Doctoral thesis (hereinafter referred to as "thesis"), title of the thesis: NEW TECHNOLOGIES FOR BIOMETRIC RECOGNITION BASED ON HAND CHARACTERISTICS

Name of the doctoral student (hereinafter referred to as "student"), name and surname:

MICHAL DVOŘÁK

Name and institution of the reviewer (full name of the reviewer, full name and country of the institution):

Gian Luca Marcialis, University of Cagliari, Italy

Please state your opinion on the following aspects of (I) the student's thesis and (II) the student's overall achievements, and (III) state your conclusion (a minimum of approx. 300 characters foreach <u>item</u> below is recommended):

I. Thesis

<u>Appropriateness and relevance</u>

Is the area addressed by the thesis appropriate to the particular scientific discipline of the thesis and does the thesis address relevant problems within the chosen area?

The thesis reports an extensive state of the art about technologies for capturing hand-based biometrics for personal recognition. It also reports the basic algorithms adopted to process the data and leading to obtain a "match" among two samples.

The topic is correctly treated and appropriate, and the main contribution is to propose some innovative technologies: in particular, 3d-based and on-the-fly scanning.

The thesis structure is basically the following:

- Introduction to hand-based biometrics, current scientific issues and state-of-the-art scanners
- Advanced scanners for hand-based biometrics: 3d, on-the-fly.
- Algorithms for hand-based personal recognition.

<u>A summary of the contributions of the thesis</u>

From your point of view, please summarize what the goal of the thesis is, what the main contributions of the thesis are, and whether the thesis has achieved the chosen goal.

Please indicate also specific contributions of the student.

The student explored the field of hand-based biometric scanning from the hardware perspective. The center of his work is based on proposing the following technologies:

(1) A line-based scanner, namely, a sensor with variable field of view, with images reconstructed by sweeping the sensor over the hand. This sensor is adopted in low cost laptops for fingerprint acquisition. The student extends the concept to the whole hand. The most interesting aspect is that the scanner is optical instead of solid-state, as the fingerprint scanners currently adopted. The student correctly states that this device «can facilitate scanning of a finger, a hand or a whole arm without having to sacrifi ce the image quality.» The system is detailed enough from the parameters viewpoint and the related hardware. The choice of using «off the shelf components, for computing and industrial components for the optical and mechanical subsystems, in order to ensure the repeatability and to eliminate the sources of error that may be present when using consumer electronics», is interesting. From the description, it is not clear how much time is required to scan the whole hand. It is not clear if the system is touchless or not.

(2) A scanner including 3d features. It is not clear which features are included.

(3) A touchless scanner, for on-the-fly recognition.

The limitation of what I found is on the lack of strict comparison with existing scanners. In some parts of the manuscript, I can find some references to existing scanners, but I cannot find a table or some other useful sections where the student's proposal clearly show to overcome the limits of the state-of-the-art. When a novel prototype is necessary, it is also necessary to explain why and which benefits are pointed out, and this is not clearly written in the thesis. A noticeable part of the thesis is the description of a commercial system to presented to a future international exhibition.

In the last part of the work, the software needed to drive the protypes developed was described. The thesis achieved a better level of significance if the systems' presentation would be coupled with an experimental analysis where, using existing hand-based recognition algorithms (for fingerprints, for example), provided images showed to be more effective and informative that that acquired with standard systems. However, the student reported a set of measurements which partly overcome this because the intrinsic features of the developed devices are pointed out.

Novelty and significance:

Please assess the level of novelty of the results and their significance for the given scientific area, for its further development, and if applicable for possible applications in practice.

Developed prototypes may be useful in many fields, beside the biometric field, also for biomedical applications. Maybe it is not perfectly clear to me, but, for example, infrared light could allow capturing images with the veins' flow, particularly relevant for personal recognition as well for biomedical investigations.

Review of a Doctoral Thesis at FIT BUT

Evaluation of the formal aspects of the thesis:

Please evaluate formal qualities of thesis and its language level.

The English language of the thesis is good.

Quality of publications

Has the core of the thesis been published at an appropriate level? Please judge the quantity and quality of the publications. When judging the quality, please take into account internationally recognized standards (WoS/Scopus quartiles, CORE ranks, specific knowledge of flagship publication channels of agiven community, etc.) in a way appropriate for the given area of the thesis.

The level of publications is averagely good, with two papers on a well-known scientific journal as IET Biometrics according to WoS and Scopus. The student also disseminated his work on several national and international conferences (Biodevices).

II. Student's overall achievements

Overall R&D activities evaluation:

Does the student's thesis, the results included into it, and possible other scientific achievements listed in the list of scientific activities indicate that he/she is a person with scientific erudition and creative abilities?

The student worked especially from the hardware viewpoint. During his work, he must be shown skills as a high level of autonomy and pro-active talent for finding a solution to the problems that arise during the design of the capture devices. I appreciated his efforts to make a step ahead by including 3d information for hand-based personal recognition. Therefore, in my opinion, I can answer positively to the question above.

Assessment of other characteristics (optional):

More characteristics of the student may be added here (e.g., awards, grant participation, international collaboration, etc.).

III. Conclusion

The conclusion should contain an explicit statement saying whether, in your opinion, the thesis and the student´s achievements until now meet the generally accepted requirements for the award of an academic degree (in accordance with Section 47 of Act No. 111/1998 Coll., on higher education institution).*

In my opinion, the thesis and the student´s achievements until now meet the generally accepted requirements for the award of an academic degree.

* Short overview of both the Act and corresponding internal BUT regulations is enclosed.

Cagliari 17.01.2023

Signature of the reviewer: