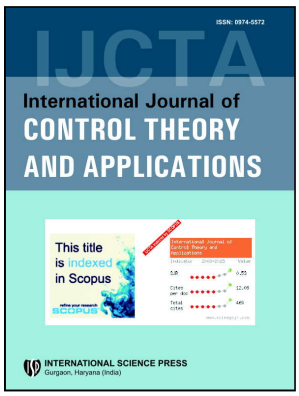

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Sensor Based Smart Hunger Management System Fused with KNN Search Algorithm for Selecting the Smart Food Containers

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Abstract: In this paper the authors are proposing a smart sensor-based architecture for serving food to the needy. Eatable fresh excess food that is going to be wasted or fresh food someone wants to serve to the hungry can keep in a smart sensor-based food container and press a push button installed on it. The request in terms of e-mail will go to an intelligent food collector system which will choose 10 nearest senders based on KNN search algorithm for. The whole process is modeled in two steps. In senders side we are using sensors, Arduiono UNO and SMTP protocol for sending email. And in the receiver side, the results obtained by KNN search are graphically shown using Matlab. The request sent and received ratio is 1, i.e. 100% success ratio in sending and getting email request. The architecture is designed for static senders and moving receiver(s).

Keywords: Smart Food Container, Arduino UNO, KNN Search, Alcohol Sensor (MQ3), Temperature & Humidity Sensor (DHT11), Ultrasonic ranging sensor (HC-SR04), Being Hum@an, Intelligent Food Collector. IoT, Smart Hunger Management System

1. INTRODUCTION

Report shows that the death rate caused due to hunger is 1 person per every 3.6 seconds among whom 75% are children [1]. One third of the world's hungry is living in India [2]. Again As civilized social being, we believe that we can apply science and technology for the welfare of mankind. While working with the betterment of the smart bin concept for smart city [3], [4] we observed that lots of people are collecting food from dustbin. Apart from reports available in our hand, we merely can observe the wastage of food daily at hotels, restaurant or even our home. This fact compelled the first author to think about the application of science and technology for saving the wastage of food and serving the extra food to the needy. Thus for the very first time the concept of an IoT based smart food container came under the project proposal idea 'Being Hum@n' during MHRD supported GIAN course on "IoT sensors, devices and data analytics" at NIT Agartala. In this present work we proposed an

Arduino based smart system for collecting the access food and take them to the hungry people. This architecture could be implemented anywhere on the globe. For experiment purpose, we choose the low cost devices. For better understanding of the whole scenario, we can take help of figure 1.

We are proposing a model for collecting extra fresh cooked or uncooked food from door to door to serve them to the hungry people. Sender is a sensor node which will be installed in the food container. When the owner of the food container wants to donate food, he or she will simply press a button and an e-mail will be sent to the food collecting van. Now, as more than one owner may be there, so we are going to select the sender nodes with the help of decision making through KNN search.

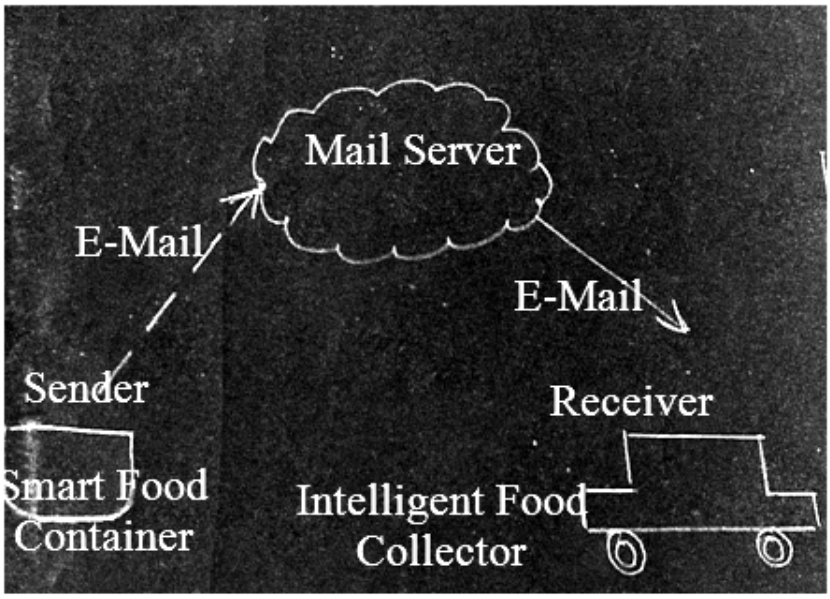


Figure 1: Smart Hunger Management System

The proposed work is trying to answer the following RQs:

1. Does the Receiver get the Sender request i.e. E-mail at proper time?
2. Do the sensor-data collected at Sender's end (viz., alcoholic strength, temperature, humidity, distance) have any future scope for research?
3. In case of multiple active Senders' how is the food collector is going to choose its' target?

The present work is mainly having two parts: the first one is to propose a working model for smart hunger management system and the second one is to select an optimal algorithm for decision making.

The rest of the paper is organized as follows. System Design and Used Optimal Algorithm(s) are discussed in sectionII. Experimental results are presented in section III. Concluding remarks are given in section IV.

2. SYSTEM DESIGN AND ALGORITHM(S)

2.1. System Design

Now, to analyse the model of the sender node, we will take the help of figure 2.

Each Arduino processor (Arduino UNO) connected at the each sender node is collecting temperature and humidity data through DHT11 (sensor 1), alcoholic strength of the food through MQ3 (sensor2) and the gap

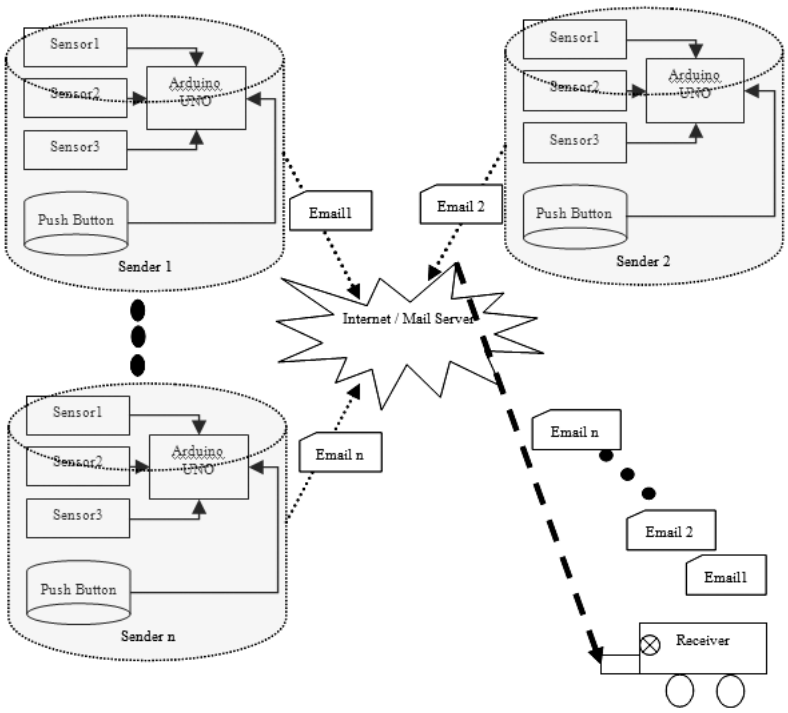


Figure 2: System Diagram of the Smart Hunger Management Model

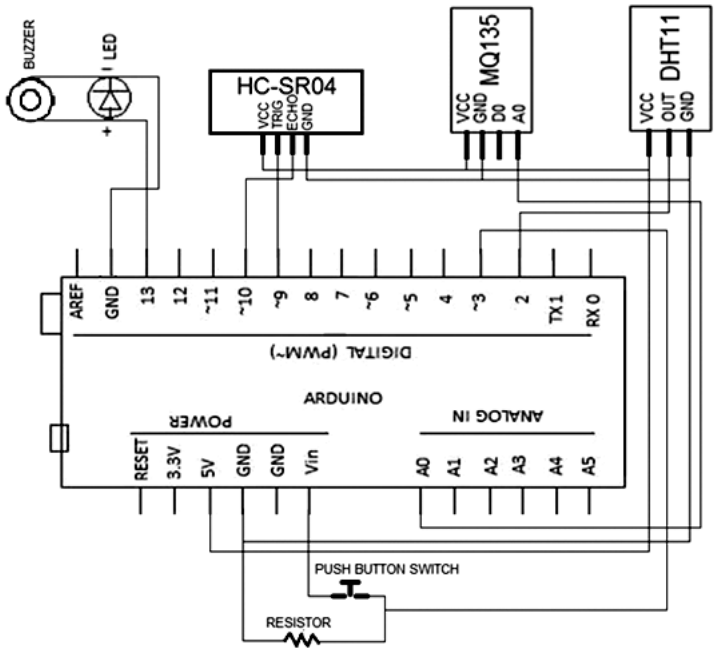


Figure 3: Detailed Architecture as well as Circuit Diagram of Each Sender Node

between the lid of the food container and the top of the food inside it through HC-SR04 (sensor 3) sensor. Once the owner of the food container feels that the food could be served, she would press a push button connected with the Arduino board. Then one email will be sent to the mail server containing the sensor data. Mail server will forward this email to the receiver end. Individual detailed system architecture comprising of the circuit diagram at each sender node is shown in figure 3. We are not using any sensor for collecting the location

information of the sender nodes as for our scenario, sender nodes are static. The location information will be kept in a database. So, the email itself will provide us the identity of the sender. For the current scenario, we are assuming that within four hours of pressing the push button, a smart food collector will collect food. In this paper we are not showing any justification for it.

2.2. Algorithm for the Proposed Model shown in Figure 3

Algorithmic Steps:

1. Calculate sensor data
2. Press the PUSH BUTTON at sender end.
3. Send sensor data to mail server
4. Get email at receiver end.

The Arduino board mounted at the lid of the food container will continuously collecting sensor data at a specific time interval. Once the push button is pressed, the final sensor values will be sent to mail server.

2.3. KNN Search Based Algorithm for Decision Making by the Receiver

Architecture of the proposed system shows that although the sensor embedded sender nodes are all static, but the receiver node may be moving or static at certain point of time. We are proposing the following algorithm for decision making for selecting sender node.

Algorithmic Steps

1. Begin
2. Plot the senders' locations (i.e. senders_location) in X-Y plane.
3. Plot the Location of the Receiver (i.e. receivers_location)
4. If no. of Senders_Node > 10

   4.1 [n,d]= knnsearch(senders_location, receivers_location,'k',10);

   4.2 Print senders_location(n,:)
5. ELSE

   Print mean(d)
6. Stop.

We are applying here KNN Searching methodology for selecting first 10 nearest neighbours. If at a time there are less than 10 activated senders, the smart Collector will the nearest neighbours through mean value calculation method. The Euclidian Distance is calculated as below:

$$d_{st}^2 = (x_s - y_t)(x_s - y_t)' \quad (1)$$

As the sender nodes are static with respect to the receiver, and the locations are already known, so the receiver is going to take its decision for choosing the senders by KNN algorithm. This portion is done using Matlab. The program will graphically show the receiver its active sender_nodes' locations as well as the nearest 10 neighbours in X-Y plane. We can also use this algorithm for more than one receivers.

In proposed work, we are giving priority to the quantity of food. For future scope, we are collecting the information of the gap between the container-lid and the food. We are assuming that all the food containers are of same size. So, sensor data indicating less distance will implicate fewer gaps between food and the closed container lid as shown in figure 4.

Each Arduino processor (Arduino UNO) connected at each sender node is collecting temperature and humidity data through DHT11, alcoholic strength of the food through MQ3 and these data along with the HC-SR04 data will be kept in a database for future experiments.

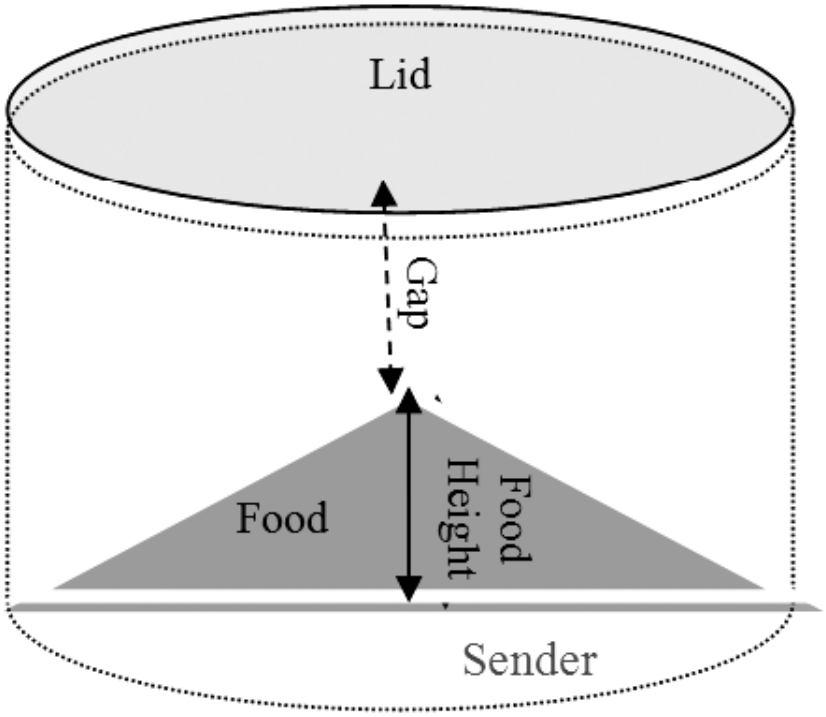


Figure 4: Quantity of Food measured with respect to height

3. EXPERIMENT AND RESULT

To test our research question (RQ)-1, we come up with the following experimental setup shown in figure 5 and the corresponding result in Table 1. We used python programming and Simple Mail Transfer Protocol (SMTP) [5]. We used 500 no. of samples and success rate of receiving the food request without fail was 100%.

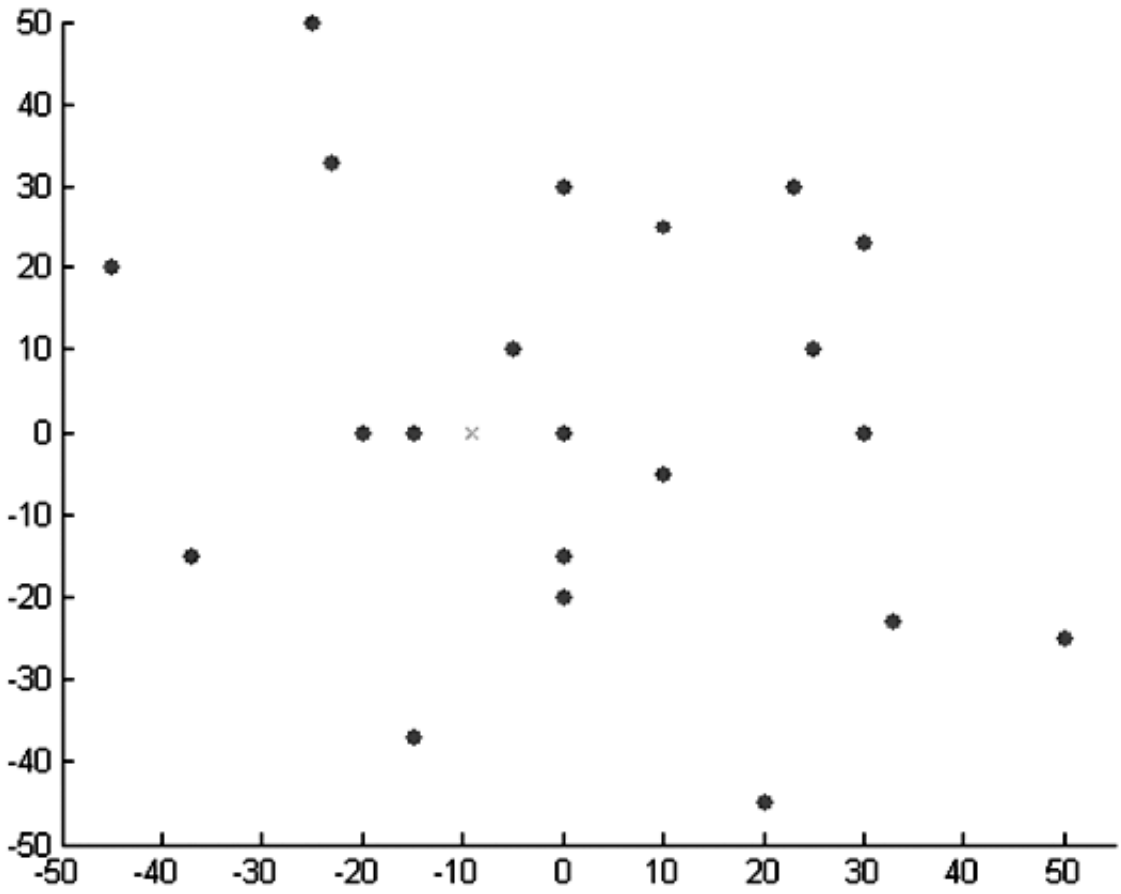
Table 1
Experiment Result for RQ 1

	Sent Mail	*Received Mail*	*E-mail Missed*
	500	500	Nil
Success Rate for RQ1		100%	

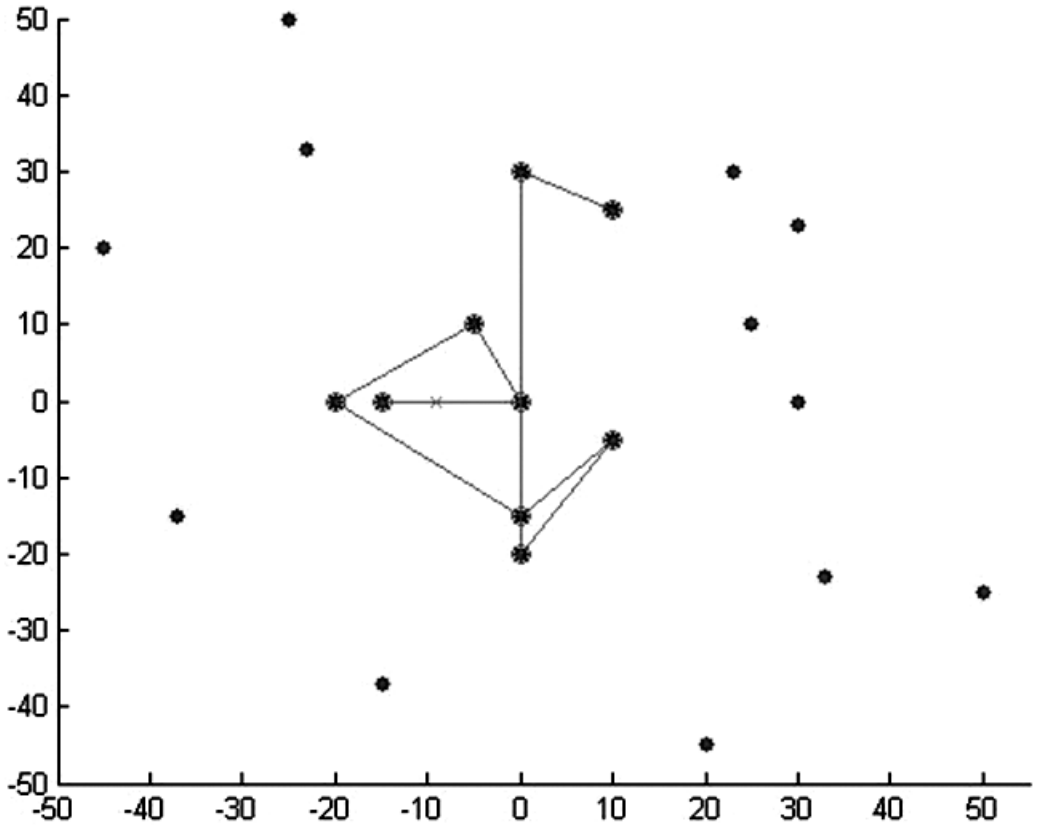
We are making a corpus for collecting the alcoholic strength of various food so that in future our system at receiver end automatically predict the freshness of food, whether it is good or not and thus answers RQ 2.

To test our research question (RQ)-1, we come up with the following experimental setup shown in figure 5 and the corresponding result in Table 1. We used python programming and Simple Mail Transfer Protocol (SMTP) [5]. We used 500 no. of samples and success rate of receiving the food request without fail was 100%.

Figure 5: Actual Experimental Setup for comparing Time and sent and received Data through SMTP. N.B.- Sender as well as Receiver credentials are hidden for privacy reason.



(a)



(b)

Figure 6: (a) Graphical representation of total no. of active senders(denoted by O) and reciever (denoted by X) at a perticular moment (b) Graphical View after generating KNN Search algorithm for finding 10 nearest active senders of the receiver at that moment.

Table 2
Sample Experiment Result obtained in KNN Search

Sender's Location	*X-axis*	*Y-axis*	*Sender's Location*	*X-axis*	*Y-axis*	*Sender's Location*	*X-axis*	*Y-axis*
Sender1	10	-5	Sender9	30	0	Sender17	-45	20
Sender2	10	25	Sender10	30	23	Sender18	-15	0
Sender3	50	-25	Sender11	-20	0	Sender19	0	0
Sender4	-23	33	Sender12	-5	10	Sender20	0	30
Sender5	-15	-37	Sender13	25	10	Sender21	23	30
Sender6	20	-45	Sender14	-25	50	Sender22	0	-20
Sender7	0	-15	Sender15	33	-23			
Sender8	0	0	Sender16	-37	-15			

	X-axis	*Y-axis*
Receiver's Location	-9	0

Nearest 10 Neighbors	*X-axis*	*Y-axis*	*Nearest 10 Neighbors*	*X-axis*	*Y-axis*	*Nearest 10 Neighbors*	*X-axis*	*Y-axis*
Sender18	-15	0	Sender12	-5	10	Sender1	10	-5
Sender8	0	0	Sender11	-20	0	Sender22	0	-20
Sender19	0	0	Sender7	0	-15	Sender20	0	30
						Sender2	10	25

By the term 'Active Sender' in RQ 3, the authors mean to say the senders which have sent request to the receiver and till now the receiver has not collected food from them. In figure 6, we are going to show sample results obtained while working with more than 10 active senders and 1 receiver with the help of KNN searching methodology. Corresponding results are shown in table 2.

The main limitation of our work is that, if people want to cheat people with bad quality of food, they can. But as the aim of the work is good and most of the people are good by nature, we are trusting on them.

4. CONCLUSION

In this recent era of Internet of Things (IoT), sensors and decision making algorithms, deep learning algorithms are used in designing several state of the art applications. In this paper, the authors came up with a low cost solution for a burning social issue. The decision making by KNN is however useful for preparing the weak learners. The proposed model is working 100% by sending, receiving email and the graphical results are helping the receiver to take decision for selecting nearest neighbor. In future step of the project, we are going to work with wi-fi shield and openIoT platform. We are also going to combine deep learning for decision making. And the sensor data that we are collecting now, could be used for future research on quality of food analysis. The main goal is, however, to serve our society, and use technology for mankind.

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