Property testing of ultrasonic sonars

The aim of this exercise is to gain experience with using ultrasonic distance measurements devices.

1   SONAR application

The application enables the communication between the computer and the sonar controller. It also shows received measurements. The graphic interface includes the stage map on which you see the sonars and the measurements. On the right side there is the sonar control panel (pict. 1). In the upper part
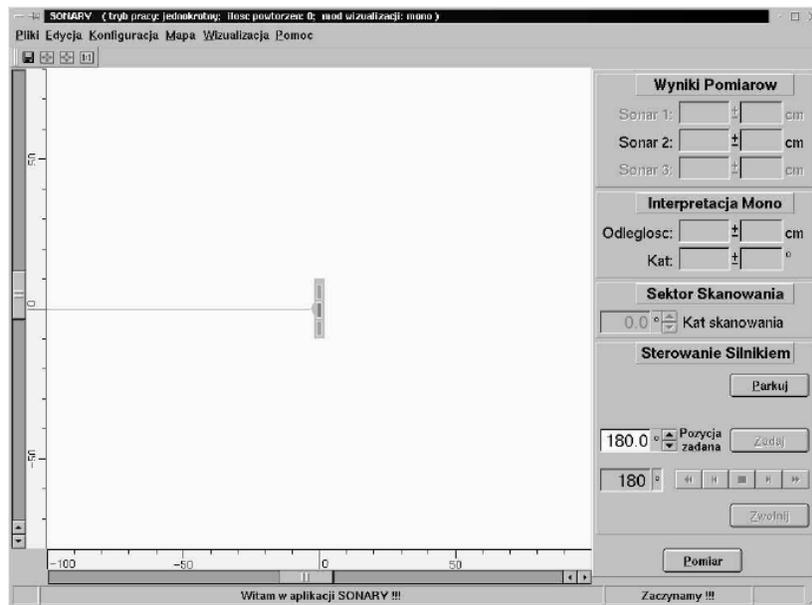

Figure 1: The graphic interface of application SONARY

of it there are the windows in which the current measurement are shown. Below, there are the windows that inform about interpretation of the current measurement. In the bottom part, there is the engine control panel which allows to change the orientation of the sonar system. The 'Pomiar' button, in the lower part of the panel, initiates measurement or the series of measurements in accordance with the selected work mode.

1

1.1 The engine control panel

The basic significance in the engine control panel has the 'Parkowanie' key. After the application starts it's the only active button (pict. 2). Press this button to set the sonar initial orientation. Thanks to the stepping motor the steering of the orientation is possible. Single step is equal to 0.9°. To change the orientation of sonar you can use buttons that allows you to control the engine (pict. 4). Using [◄] or [►] causes single motor step correspondingly

Figure 2: The direct control engine buttons

in left or right. The continuous move buttons realise continuous move in left or right side. After using one of these keys, all buttons in control engine panel are inactive, except the stop button (pict. 3).
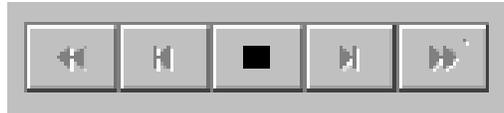

Figure 3: The direct control engine buttons in inactive state

The current orientation of sonar is displayed on the left side of control engine buttons. Angle measurement method is shown in pict. 5. The coordinate system origin is in centre of sonar system frame which is its axis of rotation.

The orientation of sonar can be also changed by giving specific position. You can do that by using the 'Zadaj' key and the window on the left of it. The given orientation must be a multiple of the single step and in interval 95.4° and 264.6°. After setting desirable value and pressing the 'Zadaj' key the sonar system turns to desirable orientation.
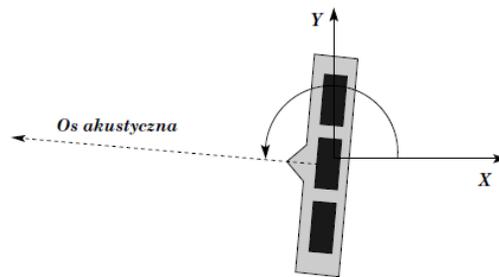
Figure 4: The direct control engine buttons

Figure 5: Angle measurement method

1.2   The scan sector

The window that lies directly above the engine control panel allows to input the size of scan sector (pict. 6).

The maximum scan sector amounts to 169.2°. The scan sector determines the scope of orientation changes that allows to make the series of measurements in the given angle interval (pict. 7). The scan sector is determined by actual position (before the measurement realisation) of the sonar system (pict. 6). Visualisation of the sector can be turned on or turned off, depending on marking or not 'Sektor skanowania' position in menu 'Wizualizacja'.
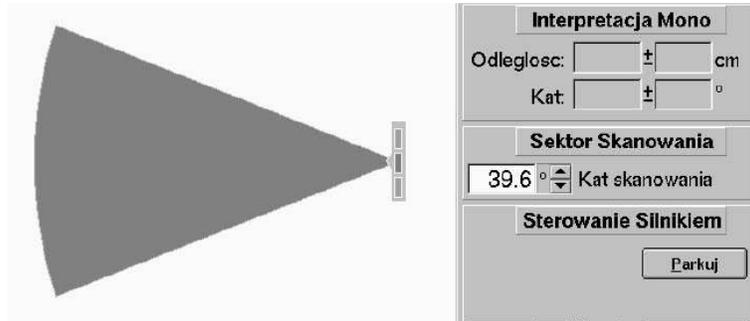

Figure 6: The scan sector panel

Figure 7: The visualisation of scan sector

Because the single step of the sonar system is 0.9° the sector size can be only the even multiply of value 0.9°, ex. 0.9°, 1.8°, 3.6° *etc.*.

When the 'Pomiar' button is pressed, the sonar system is turned to extreme left orientation of given sector and then realises following measurements. This process is complete when the sonar achieves the right border of sector (pict. 8). After this, system starts taking next measurement (in multiple measurement mode) or returns to initial position.
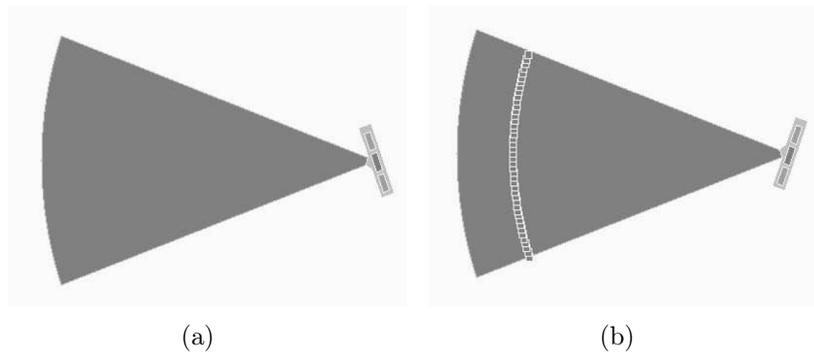

(a)   (b)

Figure 8: The scanning process: the sonar rotates from (a) the extreme left position to (b) the extreme right position

When size of the sector is equal 0°, then the sonar system takes only one measurement. For size 1.8° system takes three measurements, for 3.8° – five measurements, etc.. If the motor is released then edition window is inactive and the size of the scan sector is 0°.
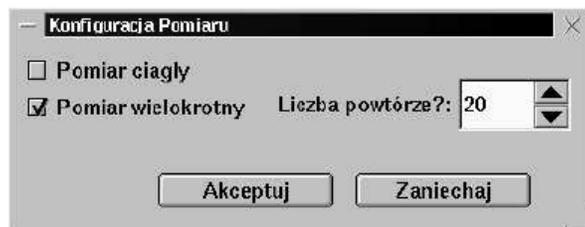
1.3 Multiple measurement

The change of the measurement method is possible by dialog 'Pomiar' in 'Konfiguracja' menu. There are three basic variants of measurement realisation:

- single measurement ('Pomiar ciągły' and 'Pomiar wielokrotny' options are unmarked (pict. 9 (a)));

- single measurement realised in a continuous way ('Pomiar ciągły' option is marked). Taking measurement is repeated until pushing 'Stop' button;

- multiple measurement ('Pomiar wielokrotny' option is marked (pict. 9 (b))). The measurement in direct direction is repeated as many times as it is given in the edit window in 'Pomiar wielokrotny' option. The least number of repetition is 4, the largest 100. The average value of all measurements in the given direction is displayed as a result. The largest deviation from the average value is displayed as an error.
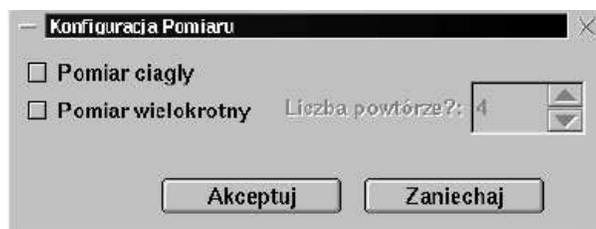
(a)

(b)

Figure 9: Multiple measurement option

It is possible to work in continuous and multiple mode in the same time ('Pomiar ciągły' and 'Pomiar wielokrotny' options are marked). The 'Pomiar

ciągły' mode is useful to define the dead zone. The 'Pomiar wielokrotny' mode is usable to define measuring accuracy.

1.4 Storage of data

Data can be stored as an image of the map with scale. It is possible to use 'Zachowaj obraz mapy' in 'Pliki' or [image]. The image is saved as a JPEG file (pict. 10). The data can be also stored as a list of coordinates of measuring points in a text file (use 'Zachowaj dane mapy' in 'Pliki').
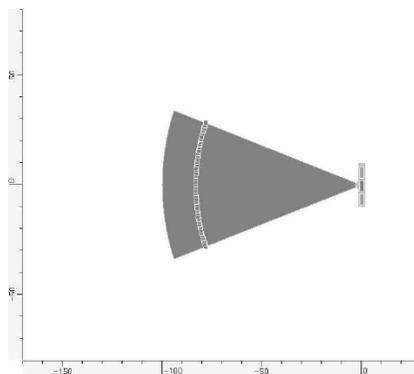

Figure 10: Stored map example

2 Task to do

- Define the dead zone of sonar.

- Define width of the beam in which the echo is registered. Take measurement for several distances.
  To define width of the beam use the stick and take the measurement in sufficiently scan sector width. By clicking on the measure point in the map, the measurement value and the sonar orientation can be read which allows to determine the beam width.

- Define measuring accuracy. Use 'Konfiguracja->Pomiar->Pomiar wielokrotny' (configuration->measurement->multiple measurement) in menu bar.

- Perform measurements of the stick by one sonar ('Wizualizacja->mono') and by sonar system ('Wizualizacja->multi'). Think about differences between measurements.

- Perform measurements of the one wall by one sonar ('Wizualizacja->mono') and by sonar system ('Wizualizacja->multi'). Think about differences between measurements.
  Obtained images add to the report.

- Perform measurements of the two walls at an angle of 90° by one sonar ('Wizualizacja->mono') and by sonar system ('Wizualizacja->multi'). Try to interpret obtained results. Think about differences between measurements.

- Based on measurement resolution and delivered program fragment in HD6303Y asembler, determine approximate clock frequency. As a approximate sound speed take $330[\frac{m}{s}]$.

```
                             ; Clock cycle ;
PETLA_NASLUCHU:
TAB                          ; 1
ANDB   (SONAR_I)             ; 4
BEQ    PETLA_NASLUCHU        ; 3
PSHB                         ; 4 ; Push the result on stack
SBA                          ; 1 ;
LDX    (Timer1_FRC)          ; 5 ;
PSHX                         ; 5 ; Push time on stack
BNE    PETLA_NASLUCHU        ; 3
```

Store the obtained ultrasonic images using 'Pliki->Składuj obrazy i mapy' option and add them to the report.