POLITECNICO DI MILANO

PhD in INGEGNERIA STRUTTURALE, SISMICA, GEOTECNICA / STRUCTURAL SEISMIC AND GEOTECHNICAL ENGINEERING - 39th cycle

THEMATIC Research Field: LONG-TERM MONITORING OF UNSTABLE SLOPES AND EARTH STRUCTURES WITH AUTOMATIC TIME-LAPSE MEASUREMENTS

Monthly net income of PhDscholarship (max 36 months)
€ 1195.5 In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	The monitoring of hydrogeological risk situations such as landslides and embankments with geoelectric measurements carried out automatically by systems installed on site permanently is a relatively young technique, still in the study and optimization phase. The aim of the proposed research is to address some open problems by proposing innovative, effective and robust solutions.
Methods and techniques that will be developed and used to carry out the research	The problems that will be addressed are: - Inversion techniques for time-lapse data It is necessary to analyze the convenience/necessity of inverting the data in time-lapse mode in relation with the complexity of the geological model of the site or of the monitored structure. For complex models, time-lapse inversion might be mandatory to prevent inversion artifacts. It is necessary to assess the level and type of complexity that requires time-lapse inversion.It is also necessary to investigate what may be the level of "memory" (weeks, months, semesters?) required by time-lapse inversion to produce its benefits without excessive raising of costs and calculation times. - Corrections for 3D effects When the monitored structure has a geometry that varies

	in the direction orthogonal to its axis (see dams and embankments), the measured data are affected by the 3D effects produced by the air or water masses nearby the sides of the structure. The data are acquired with a 2D spread, but they are intrinsically 3D. Unfortunately, the 3D inversion is unfeasible because it would be terribly ill-conditioned. We want to study and validate an iterative procedure that gradually converges to the correct solution by inserting into the loop a 2D inversion of data corrected by 3D effects on the basis of the resistivity model obtained at the previous iteration. - Models for resistivity-water content transformation The direct transformation from resistivity to water content requires that the geological model of the soil (layers, grain size, etc.) is first defined. Depending on the model, which can be more or less simple, it is possible to use empirical transformation curves after proper calibration. It is necessary to study the strategy for defining the geological model of the site (how many boreholes/cores, which geotechnical measurements) and the strategy for calibrating the empirical curves. - Strategies and threshold calibration for activating warning messages and alarms The data to be interpreted in terms of possible formation of dangerous phenomena (e.g., points of excessive and concentrated seepage) can be both the absolute values of resistivity / water content and the relative values of resistivity (i.e. the percentage changes observed over a certain period of time). Starting from these data, possibly integrated with rainfall and piezometric data, it is necessary to define strategies for the activation of attention and alarm thresholds. To this end, laboratory tests on small-scale structures, simulations with numerical models and analysis of historical data already available from selected case studies will be useful.
Educational objectives	The candidate will develop his/her research attitude and will increase the knowledge about the inversion of non linear problems, about the geoelectrical method, about the mitigation of hydrogeological risks. He will also improve

	his/her soft skills like reporting, scientific writing, oral presentations, team working, etc..
Job opportunities	Research institutions, universities, companies producing and/or commercializing equipment for environmental and/or geophysical measurements, geophysical service companies, public administrations and private or public organization managing hydrogeological risks.
Composition of the research group	1 Full Professors 1 Associated Professors 0 Assistant Professors 0 PhD Students
Name of the research directors	Luigi Zanzi

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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	597.75 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Universities, Companies, Agencies and/or National or International Institutions that are cooperating in the research: •Politecnico di Milano •LSI-Lastem S.r.l. Educational activities (purchase of study books and material, funding for participation to courses, summer schools, workshops and conferences): The Ph.D. course supports the educational activities of its Ph.D. students with an additional funding equal to 10% of the scholarship, starting

from the first year.

Teaching assistanship (availability of funding in recognition of support to teaching activities by the PhD student): Ph.D. students are encouraged to apply, upon prior authorization, to the calls to support teaching activities at the undegraduate and Master levels at Politecnico, being paid for that. The teaching assistantship will be limited up to about 80 hours, maximum half of them devoted to teaching and classroom activities and the rest to support classworks and exams.

Computer availability and desk availability: Each Ph.D. student has his/her own computer for individual use.Each Ph.D. student has his/her own desk, cabinet and locker.