INTERACTIVE SYSTEM FOR REGISTRATION
AND PROCESSING OF DIGITAL SATELLITE DATA
USING IBM PC/AT COMPUTER

Lesław A. Barański, Piotr Struzik
Institut of Meteorology and Water Management
Satellite Data Receiving and Processing Center
Piotra Borowego 14 str., PL 30-215 Kraków
Poland
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The NOAA (USA) operates a network of third generation polar orbiting satellites NOAA-9 and NOAA-10 which provides data used to meet stated requirements in support of both day-to-day environmental monitoring and global research programs. General information about the spacecraft, its orbit, and its instruments are well known (eg.Hussey W.J, 1979, Barański L.A., 1987). The resolution of images obtained from NOAA satellites are much lower then from environmental LANDSAT, SPOT satellites, but taking into consideration economic aspect and access to transmitted data in real time, the Institute of Meteorology and Water Management (IMWM) applies its informations for meteorology, water management, agriculture, land surface and environmental studies.

Receiving station installed in Middle Europe can registrate data from whole Europe including Mediterranean Sea, Scandinavia and significant part of Atlantic Ocean. The informatic system for receiving, registration and processing of digital HRPT (High Resolution Picture Transmission) data from NOAA satellites was developed at the Satellite Receiving and Processing Centre at the IMWM in Kraków. The system based on IBM PC/AT minicomputers, allows to registrate full HRPT transmission at the elevation angle higher then 5 degrees [Barański L.A., et al.,1987].

The satellite digital signal transmitted at the 1.7 GHz range with 0.66 Mbps rate is received by rotated parabolic antenna. Antenna is tracking satellite automatically. The converter 1.7 GHz/137 MHz is placed directly in the focus of antenna. Amplified satellite signal is passed to the telemetric receiver, then data stream are going to bit and frame synchronizer (fig 1). It makes code convertion, extraction of clock pulses and convertion from series to parallel transmission. Synchronizer is connected with informatic system via the special interface including two RAM buffers and control circuits which allows to registrate data in the real time. Those data are provided to minicomputer by 8255 I/O card placed in one of the IBM PC/AT slots. The informatic system consists of two IBM PC/AT minicomputers connected in local area network (D-LINK). The first one registrates HRPT data and process AVHRR (Advanced Very High Resolution Radiometer) images. It can also read and process SPOT and LANDSAT data recorded on magnetic tapes. The second minicomputer is directed for processing of TOVS (Tiros Operational Vertical Sounder) data and analogue images. D-LINK connection allows free flow of data between minicomputers.

The configuration of two minicomputers was selected for performing: registration, processing and archivisation of
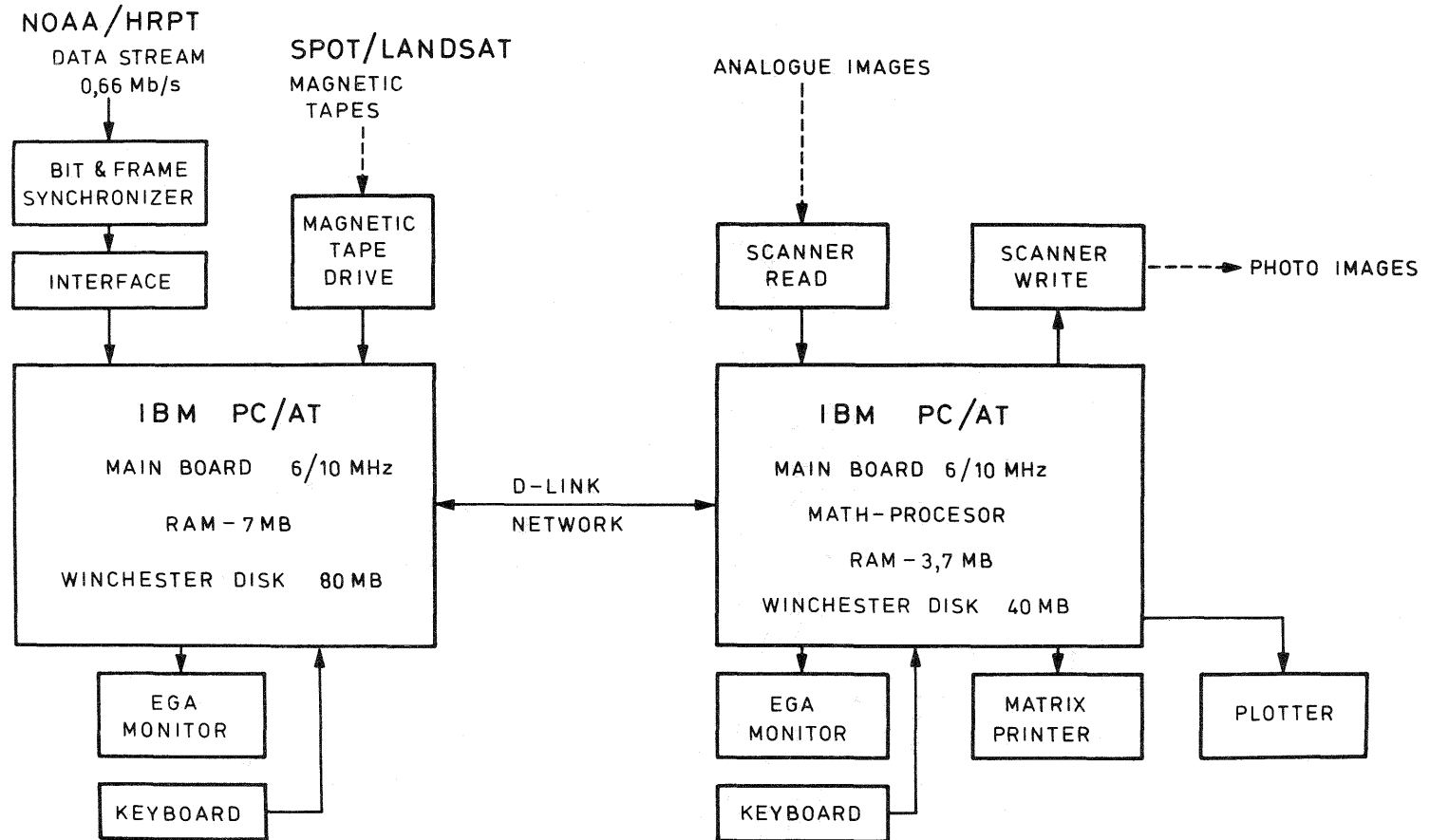
NOAA/HRPT
DATA STREAM
0,66 Mb/s

SPOT/LANDSAT
MAGNETIC
TAPES

ANALOGUE IMAGES

BIT & FRAME
SYNCHRONIZER

INTERFACE

MAGNETIC
TAPE
DRIVE

SCANNER
READ

SCANNER
WRITE

PHOTO IMAGES

IBM PC/AT

MAIN BOARD   6/10 MHz

RAM – 7 MB

WINCHESTER DISK   80 MB

D–LINK
NETWORK

IBM PC/AT

MAIN BOARD 6/10 MHz

MATH–PROCESOR

RAM – 3,7 MB

WINCHESTER DISK   40 MB

EGA
MONITOR

KEYBOARD

EGA
MONITOR

KEYBOARD

MATRIX
PRINTER

PLOTTER

Fig.1. Block — diagram of the hardware for   processing   of   NOAA,   SPOT,
LANDSAT satellite data.

satellite data. The first minicomputer connected to receiving station is equiped with:

- main board,
- RAM extention to 6 MB,
- FDD/HDD controller connected with floppy disc and Winchester disc 80 MB,
- 8255 I/O card,
- EGA card connected to the high resolution EGA monitor,
- magnetic tape controller,
- two magnetic tape drives,
- D-LINK adapter.

Presented configuration allows to registrate large capacity of data, its process and archive.Enchanced Graphics Adapter (EGA) permits visualisation of satellite images with resolution 640x350 pixels, using 16 colours selected from 64 colours palette.

The second minicomputer configuration consists of:

- main board with 6/10 MHz clock, math-processor and 1 MB RAM,
- 3 MB RAM extention,
- FDD/HDD controller with 40 MB Winchester disc,
- 8255 I/O card connected via AD/DA converters to scanner-digitizer and photoregistrator,
- plotter,
- D-LINK adapter.

Presented configuration allows to:

- read and process analogue images,
- obtain the hard copy of processed satellite images,
- process of TOVS data,
- plotting of diagrams.

For created informatic system the specialized software has been made (fig 2). During receiving time of HRPT satellite data,programme for the real time registration is executed. The file of 45 MB real HRPT data is recorded in about 10 minutes. It coresponds to part of the satellite orbit within radiohorizon of receiving station in Kraków. The content of HRPT transmission are listed below:

- AVHRR images for day and night cloud mapping, oceanographic, hydrologic, Earth surface studies in 5 spectral channels (0.55-0.80, 0.725-1.1, 3.55-3.93, 10.5-11.5, 11.5-12.5 μm),
- TOVS data from which the vertical temperature,moisture and ozon profiles are calculated,
- telemetric and calibration data.

After the end of transmission, programme for preprocessing of satellite data is executed. This programme performs the following functions:
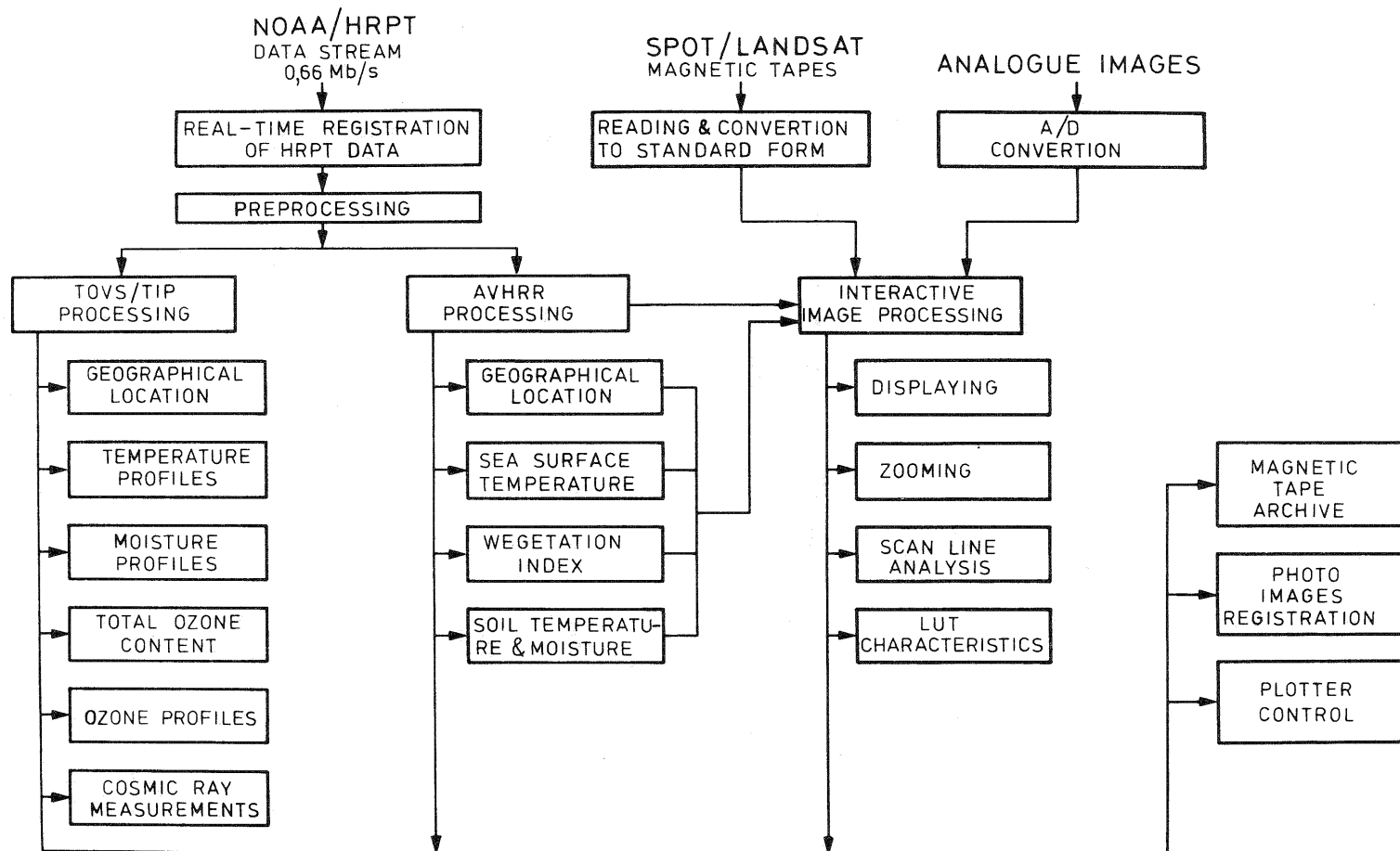
NOAA/HRPT
DATA STREAM
0,66 Mb/s

SPOT/LANDSAT
MAGNETIC TAPES

ANALOGUE IMAGES

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REAL-TIME REGISTRATION        READING & CONVERTION        A/D
    OF HRPT DATA              TO STANDARD FORM          CONVERTION

    PREPROCESSING
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TOVS/TIP PROCESSING	AVHRR PROCESSING	INTERACTIVE IMAGE PROCESSING	
GEOGRAPHICAL LOCATION	GEOGRAPHICAL LOCATION	DISPLAYING	MAGNETIC TAPE ARCHIVE
TEMPERATURE PROFILES	SEA SURFACE TEMPERATURE	ZOOMING	PHOTO IMAGES REGISTRATION
MOISTURE PROFILES	WEGETATION INDEX	SCAN LINE ANALYSIS	PLOTTER CONTROL
TOTAL OZONE CONTENT	SOIL TEMPERATU-RE & MOISTURE	LUT CHARACTERISTICS	
OZONE PROFILES			
COSMIC RAY MEASUREMENTS			

Fig.2. Block — diagram of the software for processing of NOAA, SPOT, LANDSAT satellite data.

-extraction into separate files, AVHRR images in
different spectral channels and TOVS data
including time code at the beginning of each
scan line,
-identification of lost lines based on time code
and insertion of artificial data into its place.

The time from 3 to 8 minutes for initial processing is
necessary. TOVS data are transferred via D-LINK network to
second minicomputer for processing.
The software for TOVS data processing consist of:

-geographical location of satellite data
[Borelowski J.,1987],
-retrieval of vertical temperature profiles
[Barański L.A., Rożemski K., 1985],
-retrieval of vertical moisture profiles
[Barański L.A., Rożemski K., 1986],
-retrieval of ozone mixing ratio, profiles and
its total content [Barański L.A., Rożemski K.,
1987, Barański L.A., Mrugalski J., 1988],
-cosmic ray measurements.

The results are presented in diagram form by plotter
co-working with minicomputer, and can be stored on magnetic
tapes archive.
The software for processing of AVHRR data consists of two
separate blocks: the mathematical processing, visualisation of
satellite images and results of calculations.The results of
matematical processing are:

-mapping of Baltic Sea surface temperature
[Barański L.A., Kobiec B., 1985],
-soil temperature and moisture [Barański L.A.,
Mrugalski J., 1988],
-vegetation index.

The image processing software has been made for visualisation
of NOAA, SPOT, LANDSAT, NIMBUS etc. satellite images as well as
analogue images read over by scanner digitizer. Image
processing system permits to display images step by step from
quick-look format (scale 1:4 of original image) up to enlarged
parts of image (scale 128:1). The software allows to change
displayed part of image or displayed channel. The cursor placed
on image can identify any pixel, displaying its coordinates and
value as well as any line displaying its diagram. Analysis of
the scan line permits selection of the Look up Table
characteristics.
Every image displayed on monitor can be recorded on
photoregistrator as black/white hard copy.
Presented informatic system based on IBM PC/AT for
registration and processing of satellite data, working in local
area network is open. Additional hardware and new
interpretation software can be simply added by users.

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