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Mechanisation and occupational, safety and health

The Potential of Low Intensity Radiation Devices for Carcass Evaluation

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Introduction

The Minister of Agriculture, Lockwood Smith, has recently [1] stressed the need to introduce more objective methods of carcass evaluation. With better objective methods the full monetary value of carcasses would be realised by the farmer, and he would have better information to breed animals by.

A problem facing industrial researchers is the analysis of organic-based materials (containing C,N,O and H) at high throughput. Extending methods for detecting differences in chemical composition is the key to many areas. In meat processing plants, researchers aim to automatically measure carcass fat, meat and bone percentages. This is leading to consideration of advances in medicine and aviation security. Medical instruments are not however constrained by the need for high throughput. But the algorithms and systems in medicine for anatomical problems are transferable to the meat industry. Aviation Security (AVSEC) researchers are focused on material analysis for explosives and drugs. Like meat and fat these materials are organic-based. The high throughput requirement of the AVSEC machines parallels the needs for automatic meat plant instruments. A common theme is the researcher's need to understand the detailed mechanism of the analysis method.

Approaches to Carcass and Other Organic Material Evaluation

In Table 1 is summarised some of the research approaches to carcass analysis methods.

Table 1 Research Approaches to Carcass Evaluation

Method	Principle	Development Site	Country	Key Workers
AutoFOM	ultrasound	Denmark	Denmark	J Brondum
		Calgary	Canada	
DEXA	Dual energy			
	x-ray absorption	USDA	USA	A D Mitchell
		MIRINZ	NZ	R D Clarke
		AgResearch	NZ	J Bass
GAMGAT	Dual beam	GNS	NZ	C M Bartle
NEUGAT	Dual Beam	GNS	NZ	C M Bartle
		MIRINZ	NZ	Group
Microwave	Electromagnetic	USDA	USA	A D Fisher
Robotic	Machine Vision	AMARC	UK	A Fisher
Surface Modelling	Machine Vision	AMARC	UK	A Fisher
		MIRINZ	NZ	R D Clarke
TOBEC	Electrical Conductivity	Purdue University	USA	J C Forrest
				A P Schinckel
Via Scan	Video Imaging	MRC	Australia	T Gordon
				A Drinan
Bio-imped.	Electrical Conductivity	MIRINZ	NZ	R D Clarke
		USDA	USA	
CT Scans	Tomography	AgResearch	NZ	N Jopson
Selected Cuts	Predictors	AgResearch	NZ	A Kirton
				P Rattray

An important approach is based on DEXA - dual energy x-ray absorption. Most bone densitometers used in medicine and airport AVSEC instruments use the DEXA concept. Since 1993, GNS has developed this approach (referred to as GAMGAT [2]) for boneless meat and other organic-based material analysis. Use of lower energy x-rays can improve the sensitivity to changes in Z but the effects of multiple scattering and penetration can have the opposite effect. These effects are yet to be fully understood. The thicknesses and geometry for carcasses are different to the other applications and this may be able to be used to advantage in future instruments.

Medical DEXA machines have evolved in the 1970's from small radioisotope-based instruments applied to a small body region (typically the wrist), to the present scanners which can be applied to whole body composition analysis. In this method two photon energies (or energy bands) are transmitted simultaneously to allow thickness effects to be removed [3]. Chemical sensitivity is based on detecting the differences in the Z value in the material based on changes in the photo-electric cross-section. For fat Z=6 and for lean tissue Z= 7.5. The Z for bone is about 20.

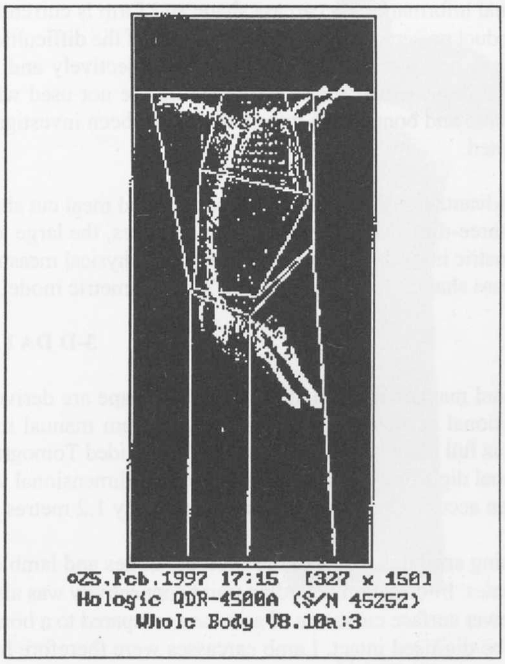

FIGURE 2

The latest machines such as the Hologic QDR 4500A installed in 1996 at Wakefield hospital, Wellington, use a x-ray tube source to obtain good bone density and whole body composition measurements. The instrument can produce an image measuring 1.8 m x 0.5 m. The scan of a whole body takes about 1 minute. Recently with meat industry scanners in mind, we scanned a mutton carcass with this instrument. The image and regions which were preferentially selected for analysis is shown in Fig.2. These regions were not particularly suitable for carcass analysis.

Airport AVSEC machines are being developed by researchers with strong funding from National Aviation Authorities[4]. The American Federal Aviation Administration (FAA) is particularly a driving force.

AVSEC machines should have the capability to detect explosives in aircraft luggage. High explosives such as *semtex* are organic-based materials rich in nitrogen. The Z value range of interest (6 to 8) is similar to fat and lean tissue in medicine, and fat and meat in the meat industry. Thus solutions which are being developed in the aviation industry for fast in-line scanning for explosives at airports is a guide (or possible solution) to automatic carcass evaluation requirements. AVSEC machines are evolving rapidly.

Throughput times required per luggage item are only a few seconds. Two years ago, no machine was considered by the FAA to be approaching the desired sensitivity. Since then one machine has reached the criteria, and others are close behind. In a recent example the image processing within luggage can be adapted separately to identify explosives, or to identify a wad of paper (money). This degree of Z discrimination is similar to that needed to discriminate fat and meat in carcasses, and is being carried out at processing speeds required for meat processing. Another important feature is that the AVSEC researchers advances is bringing down the cost of complex instruments such as computerised tomography (CT) scanners and DEXA instruments. This also is assisting the development of carcass scanners.

Conclusion

Researchers designing meat grading machines need to meet criteria of speed and cost. This may best be achieved by adapting features of the instrumentation, hardware and software of AVSEC and DEXA machines. In addition, there is much scope to extend the underlying theory to provide a better understanding of the chemical measurement mechanisms.

References

1. Address by the Minister of Agriculture, Dr. The Hon. Lockwood Smith to the Annual General Meeting of the Meat and Wool Section of the Federated Farmers, at the James Cook Centra Hotel, Wellington, 7 June 1996.

2. C M Bartle, Proceedings of the 28th Meat Industry Research Conference , MIRINZ Publication No. 942, p 279, 1994.

3. G H Kramer and C E Webber, *Applied Radiation and Isotopes*, Vol.43, 1992

4. AVSEC World '96, IATA's Aviation security symposium, Sydney, Dec 1996.