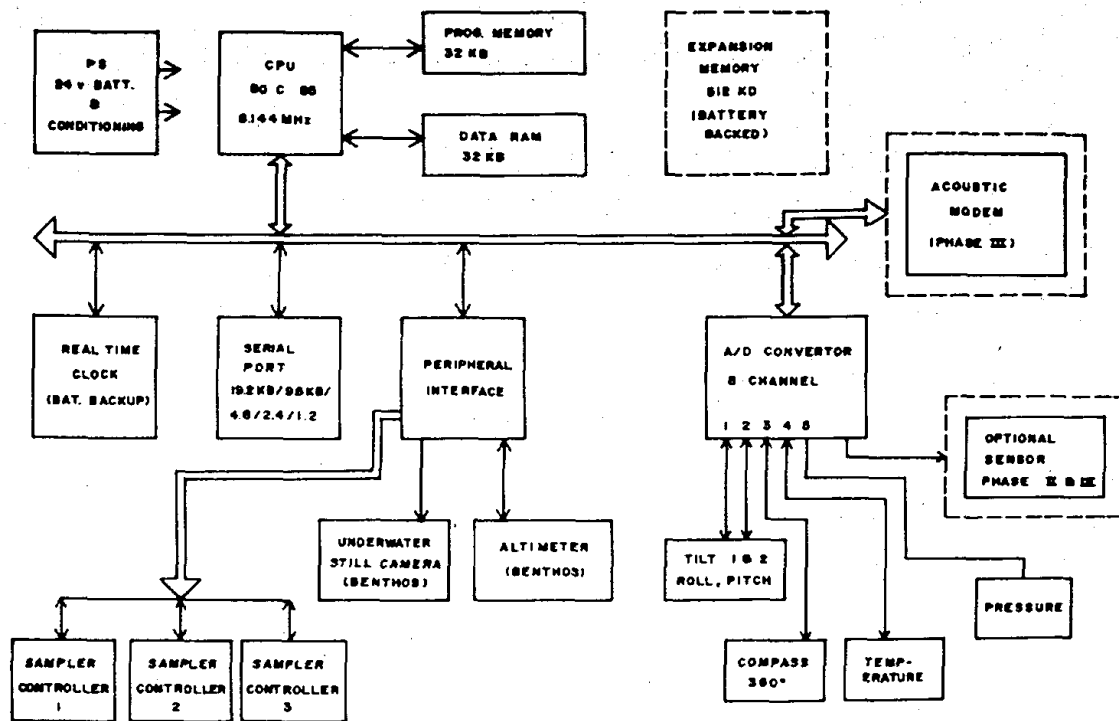


FIG. 1 SYSTEM CONFIGURATION - HARDWARE

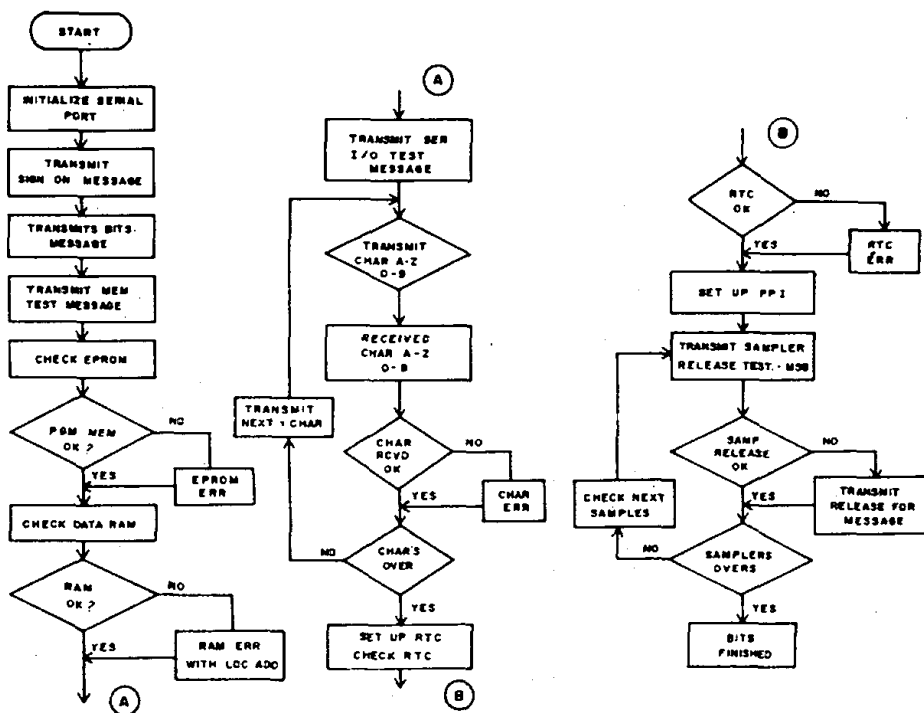


FIG. 2 BUILT IN TEST SOFTWARE FLOW CHART

Design Goals

The objective of the proposed system is to acquire data and samples very close to the seabed surface, both above and below. It is also proposed to obtain still photographs of the entire operation including the sampler operations. With a multitude of sensors, vertical water column data during the descent of the system would be collected. The data collected would be stored in memory.

The system would be designed and assembled in three parts. The final system configuration would be capable of operating at water depths of 6000 meters. Field testing would be carried out at depths of 50, 2000 and 6000 meters during each phase. General details of the work plan of each phase are outlined in Table 1. Phase I would involve basic design of the frame which would support electronics subassemblies and the samplers. The electronics part is discussed below. The sensor specifications are outlined in Table 2.

Discussion

The entire controller assembly is designed around an INTEL 80C85 [1] microprocessor operating at 6.144 Mhz. Figure 1 shows a block diagram of the hardware configuration of the system. The system has two banks of memory. The system and operating firmer would be EPROM resident while the data collected would be stored in RAM memory. A Built In Tests Software (BITS) will diagnose all the electronic subsystems after power on for proper functioning. Data acquired during the descent and seabed sampling would be stored in RAM (32 KByte) with sufficient capacity for 4 / 5 days operation. Programmable Peripheral Interface, Intel 82C55 [2], module will control the operations of the samplers and also acquire the altitude data. The 10 Bit Analog to Digital converter module AD 574 [3] will transform analog data from other sensors to the digital format. A standard RS 232 serial port, using an Intel 82C51 [4] asynchronous UART, would be provided for communication with a IBM compatible Personal Computer for all the results and transfer of data. A Real Time clock MM 58167A [5] would provide the necessary time keeping functions. During Phase I it is proposed to have a wire transmission during the deployment but finally an acoustic modem might be provided to have real time communication. System electronic sub components are low power versions wherever possible to minimize the power consumption.

When power is applied to the system, prior to deployment, BITS will test the program memory, data storage RAM, communication port, real time clock and A/D converter. Any of the sub component malfunctioning would be reported at once. The motorized sampler releasing assemblies also would be fully tested before the samplers are armed for operation. Figure 2 shows the flow diagram of BITS.

Once BITS is completed the firmware would acquire user parameters. These are time, date, station location data such as latitude, longitude, depth, station number, ships name etc. Time and date would be used to set the real time clock. It is very important that these be entered correctly as all the in-situ data collection and sampler operations are time dependent. The operator would be required to indicate as to which of the samplers are to be operated. The flow of these operations are outlined in Figure 3.

After an initial deployment delay of 30 minutes (programmable), the system starts acquiring temperature and pressure data during the descent to seabed. This data might be used to determine salinity and sound velocity of the vertical column. The data would be collected at regular time intervals and stored in RAM. The system would also be collecting attitude data of the frame to monitor the verticality and the altitude by means of a dual axis inclinometer and an altimeter. Data obtained would be presented to the operator for determining the verticality of the frame. During the entire descent from initial deployment to the frame landing, temperature and pressure data would be collected and transmitted to the operator through the serial port. The altimeter data would be monitored to determine the height of the frame above the seabed. Once the frame reaches an altitude

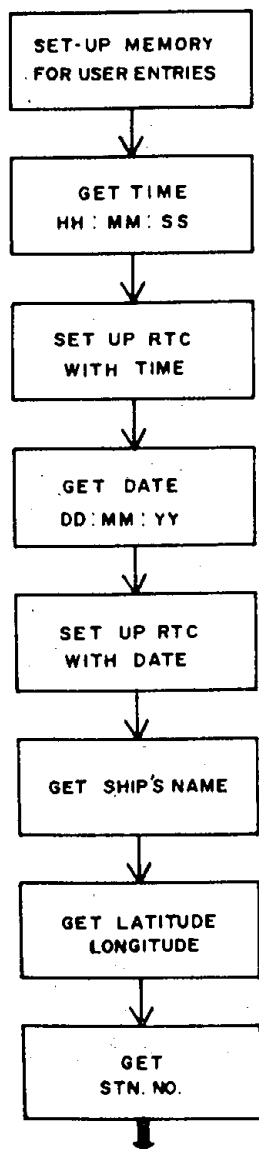


FIG. 3 USER ENTRIES FLOW DIAGRAM

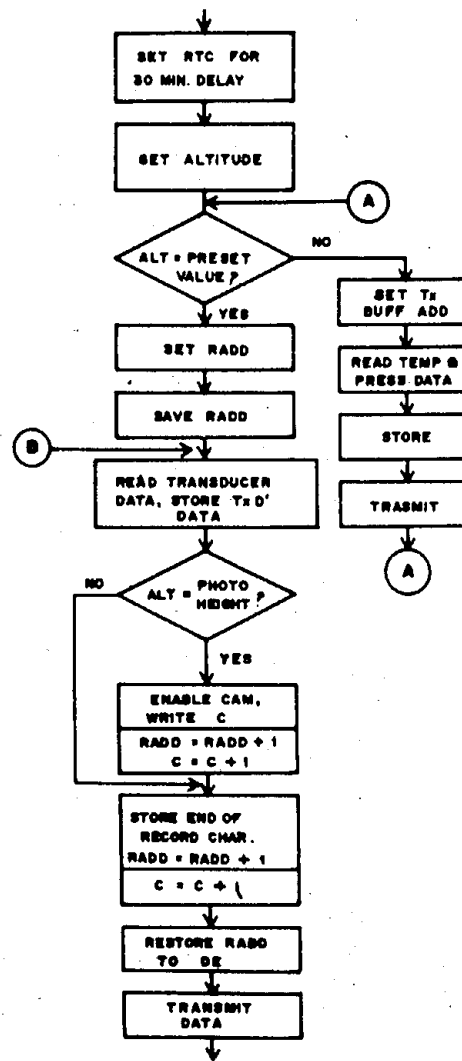
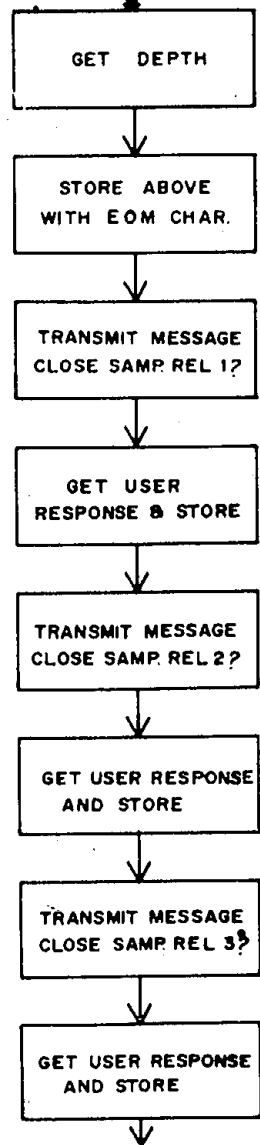
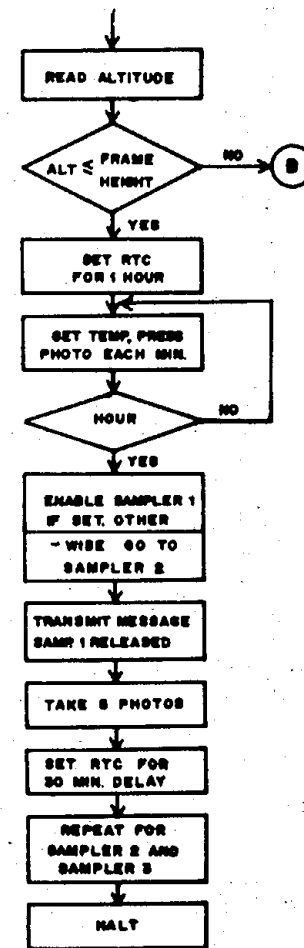


FIG. 4 DESCENT AND SEABED OPERATION FLOW DIAGRAM



of about 5 to 10 meters above seabed, still camera would be enabled to take photos of the undisturbed seabed. The altitude of the system would be obtained from a Benthos 100 KHz Altimeter [6]. The photography system also is a Benthos [7], [8] model capable of taking a maximum 800 photos. Disturbance recorded might be very useful for environmental assessments.

When the frame is properly seated on the seabed, the system software would collect sensor data, photographs for a duration of 30 minutes. As the frame would be lowered very gently to the seabed, resultant plume generated is expected to be very small. This has been observed from the photographs [9] taken during various cruises and the information available. Even a very small water mass current of 0.5 km/hr would be sufficient to move the plume away. On completion of time period, the firmware would enable two dedicated TTL compatible single lines of PPI module to turn the motorized sampler releasing mechanism. This would enable the sampler to collect the required samples. Depending on which samplers are enabled during the initialization procedure, samples would be collected. Again a delay of 30 minutes is programmed between two sampling operations for any disturbance to settle down. All the photographs of sampler operations are also collected to verify proper operations. Once all samplers are operated the software disables CPU which enters a halt mode. Data collected during descent and seabed operations are transferred to a PC after retrieval of the system on board. Figure 4 shows the flow chart for the descent and bottom operations.

Conclusion

From the various tasks to be undertaken under Phase I, the hardware designs are ready. These include the CPU, Analog signal conditioning and motorized sampler releaser boards. The designs of these cards was carried out using a CAD package with capabilities to auto test the layout designs generated. Currently, assembling of above cards and testing is being carried out. BITS, User software subroutines and the descent and seabed operations subroutines have been completed and their performance were checked on the various subassemblies prior to final design freezing. Their integration with the hardware module and final laboratory testing would be undertaken soon. The mechanical assembling of various samplers such as sediment corer, pore water sampler etc., are currently underway. It is proposed to carry out the final lab test of integrated system very soon. Subsequently, the first underwater test would be undertaken.

Acknowledgments

I would like to express my deep gratitude and thanks to Shri R.R.Nair, Head of Division and PMN project leader for his constant support, encouragement and very useful suggestions. I would also like to thank Dr. E. Desa, Director, N.I.O for allowing to use the various facilities.

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