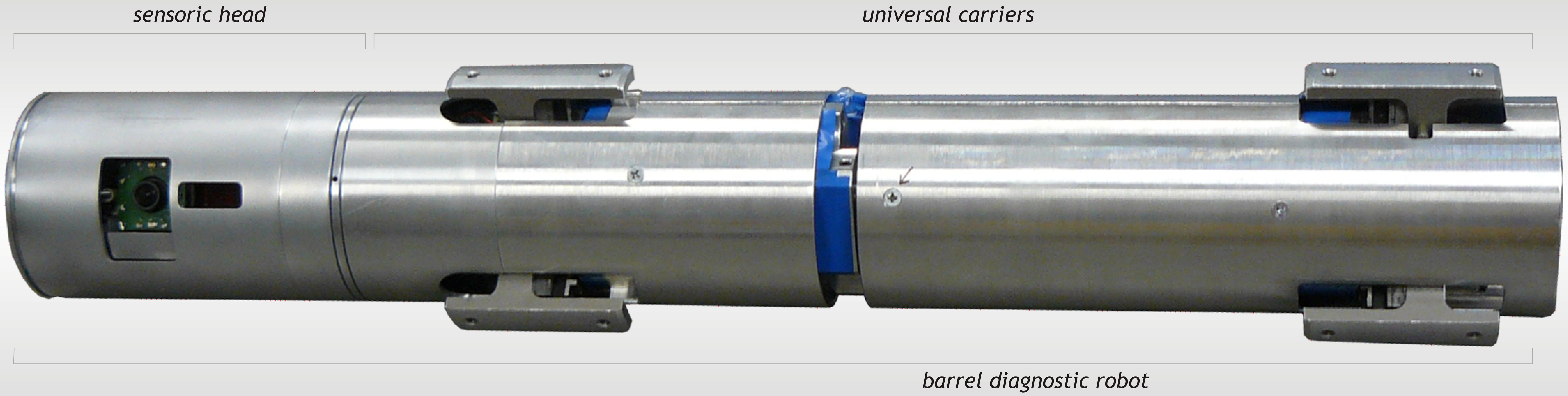
BASCAN - BARREL BORE SCANNER

Introduction

This poster deals with the design, mechanical design, electronics and software for robot that is able to diagnose gun barrels with caliber of 120 mm to 155 mm. It is second version of the robot which is in development and brings a completely new approach to scan gun barrel bore. The purpose of this device is a complete diagnostics, including the possibility to compare current state of damage with the previous record on the computer.

This diagnostic device is intended primarily for experimental research and verification of appropriate methods and technologies.



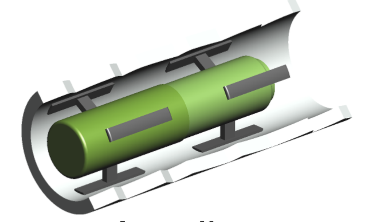
1, Hardware

a) Mechanical design

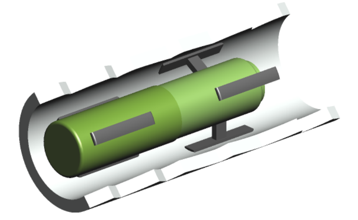
Whole robot construction is divided into two main parts - sensoric head (described in 2.a) and universal body. Carrying part of diagnostic equipment is versatile robot's body. The body has no sensors. It serves only as a movable part, which has the task of adapting to the caliber of the scanned barrel to ensure smooth movement within the barrel. It consist of several important parts:

Versatile carrier is divided into two halves which are moving against or from each other. Principle of the movement is described below. Thanks to this mechanism is device perfectly stabilized and centered during measuring.

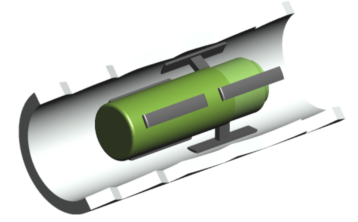
Driving system, which consists one stepper motor for shifting in the barrel and two geared DC motors for expandable arms. The arms can be adjusted from the caliber 120 mm to 155 mm.



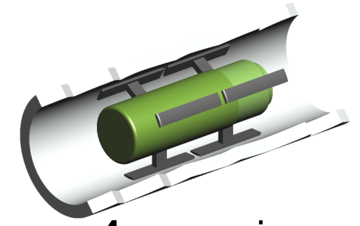
Phase 1: all arms are clamped against the inner wall of the gun barrel.



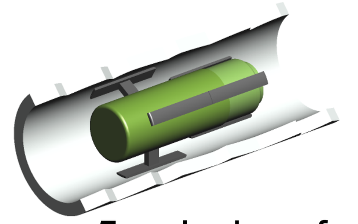
Phase 2: closing rear arms. Device is centered using front arms only.



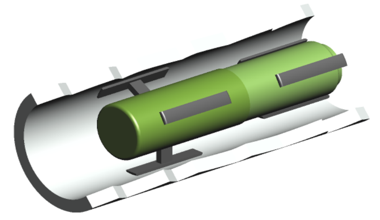
Phase 3: stretching telescopic body



Phase 4: opening rear arms.



Phase 5: closing front arms. Device is centered using front arms only.



Phase 4: expanding telescopic body. Next step follows phase 1.

b) Electronic embedded system

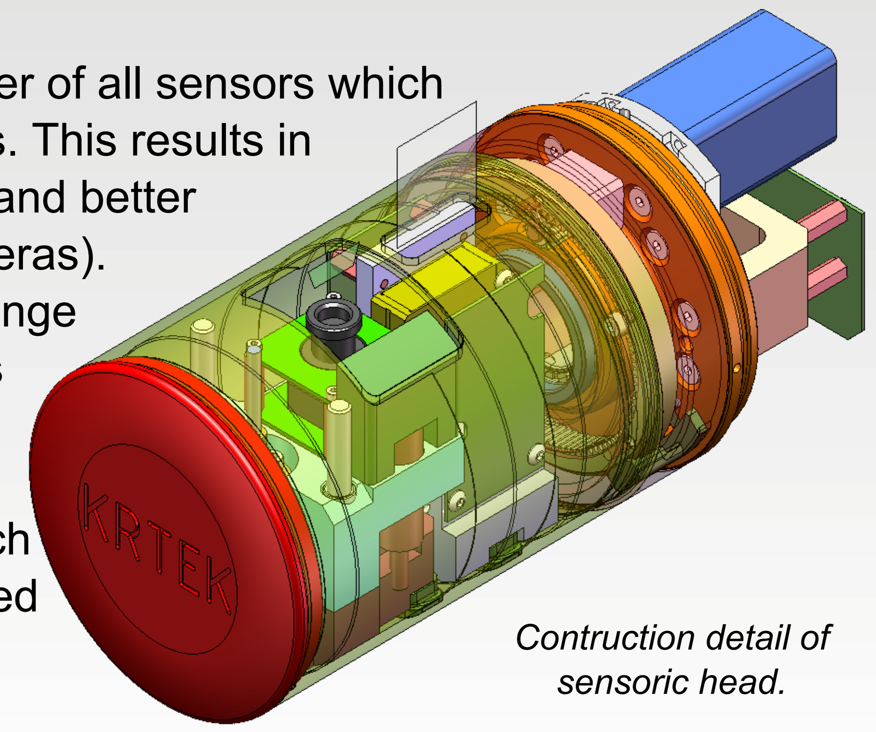
The proposed electronics system can be divided into several parts:

- **Modules for the movement** within the barrel which control and synchronize all motors.
- **Sensor modules** for data collecting.
- **Communication module** which communicates with external environment using CAN 2.0A bus and CANopen protocol.

2, Data Collecting

a) Sensoric head

Sensoric head is a swivel carrier of all sensors which are located on expanding arms. This results in approximation toward surface and better focus of the sensors (e.g. cameras). Sensoric head rotates in the range from 0 degrees to 360 degrees with resolution of 0.6 degree. In order to set the head to the starting position a magnet which indicates initial position is placed on the head.



Contruction detail of sensoric head.

b) Chosen sensors

Different types of sensors are used on each part of sensoric head:

- CCD camera with IR lighting.
- CCD camera with a bar laser lighting.
- Triangulation laser to measure the inside diameter of barrel.

Sensors are used for mapping of a surface inside the barrel. First CCD camera with infrared lighting is used to obtain detailed texture while the second camera with bar laser lighting is used for precise surface reconstruction. It can be evaluated for damage detection, profile depth and width measuring. Laser rangefinder is used for a precise measurement of the internal diameter (measured data are mainly used for calibration).

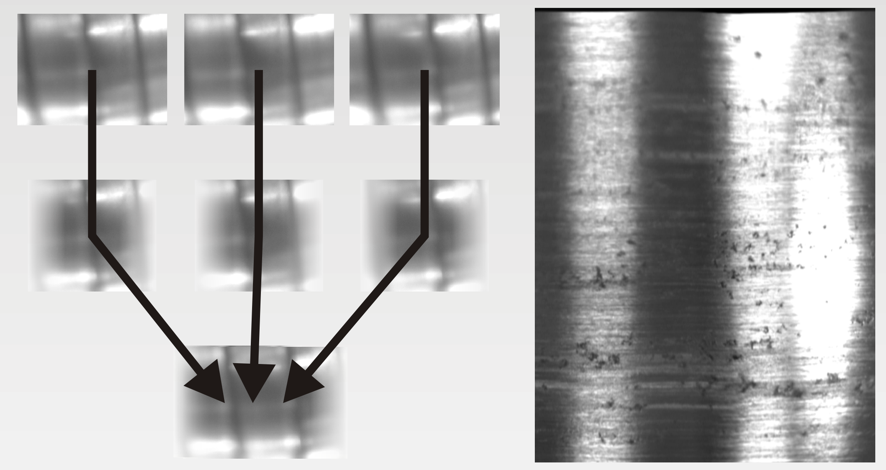
c) Barrel diagnostic

Process of scanning and diagnostic is fully automatic. When the robot is inserted into the barrel, scanning process can begin. The sensoric head is turned by a stepper motor in requested resolution to get sample data from all sensors. This implies that the whole measuring process is repeated by each step of the motor while the data are sending through a CAN bus to a computer. After one turn of the head, the whole device is moved forward to make new measuring process.

3, Data processing

a) Surface texture

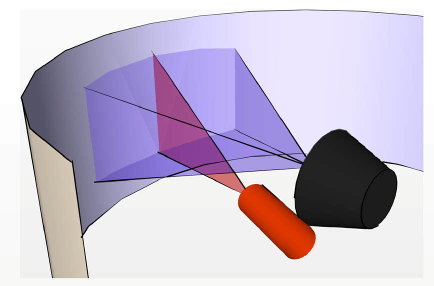
- Up to 600 images of barrel surface is obtained within one turn sensoric head.
- These images are then folded into one image.
- All these folded images create detailed map of inner barrel



Texture reconstruction.

b) Elevation profile reconstruction

- CCD camera with bar laser lighting is used for mapping elevation profile (profilometry). Laser beam hits the barrel at certain angle. The camera picks up the barrel from the perpendicular direction.
- Laser beam is then detected in the obtained image and the height map is then computed from deviation of expected position.
- Calculated values can be corrected using data from triangulation distance sensor.



Elevation profile measurement.

Reconstructed elevation profile.

c) Results evaluation

Two elevation and texture maps captured with a certain time period can be compared (automatically or manually) to check if there are some important changes on the barrel surface since last measurement.

Acknowledgement

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