DIGITAL SIGNAL PROCESSING UNIT FOR NON-COHERENT 2-D RADAR

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The non-coherent 2-D radars with analogue signal processing technique are widely used in marine navigation, in water spaces and aerodromes surveillance, and other applications where no coherent signal processing is required. The main purpose of these radar is detection and subsequent display of targets within a given radar working range.

Up to recent time the main part of arithmetical and logical operations of the input signal information in those stations was effectuated by an operator. Man-operator as a computing and decision-making element is no doubt a very flexible part of a system, but he has inherent drawbacks in memory capacity, quickness and accuracy of reaction etc. These drawbacks are very important, and cannot be effectively compensated in analogue processing systems. In this connection, in 1979 the Intergovernmental Maritime Consultative Organisation (IMCO) has adopted a resolution [1] which regulates the main standards on production digital technique for processing and display of radar information from ships radar. In particular, there was regulated a set of the so-called automatic radar plotting aids (ARPA) requirements, including automatic detection and tracking of up to 20 marine objects simultaneously, calculation of closest point of approach (CPA) and time to CPA (TCPA), and display the environment in a form suitable for operator, including alarm signals of danger predicted.

There is now produced in abroad a set of digital processing and display radar systems which in a different extent met ARPA requirements. For example, there are known solutions of the following companies: ATLAS (Germany), Furuno (Japan), JRC (Japan), TITAN (Canada), LITTON (USA). A high price of these systems is a serious limitation for their installation on both medium- and small-tonnage ships.

In 1997 year a problem of development of digital signal processing unit (DSPU) for non-coherent surveillance 2-D radar was stated in JSC "Radiophyzika". For a construction of this complex, named "NDSPU-Radiophyzika", there was chosen an optimal set of advanced and reliable electronic components. The hardware realisation of the unit as well as its functional software were organised following the principle of "open systems". It was taken the VMEbus as a most applicable architecture solution.

Radar DSPU is composed of:

- VME-create
- single-board universal computer
- specialised signal processing board
- intelligent board of analogue-to-digit conversion, and
- input signals conjunction board.

The developed architecture of "NDSPU-Radiophyzika" permits:

√ quick conjunction with different radar (including analogue ones), having different output signals parameters;

√ easy and low-cost hardware updates;

√ adapting the unit with DSP systems of "Baget" series, or other VMEbus system solutions.

The structure block scheme of "NDSPU-Radiophyzika" is given in Fig. 1.

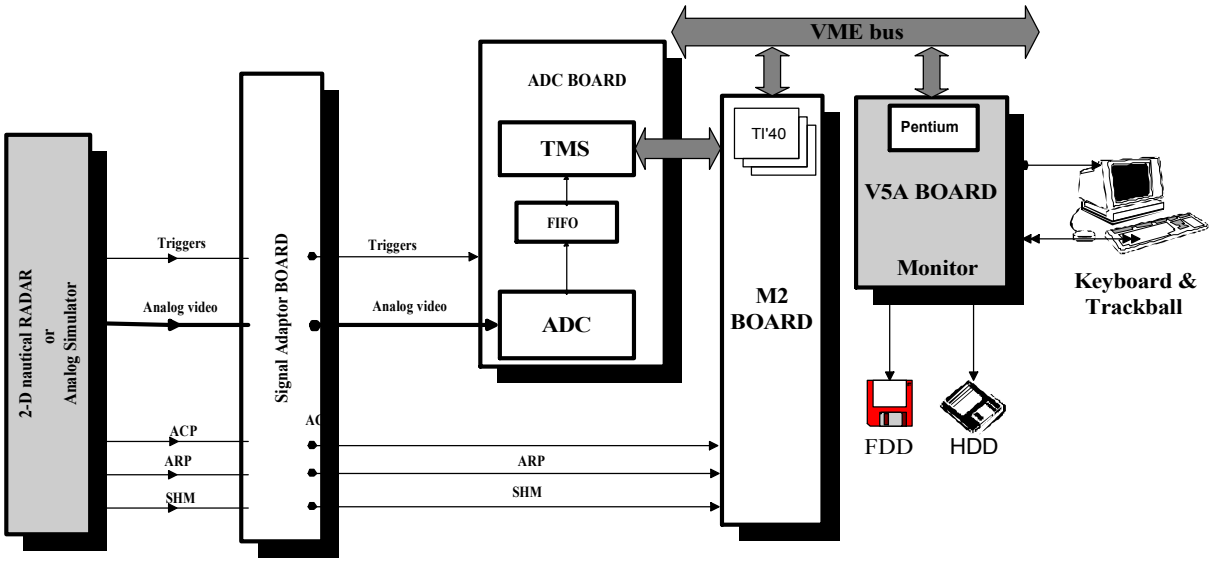

Fig. 1.

"NDSPU-Radiophyzika" provides the real-time solution of the following tasks:

- primary signal processing:

– extraction of signals from marine radar objects on the background of noise and sea surface;

– extraction of friendly signals on the background of probe pulses from other radar;

– generation of single coordinates measurements (range and azimuth) of marine radar objects;

- secondary signal processing and radar control:

– detection and tracking of marine radar objects;

– calculation of CPA and TCPA for all the tracked objects;

- display of required information on the screen and human control of signal processing;
- radar hardware and ship navigational elements control.

Analogue signals from ship's radar come to primary signal processing block, where interference pulses rejection, pulse-to-pulse signal processing, incoming data to azimuth directions affixment, view-to-view non-coherent integration, adaptive threshold processing and generation of single measurements of the detected objects are performed. Single measurements comprising coordinate information, amplitudes of the received signals and objects dimensions, are used in the secondary signal processing block for construction of objects trajectories and ARPA, as well as for control of computation process, radar apparatus and ship's navigational facilities. The processed signal, coordinate, tracking and service

information is sent to a display block where is converted to a form convenient for displaying on the operator's screen.

The software & data streams block scheme of "NDSPU-Radiophyzika" complex is given in Fig. 2.

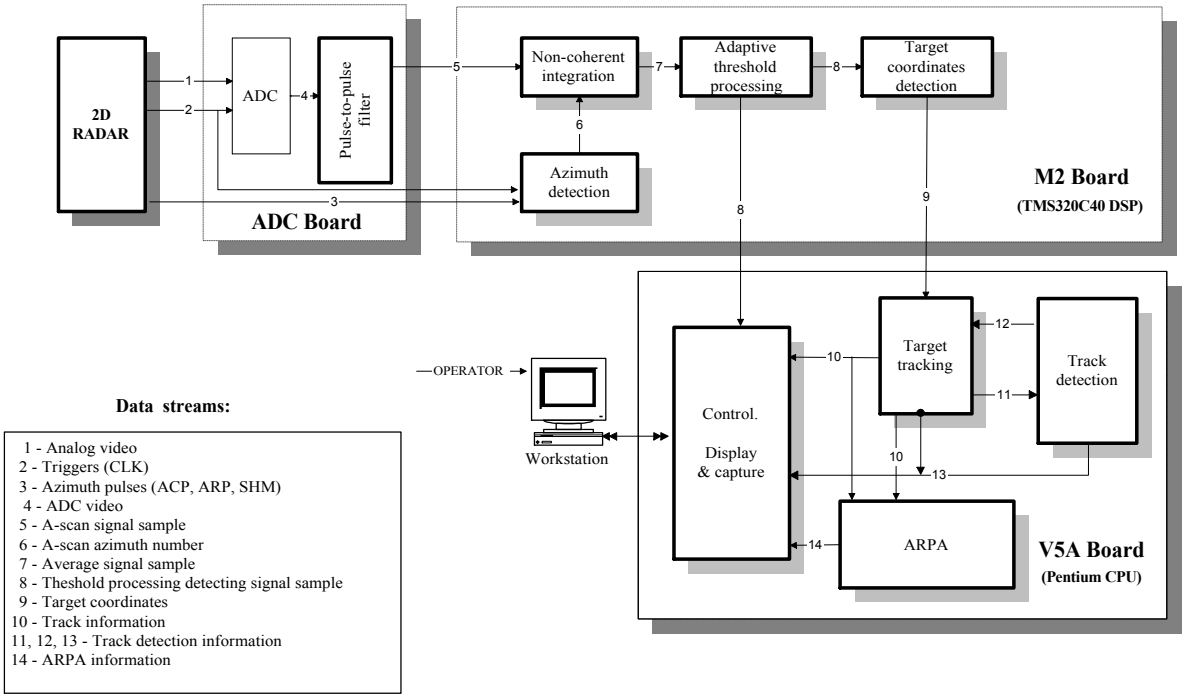

Fig. 2

The developed digital signal processing unit have successfully passed tests in the configuration of non-coherent nautical 2-D radar. It was shown that the constructed complex is highly competitive with foreign analogues, and is excellent in discrimination and tracking of small-size and remote objects.

In Fig. 3 and Fig. 4 are shown the results of "NDSPU-Radiophyzika" processing the real radar information from the observations of marine objects near the bight of Novorossiysk made by native 2-D radar in May, 1998. Fig. 3 illustrates the results of radar observations on the 6 nautical miles range scale chosen. Fig. 4 shows radar observations of the motor boat moving within 200 meters from coast. In all cases "NDSPU-Radiophyzika" has shown the stable tracking of all the detected objects.

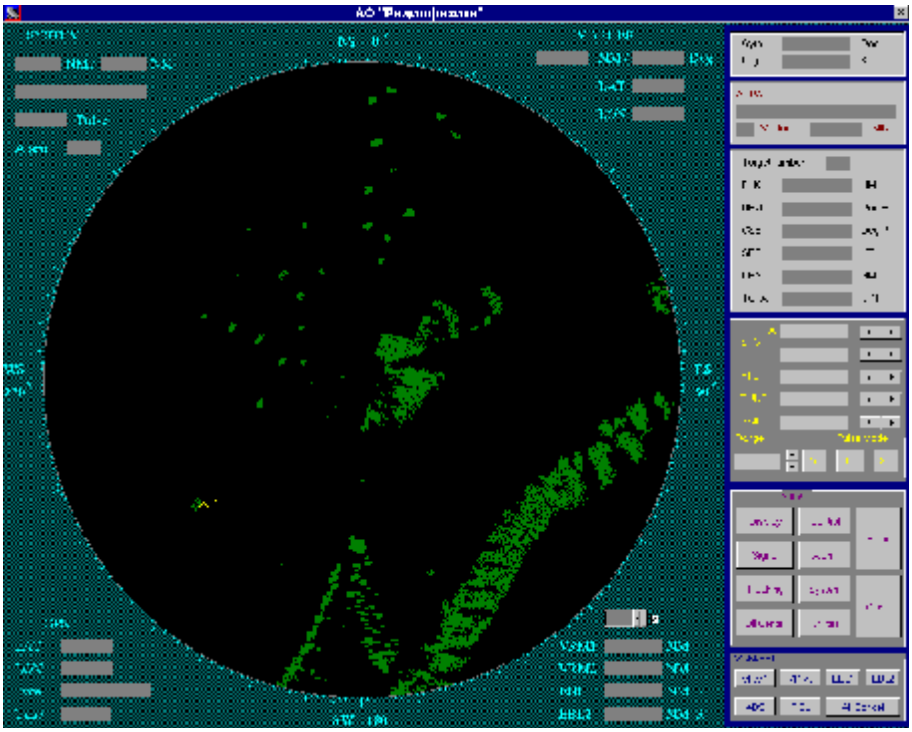

Fig. 3. The results of radar observations of ships
near the bight of Novorossiysk

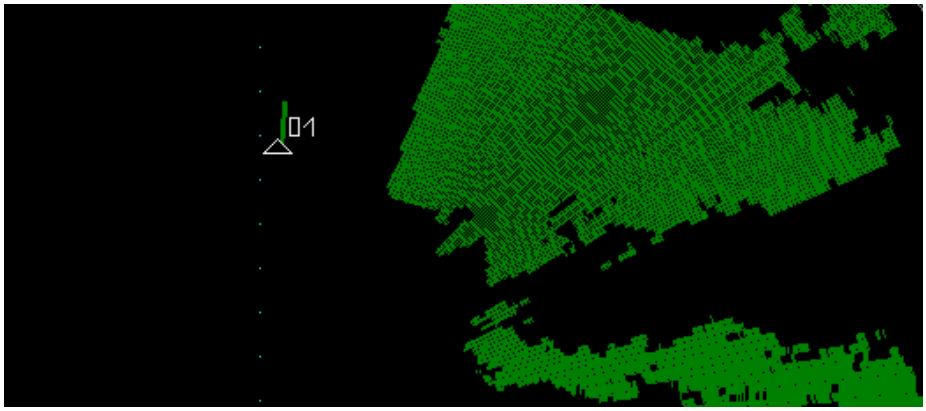

Fig. 4. Tracking of small-size object (motor boat)
within appr. 200 meters from coast.

REFERENCES

[1] IMCO Resolution A/422(XI) adopt. 5 Nov. 1979, Performance Standards for Automatic Radar Plotting Aids (ARPA).