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Smart Wearable Gadget for Industrial Safety

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Abstract—

To build a smart device which assist factory workers and other employees, IoT hardware and protocols are described in this paper. It is a wearable Glove device which is used in different workspaces where power tools are being constantly used. This apparatus is made around a microprocessor acting as a central sever, while other sensor are interfaced with microcontrollers, and it act as a link for data transformation and perform different topics. A microcontroller's works as the master and it controls the others microcontrollers attached to different sensors. In this master there is a LCD screen and few buttons, and control the other sensors and read the data in real time. There are safety features in this glove thus workers cannot use any dangerous power tools without wearing proper equipment. This glove works as a security measure in such a way that each tool will have restricted access according to the level of expertise of the worker. This glove is able to restrict the access to the tools, which are being used actively during a particular time frame. The central server and different other sensors such a heat sensor, temperature sensor and vibration sensor log the entire data which can be attached and monitored by the master glove. Whenever the user gets hurt and shouts in pain, the analysis function classify the pain and call the medical help because this system has an extra capability of analysing tone of workers. A sweep based camera module is used along the central server to record and live stream the captured video when power tool is switched on. This system focuses the importance of a worker's safety in factory floor.

Keywords— **Internet of Things, Industry 4.0, MQTT, Node, Wireless Communications, Factory.**

Introduction

With the start of industrial revolution, power tools became very important part of the factory floor. Every day, millions of people go to work and operate potentially life threatening machines. According to publicly available statistics, more than a hundred thousand people are injured in power tool related accidents every year. This results in a huge loss of precious work-force and other resources. The idea of Connected Machines is an appealing one and it can be applied to the large as well as small scale machinery to improve the efficiency and thus, the productivity in factories. It is believed that both the aforementioned ideas can go hand in hand and that we can create a solution that would help with the safety in factories and improve efficiency that would be provided by the Internet-of-Thing. In that system different sensors like temperature sensor, ambient, accelerometer can be used to capturing the data.

Related Work

Multiple hardware solutions exit to protect and increase the level of safety in any power tool or machinery. A set of safety and hazard rules are placed in workspace to limit such issues. But the current technology only aims at securing the machines and devices, but does not factor in on human errors which is one of the major issues in this case. The tools are not access locked and any user, irrespective of skill set, can use them. If proper protective measures are not taken seriously, they can lead to serious issue [1].

Proposed Work

The proposed solution is an IoT based system that implements a wearable that connects to any type of machinery and permits access based on whether proper safety equipment has been warn. We will use sensor on these equipment and send this data to a Arduino. On the Arduino, we will check if the machine, for which access is begin requested for, is free to be used and if all the proper gear is begin used by person requesting access and based on this information, the Ardunio will control a relay that will power the machine[1].

System Architecture

Data Glove is further divided into the two parts:
1. Transmitter
2. Receiver

Transmitter

This is most important section in Smart glove. This sensor simply deliver the data content from the main server system to the device and from device to system. Transmission throughout the system is performed by this device. Smart gloves use various devices to perform this operation. Temperature sensor measure -55^0 C to 150^0C. For light detection purpose LDR sensor are used. Using 3-Axis Accelometer gesture values are represented in the form of X,Y

and Z coordinates. Arduido Nano converts binary values into digital values using ADC converter, these values are processed and sent to receiver side via nRF24Lo1 transceiver. nRF24L01 performs operations of transferring and receiving in combine.

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Receiver

For all operations Aurdino UNO is important unit. Using nRF24L01 value is fetched from the Glove and transferred to ARDUINO IDE.

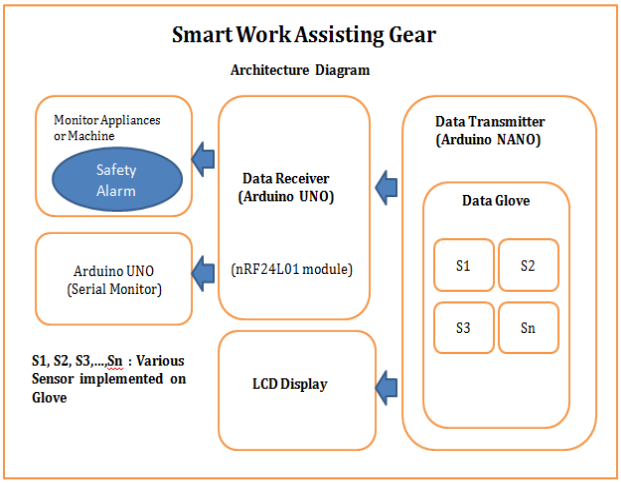

Figure 1. : Architecture diagram

Hardware

1. Arduino Nano: Based on Atmega328/168.Power supply to arduino is given through Mini-B USB connection, 5V regulated external power supply is given. Arduino Nano has 32kb and Digital Pins are 14.

2. Arduino UNO: It has 14 digital I/O PINS, USB connection, power port and ICSP header. It supports plug and play via USB port.Sensor values are transferred using Arduino Nano to Arduino IDE.

3. Temperature Sensor: It is basically used for measuring temperature fluctuations among temperature values around the sensor. LM35 is preferred sensor. It measures temperature ranging from -55 to +150 degree in Celsius.

4. LDR Sensor (Light Dependent Register): LDR works as: This is light dependent sensor. When light falls on LDR then the resistance decreases and thus conductivity increases.

5. 3-Axis Accelerometer (ADXL335): It is a low power, sensor. It measures accelerations of range ±3g. It detects the vibrations of Machinery. It measures the static and dynamic acceleration.

6. nRF24L01: It is low power transceiver that operates on frequency of 2.4 Ghz. It is mainly used for wireless communication. It is a preferred Transceiver.

Software

Arduiono IDE : It is used for embedded application development which executes on Windows , Linux, Mac etc. and supports embedded C, C++.

Equations

Voltage divider circuit

To convert resistance variation to voltage variation.

The input voltage, Vdc is divided between R1 and R2 based on their resistance values. The resistance R1 is selected such that it is comparable to R2 value.The resistance in force sensitive part is in the order of 10 W. Therefore to limit the current, a 100 W series resistance was chosen as R1. The voltage across the sensor, denoted by V2 is given by

$$V2 = (V dc * R2) / (R1 + R2) \quad (1)$$

LM 35 Temp Sensor Calculation

How to calculate analog to digital value – Formula

Use the following ratio:

$$e/V_{max} = d/2^{n} - 1$$

where

- V_{max} maximum voltage that the analog signal can assume
- **n** number of bits available for the digital encoding, Here n = 10
- **d** present digital encoding
- **e** present analog voltage from the sensor

Conclusion

This system is IoT based .Wearable glove is ready with different sensors as temperature, LDR and 3-AXIS Accelerometer, Arduino IDE, Arduino Nano, Arduino Uno. In this system 5V Battery is used. In small scale industry, smart glove that connect to any type of machinery and provides access to it based on whether Proper safety of that machine is ensured.

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