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Article

Multiplexed in-Series Macro-Bend Fiber Sensors for Personal Authentication Through Foot Recognition

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***Abstract*— This work proposes a new tactile sensing system for biometric authentication. The system operates based on the response of multiplexed optical fiber macro-bend sensors to plantar pressure. The setup contains a set of 6 in-series sensors installed in holes drilled in a foot-shaped slab of Polymethyl Methacrylate. Each sensor is a loop of standard single-mode telecommunication fiber with 2.5 mm radius, encapsulated with silicone elastomer. The instrumentation required for interrogation includes only a broadband visible light source and a ultraviolet-visible spectrometer. Personal authentication is based on recognizing the unique pattern of pressures applied by the person's foot in the metatarsal, outside of the foot arch, and heel areas monitored by the 6 sensors. The light spectrum transmitted by the set of multiplexed sensors in the spectral range from 400 nm to 800 nm carries information about the magnitude of the pressure applied on each sensor by the foot. The distribution of pressures exerted by different individuals alters the geometry of the macro-bends, resulting in spectral changes in transmitted light that allow personal authentication. Principal component analysis and support vector machine method are responsible for foot recognition. Data analysis returned hit rates greater than 85% for 6 different feet.**

***Index Terms*—** Biometric authentication, Multiplexed sensor, Optical fiber sensor, SVM

I. Introduction

Biometrics have attracted the attention of institutions and governments as a reliable method for personal authentication. Systems based on biometry designed for positive person identification can operate by comparing the individual captured biometric characteristic with that previously recorded and stored in a database or by searching the database for a match with recorded information of a set of individuals [1]. Setups based on capturing physiological and behavioral characteristics are safer than those based on traditional methods such as passwords, PINs, and cards, reducing the risk of fraud and justifying their use for human identification [2]. Whereas behavioral characteristics can change and not provide a unique recognition, physiological characteristics are considered constant over time [2]. Therefore, physiological characteristics such as those related to the shape of the human face, fingerprint, palmprint [3]–[5], and foot characteristics [1], [2], [6], among others, are promising candidates for a reliable human identification [2].

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