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Research and Integrate the Body Thermal Measuring, Washing Hand Automatically without Touching, and Giving Free Face Mask for Epidemic Prevention

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Abstract *— Facing the complicated developments of the Covid-19 pandemic in Vietnam in particular and around the world in general, a group including members of the Faculty of Electrical Engineering proposed researching ideas: designing a 3-in-in1 automatic contactless body thermometer, hand washing, and free mask ATM, simultaneously performs three functions of body temperature measurement, spraying hand sanitizer and distributing face masks completely automatically, without any intervention or impact. The device equipment includes: sensors, microcontroller board ... integrated on the system will automatically perform the measurement of body temperature at the forehead and display the results on LEDs, notify alerts via the speaker, automatic spray hand sanitizer. This device is currently being used for students of the Faculty of Electricity, UNETI before entering the workshop with very high accuracy, ensuring that the precautions can be implemented in schools, hospitals, apartment buildings.*

Keywords *— Contactless body thermometer, Contactless hand sanitizer, Face mask ATM.*

I. INTRODUCTION

The COVID-19 epidemic is going complicated in our country and around the world. With information about the mechanism of disease transmission, We found that in crowded places such as hospitals, clinics, schools, health care centers, beauty ... regular jobs contact with customers, patients, students, students ... becomes a high risk of infection if there are no protection and prevention measures. Currently, there are many units supplying to the market products such as: automatic antiseptic hand sanitizer, hand-held electronic thermometer, ATM emitting automatic masks ...

But these solutions only stop at one or combines two functions in one. [6], [7], [8]. When using these single-function products, We are still necessary to arrange personnel to carry out manual sterilization and temperature measurement procedures, which will be difficult for the units if they have to be maintained for a long time. In addition, hand-operated temperature measuring devices and hand washing is still necessary, operated by human which is also a potential risk leading to the spread of disease in the community.

Some research groups also used PIC Microcontroller or 8051 microcontroller IC ..., to measure and display the temperature. In addition, they have to design the onboard loader, or buy the devices that support charging and amplification. Translation as 8051 charging circuit, PIC charging circuit ... [5]. Based on the purpose of the research, We used Arduino Nano to manufacture thermometer automatic, contactless automatic hand wash and ATM 3 in 1 free mask currently being used for students of the Faculty of Electrical Engineering, University of Economic and Technology Industry, to hand sanitizer, hand mask and health check before entering the class. Because the Arduino nano board is a complete set of 5V power supply, a burner, an oscillator, a microcontroller, serial communication, LED, and jacks, when using, no need to think about programming connections or any other interface, just plug it into the computer's USB port to be able to connect.

Fig. 1 The Body Thermal Measuring, Washing Hand Automatically Without Touching, And Giving Free Face Mask For Epidemic Prevention

II. DEVICE CONFIGURATION

With requirements given for thermometers, contactless automatic hand wash, and ATM 3 in 1 free mask are:

The temperature sensor will measure the human body temperature, then display the temperature measurement on the 7-bar LED and have a health notification; if the temperature is higher than 38ºC, you will receive a request to get medical attention immediately

Fig. 2 Temperature measurement function

After measuring the temperature, the machine will ask people to wash their hands with a sanitizing solution provided by the machine without contact through a proximity sensor.

Fig. 3 Automatic hand washing function

If people do not have a mask, they will be notified to receive a mask free of charge from the box placed on the camera body.

Fig. 4 Chức năng phát khẩu trang tự động

With such technology, we used a number of devices, specifically:

A. Arduino Nano Board

Arduino Nano is a full, compact, user-friendly microcontroller board. Arduino Nano weighs about 7g with a size from 1.8cm - 4.5cm. [1]

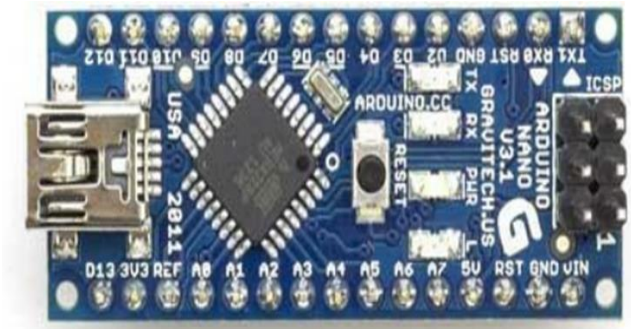

Fig. 5 Arduino Nano Board

a) Arduino Nano Technical specifications

Table 1. Arduino Nano technical specifications

Arduino Nano	Tech Specs
Analog I/O Pins	8
Architecture	AVR
Frequency	16 MHz
DC Current per I/O pins	40mA
Digital I/O Pins	22
EEPROM	1 KB
Flash Memory	32 KB of which 2 KB used by Bootloader
Input Voltage	(7-12) Volts
Microcontroller	ATmega328P
Operating Voltage	5V

PCB size	18 x 45 mm
Power Consumption	19mA
PWM Output	6
SRAM	2KB
Weight	7 gms

b) Arduino Nano pin diagram , decriptions

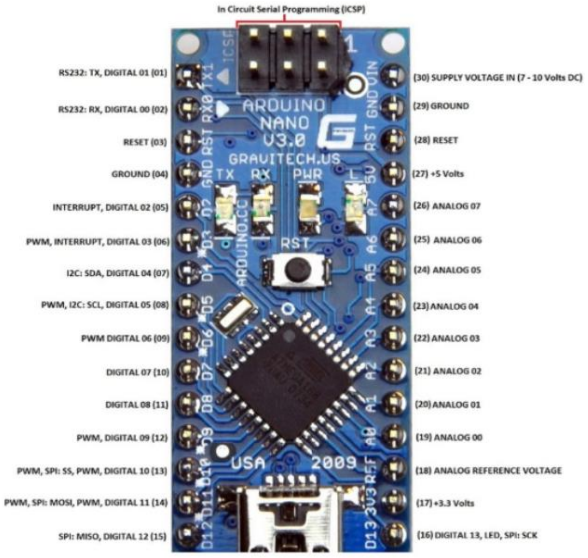

Fig. 6 Arduino Nano Pin description

Table 2. Pin description

Number	Pin name	Description	Alternative Functions
1	D1 / TX	I/O	Digital I/O TX: Data transmission
2	D0 / RX	I/O	Digital I/O RX: Data receiving
3	RST	RESET	Reset (Active Low)
4	GND	Source	Ground pins
5	D2	I/O	Digital I/O
6	D3	I/O	Digital I/O
7	D4	I/O	Digital I/O
8	D5	I/O	Digital I/O
9	D6	I/O	Digital I/O
10	D7	I/O	Digital I/O
11	D8	I/O	Digital I/O
12	D9	I/O	Digital I/O
13	D10	I/O	Digital I/O
14	D11	I/O	Digital I/O
15	D12	I/O	Digital I/O
16	D13	I/O	Digital I/O
17	3V3	Input	3.3V supply generated (by FTDI)
18	AREF	Input	Provide reference
			voltage for input voltage
19	A0	Input	Measure analog voltage in the rage of 0-5V
20	A1	Input	Measure analog voltage in the rage of 0-5V
21	A2	Input	Measure analog voltage in the rage of 0-5V
22	A3	Input	Measure analog voltage in the rage of 0-5V
23	A4	Input	Measure analog voltage in the rage of 0-5V
24	A5	Input	Measure analog voltage in the rage of 0-5V
25	A6	Input	Measure analog voltage in the rage of 0-5V
26	A7	Input	Measure analog voltage in the rage of 0-5V
27	+5V	I/O	Regulated power supply used to power microcontroller and other components
28	RESET	Reset (Active Low)	Reset the microcontroller
29	GND	Source	Ground pins
30	VIN	Source	Input voltage to Arduino when using an external power

Arduino Nano has 14 digital I / O, pins: 1, 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 and 16. Pins working with maximum voltage is 5V. Each pin can provide or receive 40mA of current and have a pull-up resistance of about 20-50kΩ. The pins can be used as input or output, using the pinMode, digitalWrite, and digitalRead functions)

- **Serial pins** RX and TX: Rx and Tx pins are used to receive and transmit TTL serial data. They are connected with the corresponding Atmega 328P USB to TTL serial chip.
- **PWM pins** 6, 8, 9, 12, 13: These pins provide an 8-bit PWM output by using analogWrite() function..
- **External Interrupt Pins** 5, 6: These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- **SPI Pins** 13, 14, 15, and 16: These pins are used for SPI communication.
- **In-built LED Pin** 16: This pin is connected with a built-in LED; when pin 13 is HIGH – the LED is on, and when pin

13 is LOW, it's off.

- **Input/Output pins** 18, 19, 20, 21, 22, 23, 24, 25 và 26: The Arduino Nano has 8 analog inputs (19 to 26), marked A0 through A7. This means that up to 8 analog input channels can be connected for processing. Each of these analog pins has an ADC with a resolution of 1024 bits (hence it would give the value 1024). By default, the pins are measured from the ground to 5V. If you want the reference voltage to be 0V to 3.3V, you can connect a 3.3V source to the AREF pin (18th pin) by using the analogReference function. Such as digital pins in Nano, the analog pins also have a number of other functions.)
- **I2C** (23, 24): Used for IIC communication using Wire library.
- **AREF** (18): Provide reference voltage for input voltage
- **RESET** (28): Reset the microcontroller

We choose to use the Arduino Nano Board because this controller is widely known from high school students to students and employees. Arduino Nano is connected to the computer via Mini - B USB port and uses CH340 to convert USB to UART instead of using ATmega16U2 chip to emulate COM port like on Arduino Uno or Arduino Mega, so the price of the product is reduced while maintaining functionality, helping the Arduino to communicate with the computer, thereby making the programming easy.

B. Temperature sensor

Currently, there are many sensors used to measure temperature, such as a thermocouple (Thermocouple), thermistor (RTD-resistance temperature detector), thermistor [4] ... However, these types of sensors have the principle of doing the direct contact with the measuring environment. The purpose of manufacturing automatic thermometers is to reduce operators and limit exposure to avoid cross-contamination of diseases. For this reason, the choice of the Melexis MLX90614 non-contact infrared thermometer is the MXL90614 chip-based non-contact infrared temperature sensor using an I2C interface that can be easily connected to any microcontroller. What is a suitable solution?

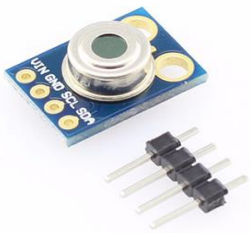

Fig. 7 MLX90614 contactless infrared thermal sensor's picture

MLX90614 temperature sensor features 17-bit ADC reader and a powerful DSP contributing to high precision, calibrated at wide temperatures: -40 to 85 ° C within sensor temperature and -70 to 380 ° C the temperature of the object. The MLX90614 sensor provides two outputs: PWM and SMBus (TWI, I2C). The 10-bit PWM offers 0.14 ° C resolution, and the TWI interface has a 0.02 ° C resolution. MLX90614 contactless infrared thermal sensor uses 5VDC power, high precision, sleep mode to reduce power consumption.

C. Proximity sensor

Fig. 8 Proximity sensor's picture

With the problem that when the user places his hand in the guide position, the machine will automatically pump an amount of antiseptic solution, so that there is no need to contact. For that problem, the team chose proximity sensor E3F-DS10C4- 10CM NPN 6-36V.

Proximity sensor E3F-DS10C4-10CM NPN 's works voltage is 6-36VDC, rated current 300mA and object detection distance from 3 -10cm. Sensor works at temperature -40 ° C - 70 ° C. The convenient sensor consists of 3 output wires, in which the brown wire is connected to + VDC 6 -36V, the blue wire is connected to the GND, and the black wire is the control signal wire (NPN signal is normally open). Object sensing distance is adjusted by means of a fine-tuned resistor behind the sensor.

D. Pump motor

Due to the low frequency of use, We choose the MB385 6-12V pump motor.

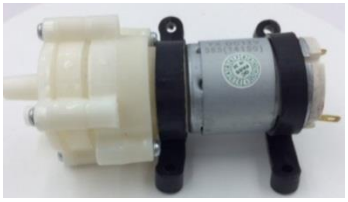

Fig. 9 MB385 pump's picture

MB385 6-12V pump motor has a capacity of 5-12W, voltage 6-12VDC, current consumption 0.6-2A, working at -30 - 80 ° C. The pump motor has a size of 90x40x35mm with a pump flow of 1-2l / min, the suction head is <= 2m from the water, and a high water repulsion <= 3m.

E. ATM mask machine's motor

With the request that when people need to "withdraw" the mask for free, When they press the button on the left-hand side, the mask box is immediately pulled out and closed automatically. The research team uses the geared motor DS-400, which is automatically reverse rotation by the limit switch.

Fig. 10 Geared motor DS-400's picture

Geared motor DS-400 with the capacity of 80-100W, operating voltage 6VDC - 24VDC, deceleration rate: 1/4. Motor's weight is 475g, motor's size 57x38mm 130x28, shaft diameter 8mm. It has the advantage of being compact; the DS-400 motor is a suitable choice for the thermometer model, automatic antiseptic hand wash, and ATM 3 in 1 free mask.

III. CONTROL PROGRAM AND RESULTS

The program control algorithm is described in Figure 10. Based on the principle that any object with a temperature above -273oC emits electron radiation. When the person puts his forehead near the sensor position, the MLX90614 contactless infrared thermal sensor will measure the energy level and convert it into an electrical signal transmitted to the Arduino Nano signal processing circuit; it will calculate the temperature and display the results on the 7-bar LED screen while simultaneously reading the measured temperature. If the subject's temperature is less than 37.5^{o}C, the message "normal body temperature" will appear, and if the temperature of the object is 37.5oC or more, there will be a warning "high temperature, please get medical examination immediately." After that, the machine will ask people to wash their hands with a disinfectant solution without contact through proximity sensor E3F-DS10C. When you put your hand in a position near the machine (with instructions), the sensor will detect the signal and send it to the Arduino Nano to close the electronic circuit. When the circuit is closed, an instruction will be sent to the Delay circuit to create a delay (timer circuit); this Delay circuit will power the pressure pump MB385 to operate. The pressure pump will suck solution from the reservoir and spray the solution nozzle through the tio pipe (it usually runs for 2 seconds to allow enough solution to spray as recommended by the Ministry of Health, that avoid wasting when spraying heavily or little spray, not enough solution required). If peoples do not have a mask, they just need to press the button on the machine; the mask box will automatically push out to the recipient with the prompt "each person should only get one for yourself." And after 8 seconds, the mask holder will automatically pull back. [1], [2], [3]

A. Control program

```
#include <TimerOne.h>
#include <Adafruit_MLX90614.h>
#include <Arduino.h>
#include <JQ6500_Serial.h>
#define PROX_INPUT        12
#define SHIFT_CLK         A1
#define MOTOR_IN2         11
#define SW_IN             3
#define BT_STATE_OPEN     1
#define TIMER_INTERVAL    5000        // 5 ms
BLINK_INTERVAL
#define SOUND_HELLO_OFFSET        12
#define SOUND_TEMP_NORMAL_OFFSET  18
#define WARNING_TEMP      37.5
void Mp3Init();
void TempInit();
.....................
/**
 * 7seg pin mapping
 * A -> 4
 * B -> 6
int shift_num[11] = {
  0x82, // 0
  0xBE, // 1
};
int shift_en[4] = {
  0x01,
  0x04,
...
};
int sound_len[20] = {
  0,     // Invalid
  350,   // muoi
  300,   // mot
  300,   // hai
  4300,  // xin chao
  1428,  // than nhiet
};
void TempRead(int num)
{
    for (int i = 0; i < 3; i++) {
    int digit = 255;
    switch (i) {
      case 0:
        }
void MotorInit()
{
  pinMode(MOTOR_IN1, OUTPUT);
  pinMode(MOTOR_IN2, OUTPUT);
     case 1:
       digit = (num / 10) % 10;
       if (digit == 0) {
         digit = 255;
       }
```

```
      else if (digit == 1) {
        digit = 16;
      }
      break;
    case 2:
      digit = num % 10;
      if (digit == 0) {
        digit = 10;
      }
  analogWrite(MOTOR_IN1, 0);
  analogWrite(MOTOR_IN2, 0);
  pinMode(SW_BT,  INPUT);
}
  else {
    is_blink = 0;
  }
                if (digitalRead(SW_IN)) {
      drawer_state = -1;
      analogWrite(MOTOR_IN1, 0);
      analogWrite(MOTOR_IN2, 100);
  if (((drawer_state == 1) && !digitalRead(SW_OUT)) ||
((drawer_state == -1) && !digitalRead(SW_IN))) {
    analogWrite(MOTOR_IN1, 0);
    analogWrite(MOTOR_IN2, 0);
    drawer_state = 0;
```

B. Results

Fig. 11 Realistic images when using the machine

We have compared the results of the features when using the 3 in 1 machine with some common temperature measuring devices such as a mercury thermometer, electronic thermometer, antibacterial hand sanitizer, method regular mask distribution, and comparison results in tables 3, 4 and 5

Table 3. Table comparing temperature measurement methods

Mercury thermometer	Electronic thermometer	Thermometer, hand wash, and automatic 3 in 1 mask generator
		
It gives the most accurate results, but taking a long time, still, need to be exposed, leading to the risk of infection	It gives a quick results, but it has to support from medical staff; it is also without built-in antiseptic and masks dispensing functions	It returns results quickly and integrates with other functions. However, the result has a small error depending on the distance to the sensor. The advantages do not need an operator and avoiding contact.

Table 4. Table comparing antibacterial hand washing methods

Containers for antiseptic solutions in schools, offices, and commercial centers	Thermometer, hand wash, and automatic 3 in 1 mask generator
	
Everyone has to contact with the solution it makes a source of infection. Furthermore, it does not have an exact amount of solution for disinfecting each hand wash, Which makes the user either not spraying the required amount of solution, or spraying too much is wasteful.	The hand sanitizer automatically's sensor will detects when the hand is placed under the tap, and the pump automatically pumps out an amount of hand sanitizer according to the present time, just enough disinfectant solution for the times used.

Table 5. Table comparing distribution masking methods

Distribute masks directly	ATM masks	Thermometer, hand wash, and automatic 3 in 1 mask generator
		
Needs direct support from medical staff and does not integrate antiseptic and body temperature functions	There are no built-in antiseptic and body temperature measurement functions	To ensure the safety of epidemic prevention and control such as: people who come to receive masks are washed with their hands to kill bacteria and have their temperature measured.

IV. CONCLUSION

The authors used the Arduino Nano Board combining temperature sensors, proximity sensors, and liquid pump motors to make thermometers, wash hands automatic contactless, and hand out free masks 3 Print 1. This product can be applied in schools, hospitals, apartment buildings .... The device is easy to use, completely automatic, does not require contact, so it is convenient to measure body temperature, wash hands with antiseptic as well as reduce the risk of cross-contamination. When powered, the machine has 24 hours of continuous operation. After being put into use for students of the Faculty of Electrical Engineering, University of Economic and Technical Industry. This machine only costs about 1 liter of antiseptic solution for about 150 people. , this number has been greatly reduced compared to before using manual sprays. Body temperature measurement only requires a minimum distance of 2cm between the forehead and the sensor, the measurement accuracy at room temperature is ±0.2 ° C depending on the distance between the person and the sensor, the shortest time between 2 measurement is 2.5 seconds, it can be reduced to 0.5 seconds. In addition, the non-contact automatic antiseptic body thermometer, hand wash, and ATM free mask are limited when used outdoors due to the fabrication of electronic components; the accuracy and longevity of the equipment will not be high in the climatic conditions of our country.

Products of lecturers and students of Faculty of Electrical Engineering, University of Economics and Technology Industry has low cost compared to equipment outside the market (the cost of purchasing equipment is about 2.5 million VND), but it still guaranteed full of all necessary features for disease prevention. This device is being cloned and put to use to perform temperature measurements, wash hands and disinfect for students, officers, employees, and visitors to work, transactions, medical examination, also. As installed for units in need. Not only the meaning that is it automatic, without the need for the operator to avoid contact and cause infection, but also the machine also ensures operation accuracy. This is one of the effective solutions to improve morale and sense of responsibility for disease prevention in current conditions.

ACKNOWLEDGMENT

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