
General Discussion

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General discussion

SIR HERMANN BONDI, K.C.B., F.R.S. (*Churchill College, Cambridge, U.K.*).

(i) I see that our main concern is to stimulate the potential civil users to come forward and let us know their requirements with some precision. Because it has become clear that there are no general answers to all questions, our work needs to be targetted. The military user can be more definite and say that he wants to see where specific targets are. Can one be equally specific about particular civil needs?

(ii) Nor do I believe that money need be an obstacle. In the commodity markets an interpretation of remotely sensed data ahead of other knowledge should give a tremendous advantage to somebody buying or selling futures in, say, coffee. For, with sufficient knowledge and expertise, the data should reveal the state of the crop in all parts of the world.

How can these sources of funds be tapped?

(iii) What other civil uses might involve very large sums of money?

J.-P. A. L. MULLER.

(i) Yes. Examples include the state of the atmosphere and oceans; where changes in land use or other anthropomorphic activities have occurred (in, for example, the revision of civilian maps or the monitoring of the Chernobyl nuclear disaster) to the location of mineral resources.

(ii) The problem is that remotely sensed data cannot yet be used to provide the information with a sufficient confidence and to a given level of accuracy required by the commodity markets. The principal difficulties are in the sensor designs and the reflectance extraction algorithms which cannot be used to identify a unique spectral signature. Hope remains with steerable imaging spectrometers which will enable more quantitative information to be extracted on the surface cover by both looking for key factors (e.g. at a particular bi-directional view for certain wavelength combinations) and removing atmospheric effects.

(iii) Oil and gas exploration, and national mapping, might involve very large sums of money.

C. J. OLIVER. Research into SAR image-interpretation is unfortunately expensive to embark upon in terms of both image-production and image-interpretation. It is therefore one of those chicken and egg situations in that you are most likely to get funds for research you have already been successful in! However, the military user may have tasks of such high military priority that he is prepared to fund high-risk research. In the civil field, though the same principle should apply, the financial balance between cost and possible effectiveness is probable more difficult to quantify. Various lessons from MoD research may, however, be relevant to the civil field. For example, it is not productive to embark initially on a global image-understanding approach because the problems are so wide ranging. Instead one should endeavour to factorize out from the total problem various key elements, each with important consequences, which may be tractable within a reasonable time frame. Such clearly defined tasks can be convincingly demonstrated to succeed (or fail) and will tend to establish a climate in which more speculative ventures, with possibly greater potential benefits, may be supported. Expensive long-term

research should be associated with shorter-term real applications arising from the total research programme.

SIR HERMANN BONDI, K.C.B., F.R.S. Many years ago already, remotely sensed pictures were splendid wall decorations for the managing director's office. Today we learned of the long and laborious path from the cosmetically pleasant to the useful. It is good to hear that there are people putting in this hard and prolonged effort. However, to focus it well, we need the users. When do contributors believe the work will be sufficiently far advanced to stimulate our prospective customers?

J.-P. A. L. MULLER. I believe that this will happen when both unique questions can be formulated and the problems of multilevel knowledge invocation can be solved, particularly low-level feature extraction.

C. J. OLIVER. My presentation on aspects of clutter modelling and superresolution concentrated on some of the more speculative aspects of our research programme, aimed about 10 years ahead. Within the same research section we have produced important patented applications on the automatic production of focused, distortion-free, SAR images enabling detailed comparison of different images to be made. Research on these capabilities is essentially complete and we are in the development stage in which the methods are being installed on the RSRE SAR processor. Thus, research into a few important problems is already sufficiently far advanced for exploitation to be seriously considered. One would expect that continuing long-term research should progressively yield further capabilities.

S. QUEGAN. The path from the pleasant to the useful is longer and more laborious than it should be, largely because the funding and effort put into interpretation of data is in many cases grossly out of proportion to the large amounts expended in acquiring that data. The results presented have been the fruit of a small group of people who are taking the interpretation problem seriously.

As far as SAR is concerned, users need to have data to be interested, and until the launch of *ERS-1* such data will not be readily available. It is essential, however, that along with the data we supply the interpretation tools. At the present level of effort, I do not believe that these tools will be ready in time for *ERS-1* (at least as regards land use), and unless the effort is expanded it would be optimistic to expect them before the end of the century.

J. R. MILFORD (*Department of Meteorology, University of Reading, U.K.*). I would like to draw attention to an example from our work, funded by the U.K. Overseas Development Administration, which illustrates the Chairman's opening remarks particularly well.

We are developing methods for monitoring tropical rainfall by using *Meteosat* data: even if this can only be done crudely it will be useful in data-sparse regions, where there is no viable alternative for estimating the average rainfall. The intermediate product is the total duration of cold cloud (temperature below -60°C) over a ten-day period. Our research aims to find the optimum relation between the duration and the rainfall.

It is clear that any regression will leave a sizeable residual variance, but comparison of cross sections through the cloud duration map and the isohyetal map drawn from surface gauges

shows close qualitative correspondence, particularly in the positions of the minima. It may be that this alone makes the procedure worthwhile because rainfall minima over two or more successive ten-day periods during the rainy season would immediately indicate areas where most forms of agriculture are at risk.

To return to the Chairman's remarks, our experience shows the considerable effort which is needed to develop data-processing methods to the stage at which they match the sophistication of the data-gathering hardware. Development of the rain estimating technique has required about 20 man years, and will need as much again before we have operational methodology with known limits to the accuracy of the outputs in different regions of Africa. Fortunately specialist hardware and software is under development within the UN FAO.

The second point which we would support is that we need better communications with the users, such as FAO, UNDP, regional organizations and governments to match their specific needs with the type and reliability of outputs which we can deliver.

A third point is that the outputs are not of a kind which can bring quantifiable commercial rewards, and therefore have any identifiable market price. An international long-term programme is the only feasible kind of support for the satellite and the data processing system, and we are fortunate to be working with *Meteosat*, to which Europe already has a long-term commitment.