Utilization of moving grids for nonstationary nonlinear problems in solid and fluid dynamics

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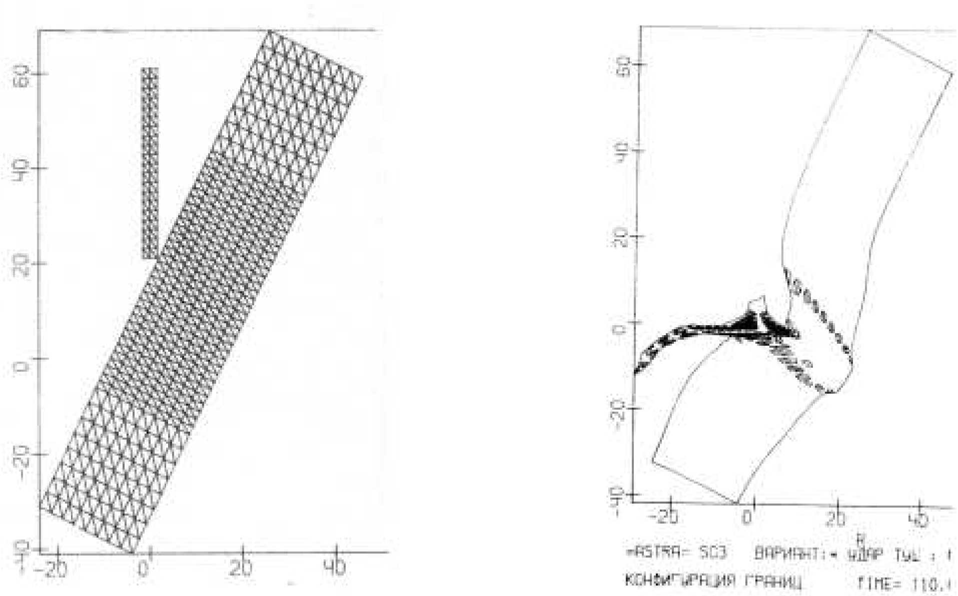
1. Introduction: what for we need moving grids:
   a) to describe a motion of media b) to improve an accuracy
2. Lagrangian grids:
   a) Large strains, b) Contact interactions, c) Discontinuities.
3. Arbitrary moving adaptive grids:
   a) adaptation to geometry, b) adaptation to solution

Tricky additional/alternative techniques:

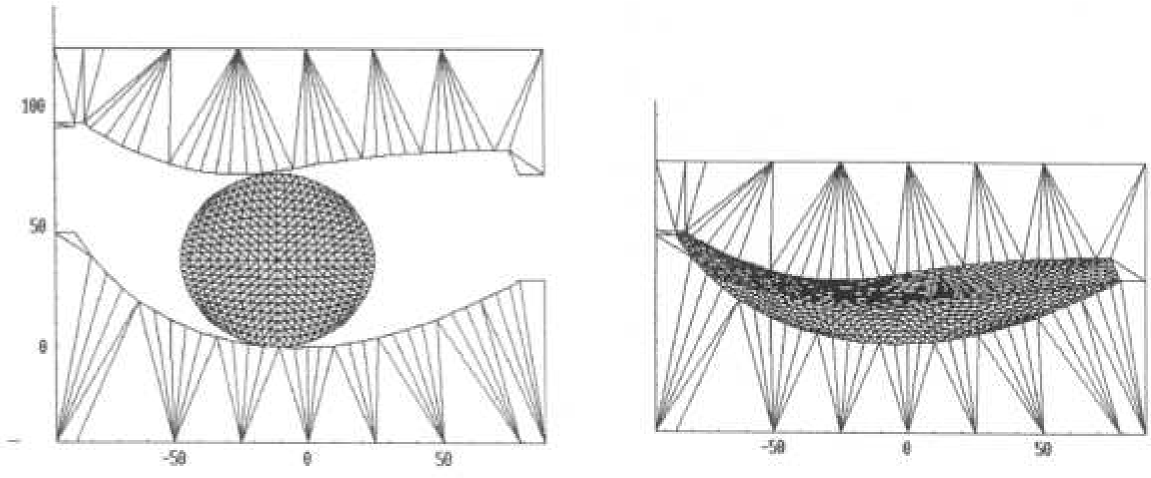
4. Continuous markers: complex motion, memory saving
5. Discrete markers: very complex motion
6. Complex 3D geometry without adaptation at all
7. Outcomes

2. Lagrangian grids. Large strains. Contact interactions. Discontinuities.



Colliding elastic plastic bodies (Calculated using code ASTRA Black cells show narrow bands of damaged material (discontinuities)

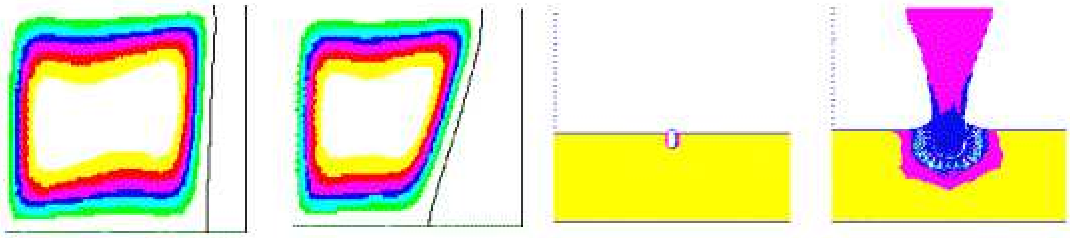
3. Arbitrary moving adaptive grids: a) adaptation to geometry



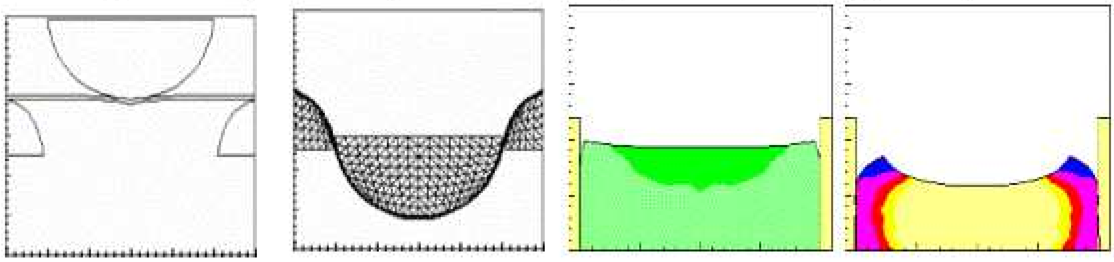
A forging production technique for turbine bucket

(Calculated using code ASTRA)

3. Arbitrary moving adaptive grids: a) adaptation to geometry



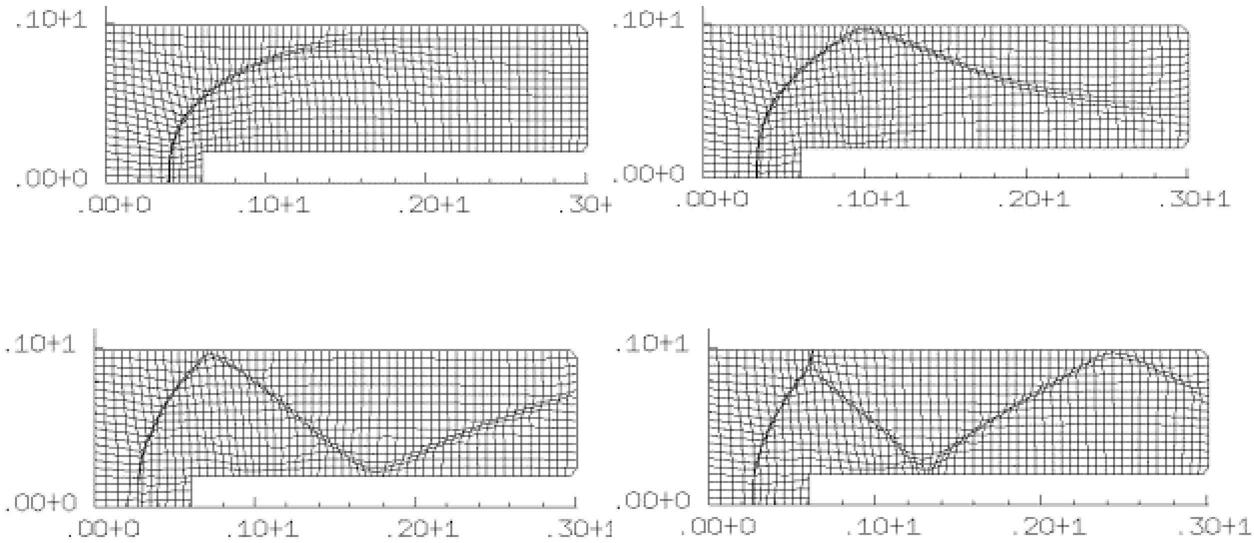
Stefan problem (water-ice) Explosion of a charge in a ground



Forming a cap Sintering of a powder composite

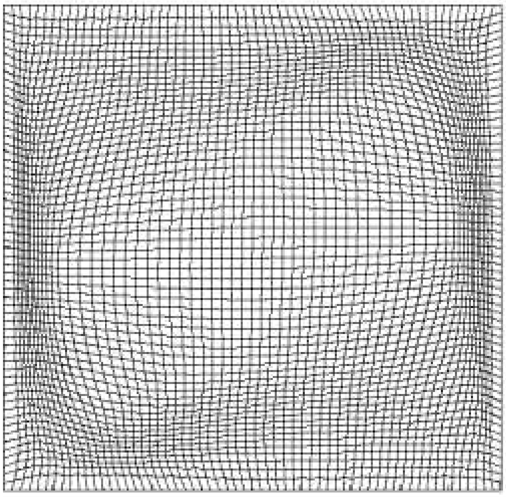
(examples are calculated using code ASTRA)

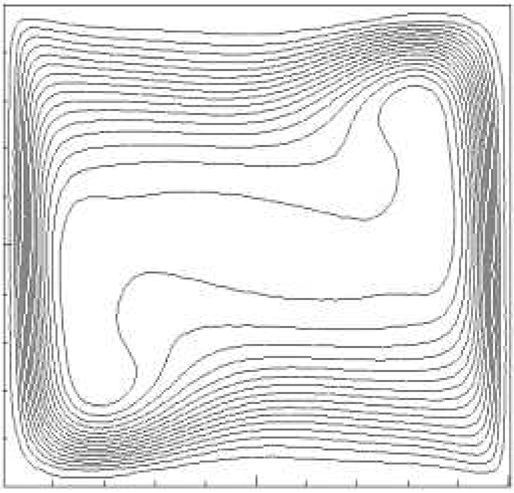
3. Arbitrary moving adaptive grids: b) adaptation to solution



Supersonic flow (M=3) in a channel with a step (Calculated using code ASTRA)

3. Arbitrary moving adaptive grids: b) adaptation to solution

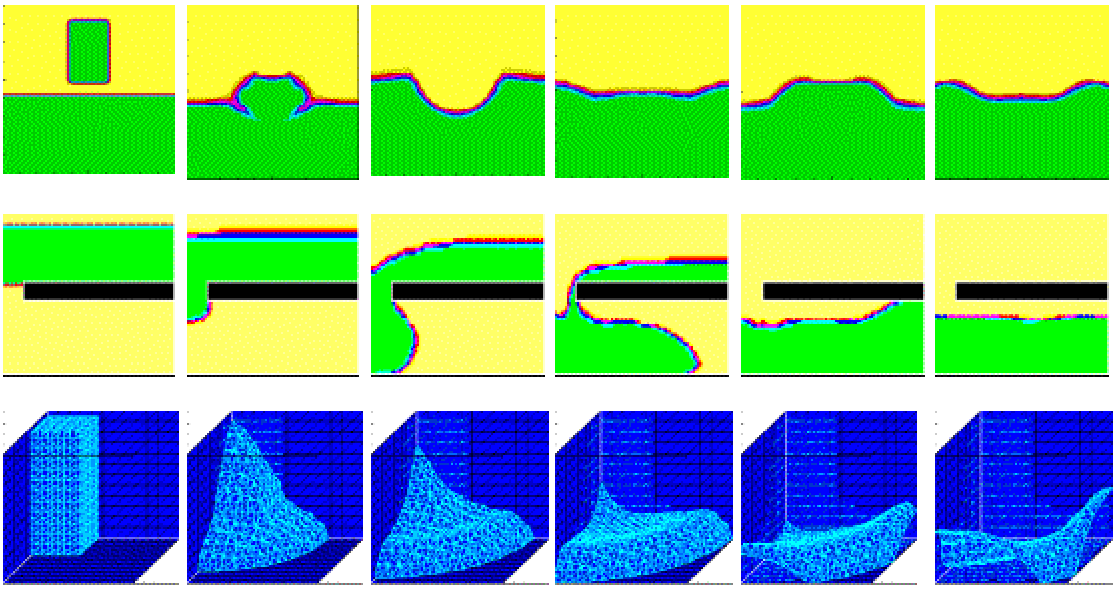




Thermal convection of an incompressible viscous fluid (Gr=1e7, Pr=1) in a cavity. The adapted grid and stream lines are shown for developed flow: steady state is absent in this case. (Calculated using code ASTRA).

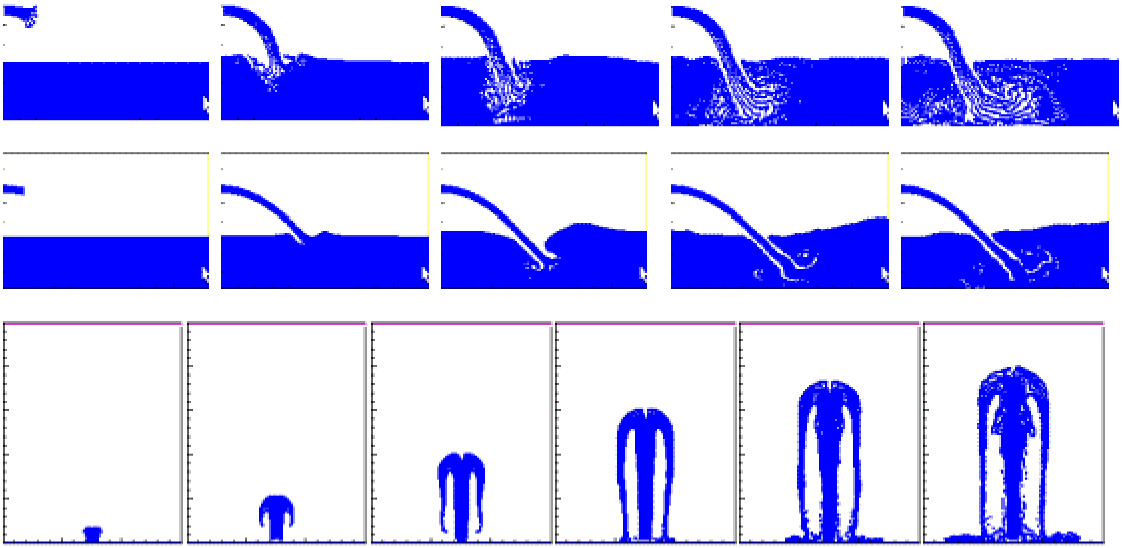
4. Continuous markers: complex motion

$$\partial C / \partial t + \mathbf{u} \cdot \nabla C = 0: \quad C = 0 \text{ - empty} \quad C = 1 \text{ - not empty}$$



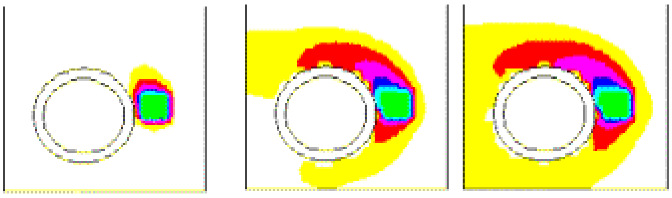
Various cases of water falls (Calculated using code ASTRA)

5. Discrete markers: very complex motion

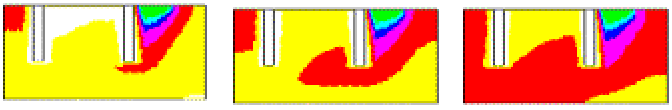


Various cases of free stream jets (Calculated using code ASTRA)

6. Complex 3D geometry without adaptation at all



Horizontal plane
(day surface)



Vertical plane

Filtration of a contaminant in a porous ground with an underground cylindrical fence
(Calculated using code ASTRA)

7. Outcomes

Outcomes are obvious:

a) Exercises show that no universal grid-based technique exists. Every one from techniques considered above has its advantages and, unfortunately, drawbacks.

Therefore:
b) the choice of optimal technique still depends on particular class of problems;

c) for proper description of a continuum motion a variety of different grid-based techniques should be developed and implemented in general application codes;

d) joint use of several suitable techniques looks perspective.

References, recent papers and demo results can be found
on web-page: *http://www.ipmnet.ru/~burago*