Assignment-2

The Mystery of the Missing Super Robot
لغز الرجل الآلي المفقود

تمهيد:

قرب انتهاء الحرب العالمية الثانية، كان المهندسون اليابانيون قد عكفوا على تطوير رجل آلي ضمن برنامج بحثي سري للغاية. كان الهدف هو حماية الإمبراطورية اليابانية و جعل الحرب لصالحها. بعد حوالي 27 محاولة، تمكن المهندسون من صنع رجلا آليا يمكن التحكم به عن بعد. ولكن في تلك الآونة كانت الحرب قد انتهت، فوظف الرجل الآلي للاستخدام المدني تحت سيطرة حسام الذي يبلغ من العمر 12 عام. حسام هو ابن دكتور ومخترع كبير، وهو الدكتور فريد الذي اخترع وصمم النموذج الأولي للرجل الآلي قبل أن يتوفى في ظروف غامضة. وقد تولى الدكتور كمال صديق الدكتور فريد رعاية الولد اليتيم حسام حتى أصبح قادرا على متابعة المشروع معه. خلال احدى المهمات المدنية، فقد الرجل الآلي و اختفى من على شاشة الرادار المزود بها جهاز الحاسوب المتحكم بالرجل الآلي و الخاص بحسام. لدى حسام خطة علمية لحل لغز الرجل الآلي المفقود و تحديد مكانه. لكنه بحاجة الى مساعدة في كتابة برنامج الحاسوب. فهل من معين؟

Part-A:

Dr Kamal and Husam were operating the Super Robot in a civilian mission, when it was suddenly lost and disappeared from the radar's screen on Husam's computer. Husam now wants to find the location of the Super Robot. He mentioned the following plan to Dr Kamal:

We have three **known** locations which have wireless computers and can connect to the Super Robot: Husam's location, Dr Kamal's location and the LAB's location. Denote these location by $\mathbf{x_i} = (x_i , y_i)$, (i = 1, 2 and 3). Denote the **unknown** Super-Robot location by $\mathbf{x} = (x, y)$. The distances between the three given locations and the Super Robot location are also **known** and are denoted by ($\mathbf{r_i}$, i = 1, 2 and 3).

The reason these distances are known is due to a feature in wireless devices, which is the received signal strength indicator (RSSI). The RSSI can be used to measure the distance between two communicating nodes. RSSI values in our network are in the range of 0 . . . 256. Dr Kamal and Husam conducted a series of experiments on the Super Robot in the past to derive the relationship between RSSI and distance and found it to be:

$$r = 10^{(C - RSSI)/(10N)}$$

where,

r: distance in meters.
C: factory-calibrated, read-only constant that indicates the expected RSSI at a distance of one meter.
N: constant depends on the environmental factor. Range 2-4, low to high strength.

RSSI: obtained RSSI value from the wireless device.

Thus, in two dimensional space, knowing the received RSSI from the Super Robot means that it will approximately be on a the circumference of a circle with radius "**r**" and centered on the current location of the receiving computer. To determine the exact location of the Super Robot we need to find the **intersection point** of at least **three** circles as shown in Figure-1.

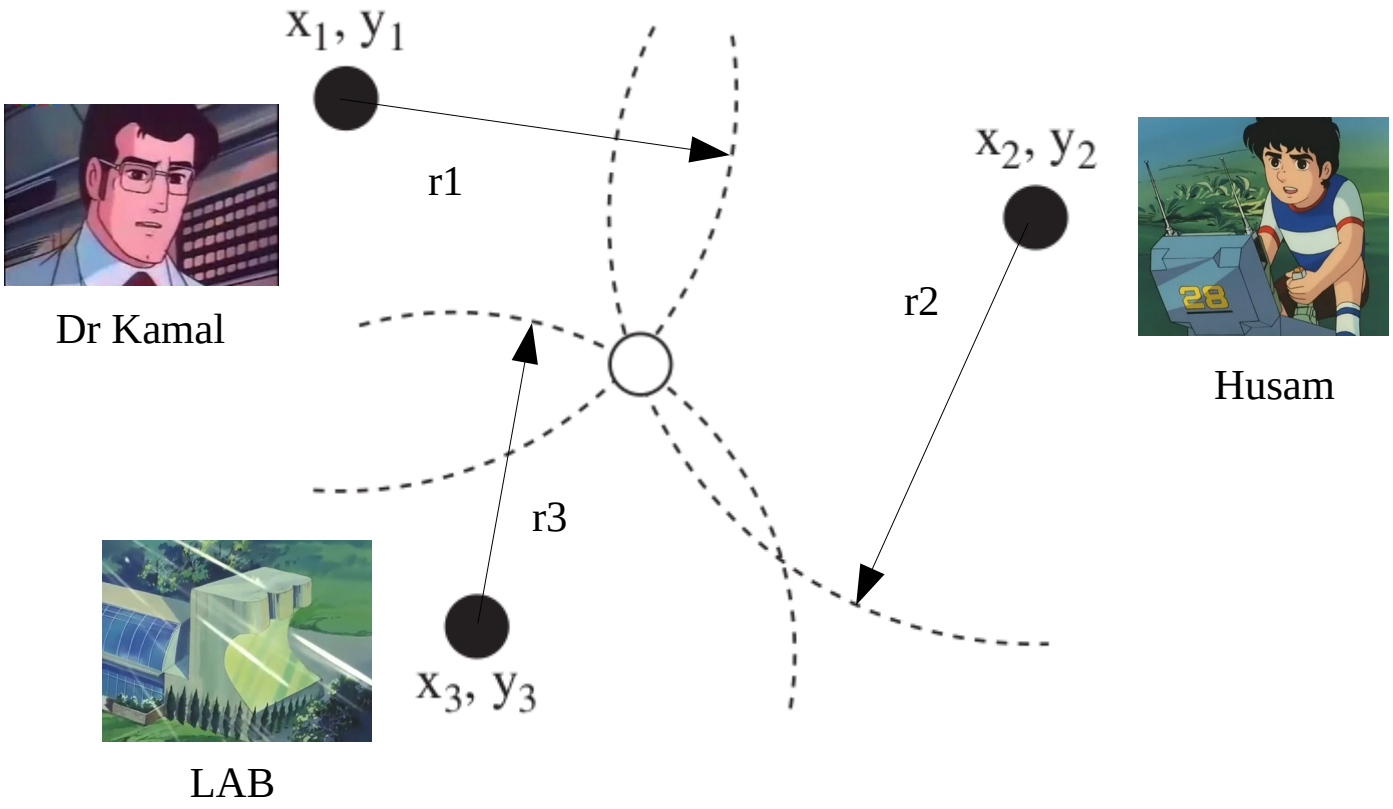

Figure-1: The Super Robot is represented by the small white circle in the middle.

Referring to Figure-2, Dr Kamal will send a packet to the Super Robot, the payload (data part) of this packet contains the command STOP. This will command the Super Robot to stop movement and halt position. The Super Robot will reply by a packet, the payload of this packet contains the message OK. Upon receiving the reply packet, Dr Kamal's computer will report the received RSSI and calculate r1.

You are required to help Dr Kamal by writing **two** Java programs, one to run on Dr Kamal's computer and the other to run on the Super Robot.

Program-1 (on Dr Kamal's computer):

a) use the UDP protocol.
b) ask the Super Robot for its IP address.
c) send a packet with payload STOP to the Super Robot.

d) receive the reply packet with payload OK on Dr Kamal's computer.
e) assume r1, x1 and y1 are now known. Send this information in one packet to Husam's computer.

Program-2 (on Super Robot):

f) use the UDP protocol.
g) receive a packet with payload STOP.
h) reply by a packet with payload OK.

The staff at the LAB will run Program-1 on their computer instead of Dr Kamal's computer to determine r3, x3 and y3. So, Husam after running Program-1 on his computer, instead of Dr Kamal's computer can also determine r2, x2 and y2. Now, Husam has all the information he needed to calculate the position of the Super Robot. Particularly, Husam now nows: r1, r2, r3, x1, x2, x3, y1, y2 and y3.

You are required to help Husam by writing another **two** Java programs, one to compute the position of the super robot and send that information to both Dr Kamal's computer and LAB's computer. The second program will run on Dr Kamal's computer and the LAB's computer and will receive the information that Husam's computer sends.

Program-3 (on Husam's computer):

i) solve the location equations and determine the position of the Super Robot, that is, find **x,** where, **x**=(x,y).
j) use the UDP protocol to send this information to both: Dr Kamal's computer and the LAB's computer.

Program-4 (on Dr Kamal's computer and LAB's computer):

k) receive the information sent by Program-3 and print it on the computer console.

Part-B:

The RSSI measurements were not accurate, as a result, the three circles shown in Figure-1 did not actually intersect. Suggest a solution that Husam can use and modify his Java program so he can approximate the location of the Super Robot. Show the changes to Husam's program.

Work in groups of **two** to solve both **Part-A** and **Part-B** of this assignment.

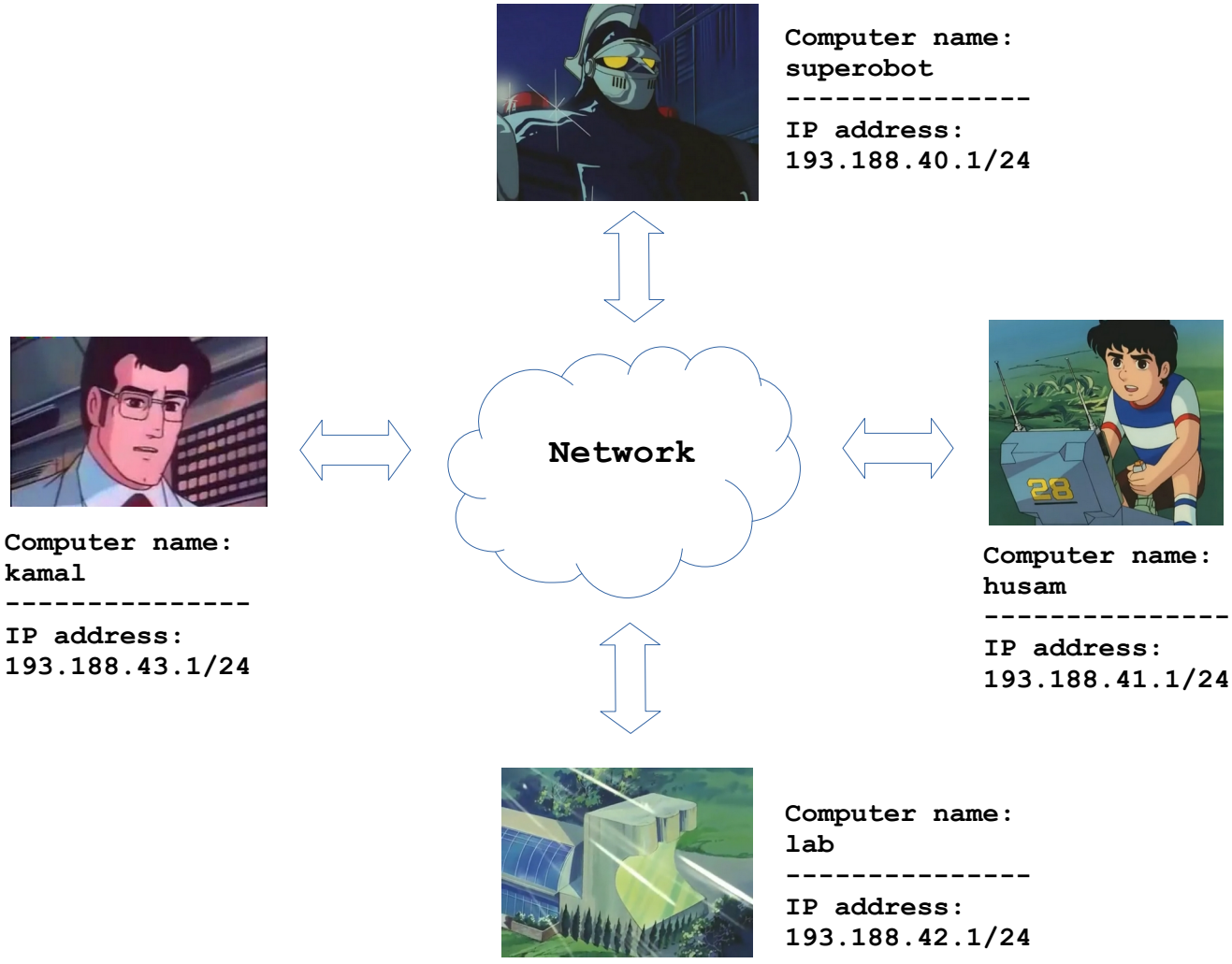

Figure-2: General computer-network setup.

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