Bauman Moscow State Technical University

Non-contact Remote Bio-Radiolocation Method of Sleeping Monitoring

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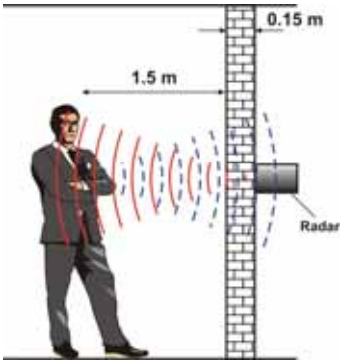
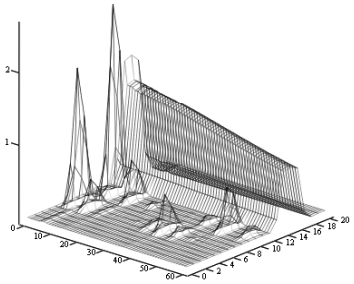
Abstract

The results of sleeping monitoring experiments are presented. The multifrequency radar with signal step modulation is applied. Breath and pulse oscillograms are given. The influence of some moving artifacts (features) is shown. Sleeping in calm and stressful conditions is compared.

Bio-radiolocation

The detection and diagnostic monitoring of humans (even behind opaque obstacles) by means of radar (RAdio Detection And Ranging) can be called bio-radiolocation.





Physical background of the method

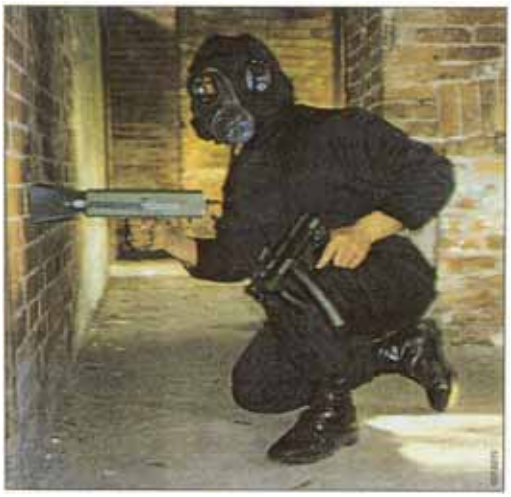
Electromagnetic signals coming from a radar are able to probe the human body. There is a definite difference in dielectric properties of a heart muscle and blood, air and chest, chest and lungs. What is more the magnitudes of permittivity and conductivity of the concrete tissue also depend on the range of frequency they are being probed. So the reflection of radio frequency energy can be found.

Doppler effect takes place. Probing signal reflecting from the moving boundary changes its phase. The inflection of the phase is measured by means of radio interferometer.

Possible applications of bio-radiolocation

Detection of live persons under debris

Detection of people inside buildings during antiterrorist operations



Security systems of remote diagnostics of people in important objects

Remote lie-detector

Latent detection of psycho-emotional state of participants of negotiations

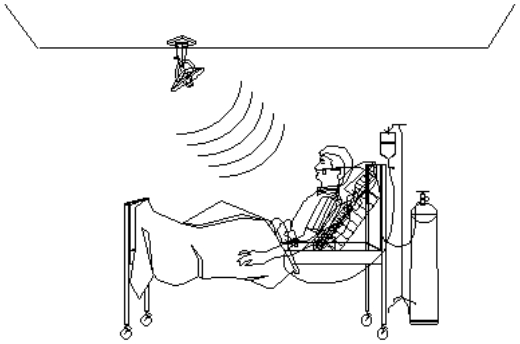
Distinguishing wounded men from dead ones on a battlefield

Potential areas of bio-radiolocation applications in medicine:

- somnology, patient monitoring during sleeping with the purpose of detecting sleep dysfunctions;
- cardioreanimation, when application of contact sensors is difficult or impossible;
- patient heart rate and respiration monitoring when application of contact sensors is difficult or impossible, e.g. monitoring of burnt patients;
- fetal monitoring without application of ultrasound sensors which require a direct contact with the mother;
- non-contact evaluation of the psycho-emotional human condition, e.g. the emotional condition of critical machinery operators;
- space medicine and remote monitoring of astronaut activity…

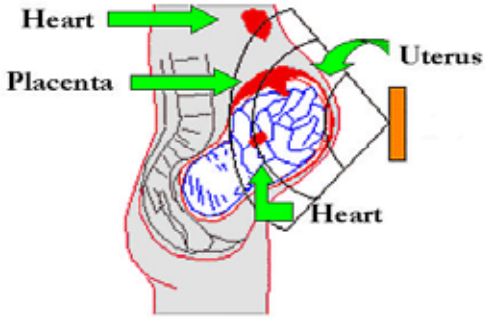
Intensive care units

As the electromagnetic signal is not practically influenced by clothes or blankets and the useful range is in the order of a few meters, a through-clothing heart rate monitor on the base of bio-radar cab be utilized.



Fetal monitoring systems

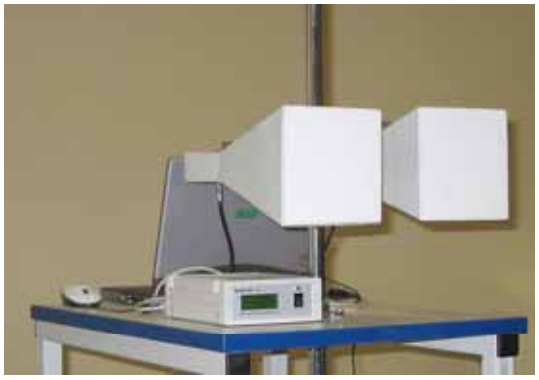
Bio-radar signal contains data about maternal heart rate, maternal breath rate, fetal heart rate, fetal movements and uterine contractions as well.



Space medicine

Monitoring of astronauts movements inside and outside the spacecraft, and remote monitoring of their health.

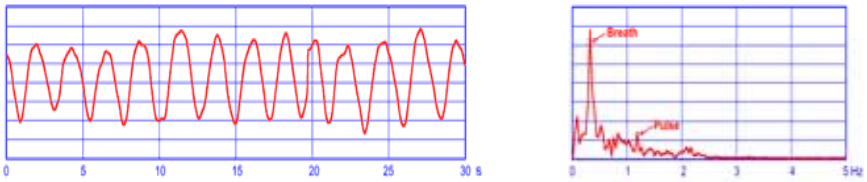
Design of bio-radar



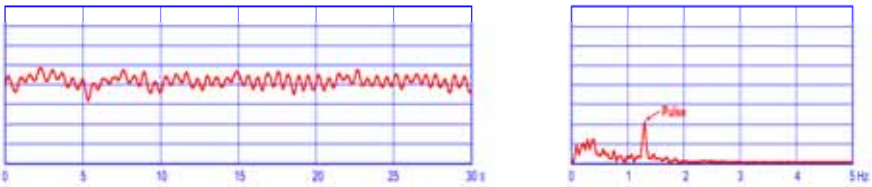
The bio-radar design has 16 operating frequencies in range of 3.6-4.0 GHz. The radar can measure the distance to a person under investigation and has improved abilities to filter noise and background reflections.

Breathing and pulse patterns

Signal ***Frequency Spectrum***



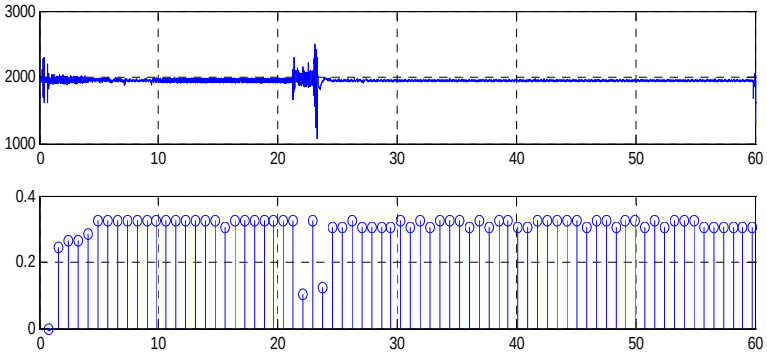
Breath and pulse oscillogram of the examinee at rest



Pulse oscillogram of the examinee while holding of breath

Sleeping and staying awake

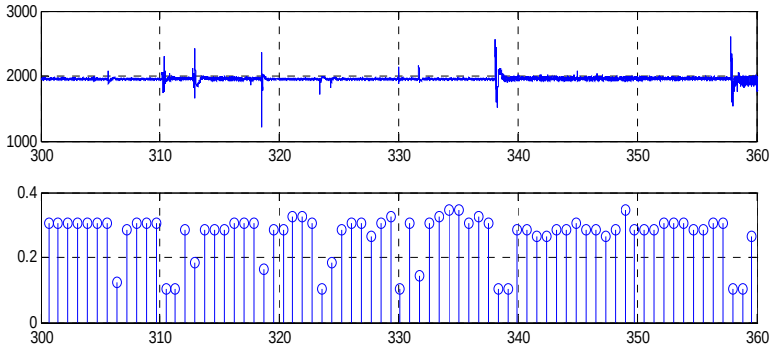
There is a noticeable difference in receiving signal while sleeping and staying awake. When falling asleep, the amplitude becomes lower.



Receiving signal by radar and max frequency

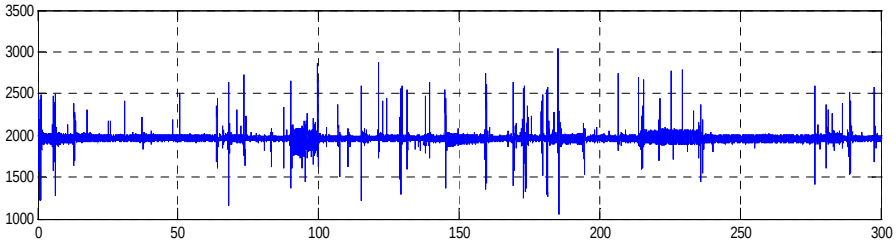
Troubled sleeping

When moving, the frequency is lower than average one at periodic breathing. It can be explained in the way that moving components appear in low parts of the spectrum.

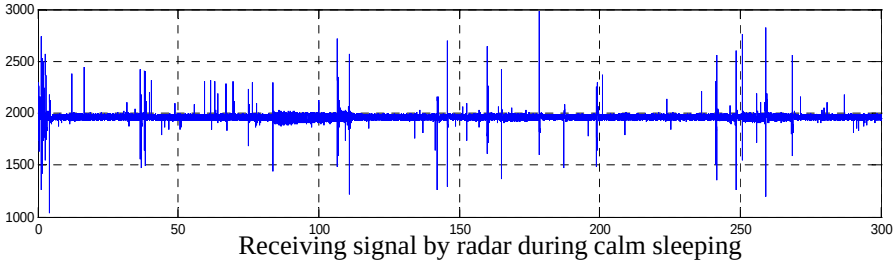


Receiving signal by radar and max frequency during troubled sleeping

Sleeping in calm and stressful conditions



Receiving signal by radar during troubled sleeping



Receiving signal by radar during calm sleeping

Conclusions

• The method of Bio-radiolocation, applied in sleeping monitoring, turned out to be a representative mean affording to detect moving of the patient while sleeping and observe breath and pulse patterns.

• Breathing rate is supposed to be an objective parameter, reflecting sleeping dysfunction as well as the state of staying asleep and awake.

• The periods of troubled sleeping can be pointed out by the high amount of moving artifacts (features).

• Moving components appear in low parts of the frequency spectrum.

• To discern such artifacts as cough, sneezing and overturn more detailed data processing should be done.

References

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Acknowledgements

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Questions…