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Student Body Temperature and Physical Distance Management Device in the Classroom using 3D Stereoscopic Distance Measurement

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ABSTRACT: The escalation of the COVID-19 (coronavirus) has caused an economic crisis in most countries in the world. Significantly this pandemic situation damaged the education sector very severely. Students lost their valuable learning time in schools. If the government reopens the institutions, this virus's impact will be more unless the students will follow the physical distancing and mask-wearing. We designed an Internet of Things (IoT) and an Artificial intelligence-based paradigm that uses object detection based on convolution neural networks (CNN) to detect the COVID symptoms and people by measuring temperature and maintaining the physical distance between students the Classroom. In previous algorithms, researchers used the Opencv algorithm to measure the distance between two persons. Due to overlapping in images captured by the camera, the efficiency of this algorithm is significantly less. In this algorithm, we used a stereoscopic distance measurement algorithm to overcome this problem. Our system will be useful to maintain physical distance between people, and it gives the best efficiency compared to previous algorithms.

I. INTRODUCTION

Stereoscopic Vision:

Imagining and extricating spatial data from advanced pictures, taken from two vantage focuses, alluded to as sound system vision. Looking at the public places of items in the casings empowers 3D data extricating just as in the organic cycle. The typical instance of sound system vision organizes two cameras evenly inside a base separation, pointing in a similar course. This course of action brings about two alternate points of view[1]. A human may think about the half-photos of the stereogram in a stereoscopic gadget. A PC applies calculations to consequently coordinate relating focuses and store the profundity data in a divergence map. First, the working chain begins from the camera adjustment, trailed by picture refinement, and stereoscopic picture correction. The stereoscopic window ought to be balanced for the helpful review. A difference guide might be changed over into a point cloud, spoken to by 3D facilitates with a known scale or utilized to introduce spatial scenes in a single picture by mouse development or screen pivot on cell phones. The stereoscopic window ought to be balanced for a helpful survey. A uniqueness guide might be changed over into a point cloud, spoken to by 3D facilitates with a known scale or utilized to introduce spatial scenes in a single picture by mouse development or screen revolution on cell phones.

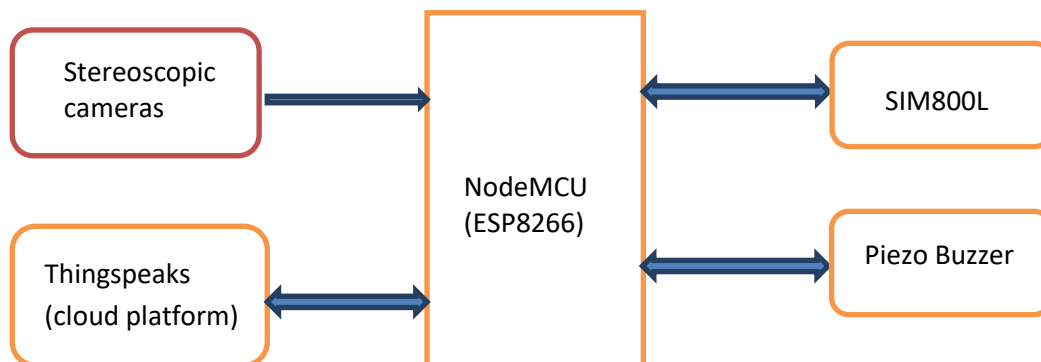


Figure 1: Block diagram of the device

II. EXPERIMENTAL SETUP

NodeMCU(ESP8266)

NodeMCU is an open-source Lua based firmware and advancement board, as shown in figure 2. exceptionally focused on IoT based Applications. It incorporates firmware that sudden spikes in demand for the ESP8266 Wi-Fi SoC from Espressif Systems, and equipment which depends on the ESP-12 module. The NodeMCU ESP8266 improvement board accompanies the ESP-12E module containing an ESP8266 chip having Tensilica Xtensa 32-cycle LX106 RISC microchip[2]. This chip underpins RTOS and works at 80MHz to 160 MHz movable clock recurrence. NodeMCU has 128 KB RAM and 4MB of Flash memory to store information and projects. Its high preparing power with in-assembled Wi-Fi/Bluetooth and Deep Sleep Operating highlights. It is shown in figure 2.

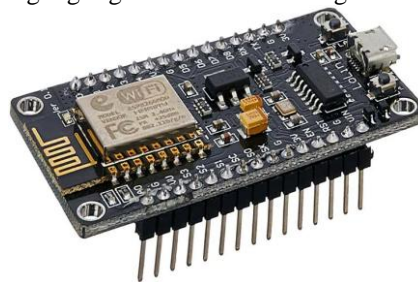


Figure 2: NodeMCU –ESP8266

Thermal infrared cameras utilizing a matrix of pixels do have comparative mathematical operations like viewpoint photographs shown in figure 3. So a geo-reference of the determined object (student) temperatures is conceivable by methods for orthophotos. An adequate mathematical operation on the thermal image requires the knowledge of the image geometry, which is not available by the factory. The stereoscopic camera in figure 3 will take the images from different angles to identify the exact distance between two students. This stereoscopic camera is having thermal imaging capability[3]. It will detect the temperature of the object, which is in a specific region. The significant advantage of this camera is, it will differentiate overlapped objects in a single image. Then only, any system can measure the distance between two objects, with minimal error.



Figure 3: Stereoscopic camera (5MP OV5647)

At the core of the module is a SIM800L GSM cell chip from SimCom, as shown in figure 4. The chip's working voltage is from 3.4V to 4.4V, which makes it an ideal contender for the direct LiPo battery gracefully. This settles on it a decent decision for installing into ventures without a ton of room. All the critical information pins of the SIM800L GSM chip are broken out to a 0.1" pitch headers. This incorporates pins required for correspondence with a microcontroller over UART[4]. The module upholds the baud rate from 1200bps to 115200bps with Auto-Baud recognition. The module needs an outside receiving wire to associate with an organization. The module accompanies a Helical Antenna typically and binds straightforwardly to the NET pin on PCB. The board additionally has a U.FL connector office if you need to get the receiving wire far from the board.

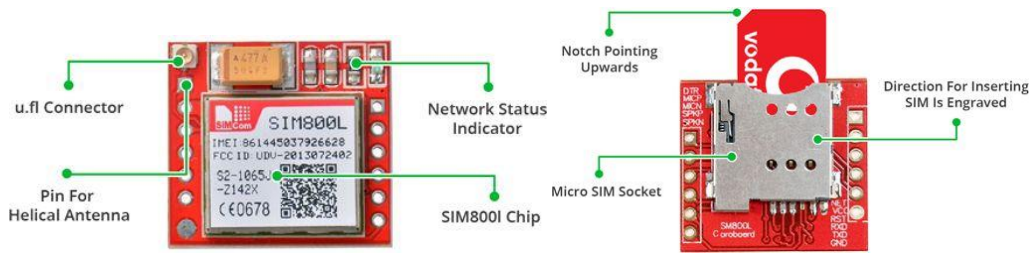


Figure 4. GSM module used in this device (a)front side (b) backside

III. WORKFLOW OF DEVICE

Computer vision is a multidisciplinary field that has useful for object classification in real-time applications. In recent years we use convolution neural networks CNN in self-driving cars that have taken center stage. Another integral part of computer vision is to measure the distance between objects[5]. The difference between object detection algorithms and classification algorithms is that we try to draw a bounding box around the object (student) of interest to locate it within the image in detection algorithms. In the proposed system, we used stereoscopic cameras with thermal image capability. The system identifies all the students as object detection. It will measure the temperature using thermal scanned images, an inbuilt function of the stereoscopic camera. Based on the infrared characteristics, the temperature will be measured with different color variations in the images[6]. The images shown in the figure differentiate high-temperature students from others, as shown in figure 5(a&b). The flow diagram of the device is shown in figure 6.



Figure 5: (a) Image captured in the Classroom by the device (b) thermal image.

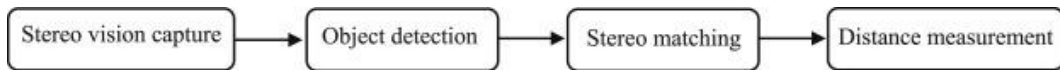


Figure 6: The flow diagram of the proposed method.

When the student entered the Classroom, he will be detected by the camera in the device. In this camera, using the thermal imaging principle, it will detect the temperature of the student. If he has a higher temperature, the device gives buzzer and sends the information to a higher authority like the principal. This device is attached to the top of the blackboard, capturing the images and videos of the Classroom's complete area, including students. Once the system identifies the student, it will lock the geometric position of that student. The 3D models of the proposed device are as shown in figure 7.



Figure 7:3D model of the proposed device

Our device always checks the distance between two students continuously. We gave here 4 feet of threshold distance. If any two students are closer, i.e., less than 4 feet limits, the buzzer will be activated and sends information to the principal through the GSM module. (SIM800). We have many algorithms like the Euclidean distance measuring method, Manhattan Distance measurement algorithm, and Cosine Index algorithms to measure the distance between two objects. However, due to low efficiency in overlapping objects in images, we propose a new algorithm for distance measurement, i.e., the stereoscopic distance measurement method explained in the next section.

IV. STEREOSCOPIC DISTANCE MEASUREMENT

As shown in figure 8, the stereoscopic camera model and the deep learning method are combined to obtain the three-dimensional coordinates (X_L, Y_L, Z_L) of the target in the left camera coordinate system. Then the distance between the obstacle object and the binocular camera device is calculated. Therefore, the formula (10) of the position coordinate of the right camera optical center $(X_R, Y_R, Z_R, 1)^T$ in the coordinate system can be obtained according to the formula given below.

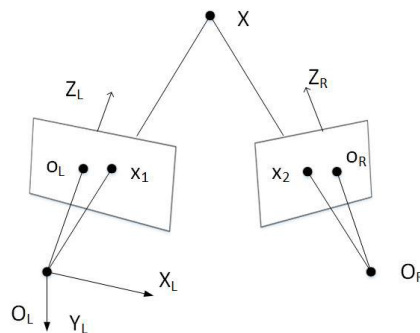


Figure8: 3-dimensional reconstruction model

From the known three coordinates, from Cosine's Theorem, the angle between the left camera and the obstacle line v_1 , the left camera and the right camera line of the line v_2 can be calculated, and the distance between the target and the binocular camera is obtained. The distance D between the target obstacle and the vehicle is as shown in formula[7].

$$\begin{bmatrix} X_R \\ Y_R \\ Z_R \\ 1 \end{bmatrix} = \begin{bmatrix} R_{3 \times 3} & t_{3 \times 1} \\ 0 & 1 \end{bmatrix} \begin{bmatrix} X_L \\ Y_L \\ Z_L \\ 1 \end{bmatrix}$$

From the known three coordinates, from Cosine's Theorem, the angle between the left camera and the obstacle line v_1 , the left camera and the right camera line of the line v_2 can be calculated, and the distance between the target and the binocular camera is obtained. The distance D between the target obstacle and the vehicle is as shown in the formula.

$$\cos \theta = \frac{v_1 v_2}{\|v_1\| \|v_2\|}$$

$$D = \sin \theta \cdot v_1$$

Sample code to compute the stereoscopic distance between every two points in an image



```

%% stereoscopic distance measurement

from scipy.spatial import distance
def compute_distance(midpoints,num):
    dist = np.zeros((num,num))
    for i in range(num):
        for j in range(i+1,num):
            if i!=j:
                dst = distance.stereoscopic(midpoints[i],
                midpoints[j])
                dist[i][j]=dst
    return dist
    
```

V. RESULTS AND ANALYSIS

We compared our results with previous algorithms like the Euclidean distance measuring method, Manhattan Distance measurement algorithm, and Cosine Index algorithms. We consider a classroom with ten students. Some of them are overlapped in the image. In other distance measurement algorithms, we got a significant distance between overlapped objects is 0.01m to 0.02m. When we use our proposed algorithm, we got the distance is 0.5m, where the actual distance is 0.8m. We repeatedly conduct this experiment for various distances between objects, both overlapped and non-overlapped images. Observations are given in table 1.

Table 1: actual distance between students and algorithm-based distance measurement

S.No	Euclidean	Manhattan	Cosine Index	The proposed method using stereoscopic	Real distance
1	2.2m	2.1m	2.2m	2.25	2.8m
2	1.5m	1.2m	1.3m	1.5m	1.7m
3	3.1m	3.1m	3.7m	3.6m	3.8m
4	1.8m	1.8m	1.6m	1.8m	1.6m

VI. CONCLUSION AND FUTURE SCOPE

If this system is installed in every Classroom, there is no need to get tense about spreading COVID in schools. We can save the students from this pandemic. Maintaining the physical distance between students may be a difficult task for teachers. One mistake also leads students' lives into the threat. Using this device, physical distance management can be easy for school management and manual managing. Our algorithm will be used correctly to avoid the error in distance measurement in overlapped objects in images. In our research's continuity, we are adding mask identification using convolution neural networks in this device. It will be more useful in the future.

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